Northstowe

Phase 1 Planning Application

Energy Statement
(incorporating Renewable Energy Statement)

February 2012

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Northstowe

Energy Statement (incorporating Renewable Energy Statement)

Energy Statement in support of the Planning Application for the Proposed Phase 1 of the Mixed Use Development at Northstowe by Gallagher.

This report has been undertaken by Donald Sinclair of Richard Hodkinson Consultancy.

Schedule of Issue

Version	Date	Reason for Issue	Issued By	Approved By
v.1	25.08.2011	Scoping Document	Donald Sinclair	
v.2	06.09.2011	Outline Document	Donald Sinclair	
v.3	25.10.2011	Draft – Work in Progress	Donald Sinclair	
v.4	16.11.2011	Updated Draft	Donald Sinclair	
v.5	15.12.2011	Final Draft	Donald Sinclair	Richard Hodkinson
v.6	01.02.2012	Incorporate Comments	Donald Sinclair	Richard Hodkinson
v.7	10.02.2012	Submission	Donald Sinclair	Client

Executive Summary

Key Development Priorities

i. Northstowe is to be an exemplar sustainable New Town. The key development priorities, agreed by the Joint Promoters, Gallagher and the Homes and Communities Agency are: -

- Exceed the sustainability standards for energy efficiency, reduction in CO_2 emissions and the inclusion of low carbon and renewable energy technologies set out in the adopted Local Development Plan Documents through following an energy hierarchy of energy efficiency and then low carbon / renewable energy technologies. The Joint Promoters, Gallagher and the Homes and Communities Agency, fully support these policy targets.
- Exceed planning policy requirements with a proportion (currently expected to be 65%) of the Phase 1 development being built to the Government's 'Zero Carbon Home' standard.
- Minimise the environmental impact and mitigate the effects of climate change
- Be adapted to climate change by creating dwellings that will be energy efficient, useable and comfortable to live in now and for the future, offering maximum value and affordability for residents
- Development of high quality private and affordable homes with associated employment, retail, commercial, educational and recreational facilities
- Creation of an environmentally, socially and economically viable sustainable community, within which residents are directly engaged
- A flexible approach in responding to emerging exemplar performance standards in each phase over the development period as these come forward

ii. The energy strategy proposals detailed in this Energy Statement are designed to meet the key development priorities and planning policy requirements as outlined above. Energy efficiency measures and low carbon / renewable energy generation will create low / Zero Carbon Homes which meet the environmental objectives and make a visible statement about the high levels of sustainability that Northstowe will achieve. In using less energy, these dwellings will be socially, economically and environmentally sustainable with affordable energy bills. The flexibility of the design proposals enables these high standards to be achieved throughout this phased project in a viable manner. In designing to specifically minimise summer overheating, the dwellings will be adapted for climate change.

iii. An innovative and coherent approach is needed, and proposed, to meet all of these key development priorities. This will create a New Town in marked contrast in terms of layout, building design and lifestyle to previous large scale developments within Cambridgeshire and the UK.

iv. The table below summarises the project requirements and the proposals for Northstowe that address these requirements.

Summary Table: Planning Policy Compliance		
Policy Requirement		**Northstowe Proposals**
Policy Target	Energy Efficiency: **10%** Reduction in regulated CO_2 emissions over **Building Regulations (2006)**	**31%** reduction in regulated CO_2 emissions over **Building Regulations (2006)**
	Low Carbon / Renewable Energy Generation: **10%** after energy efficiency	**11%-15%** achieved on a dwelling scale
Policy Aspiration	Low Carbon / Renewable Energy Generation: **20%** after energy efficiency	In addition to the above, a viability study is to be undertaken for the provision of medium scale wind turbine(s), which increases renewable energy generation **above 20%** for Phase 1
Building Regulations Requirements	Building Regulations (2016): 'Zero Carbon Home'	Zero Carbon Hub Fabric Energy Efficiency and Carbon Compliance standards to be met, with Allowable Solutions for the remainder

Sustainable Energy Standards

v. Energy Efficiency: The Northstowe proposals prioritise energy efficiency over low carbon or renewable energy generation. It is intended to meet the Zero Carbon Hub (ZCH) Fabric Energy Efficiency (FEE) Standards for Zero Carbon Homes. These standards are designed to "*realise our* [the Government's] *ambition of the highest practical energy efficiency level realisable in all dwelling types*"[1]. As such, they represent the exemplar standard in the energy efficiency of dwellings.

vi. Policy NE/1 of the South Cambridgeshire District Council Local Development Framework Development Control Policies requires a 10% reduction in CO_2 emissions through energy efficiency over Building Regulations (2006).

vii. By meeting the Zero Carbon Hub Fabric Energy Efficiency standards, this planning requirement will be substantially exceeded. The energy modelling that has been undertaken for this project

[1] Ministerial Statement by Rt Hon John Healey, Quoted in Zero Carbon Hub: Defining a Fabric Energy Efficiency Standard for Zero Carbon Homes

estimates that the use of enhanced energy efficiency measures to meet the Zero Carbon Hub's fabric Energy Efficiency standards, shows that the development will achieve an 8.6% reduction in Regulated CO_2 emissions over Building Regulations (2010). This represents a 31% improvement over Building Regulations (2006), substantially greater than the 10% required by planning policy.

viii. Low Carbon and Renewable Energy Technologies: The South Cambridgeshire Development Control Policies, Northstowe Area Action Plan and East of England Plan require that 10% of total energy demand is generated from low carbon or renewable energy technologies. The Northstowe Area Action Plan suggests that an aspirational target for Northstowe is to aim for 20%.

ix. The proposals in this Energy Statement outline a microgeneration approach to energy supply which will enable between 11% and 15% of energy to be provided from low carbon or renewable energy technologies. In addition to this, Gallagher are exploring further measures, which are detailed below, to increase the proportion above 20%.

x. Code for Sustainable Homes: It is intended that all dwellings are built to Level 4 of the Code for Sustainable Homes. In addition to other wider sustainability issues (detailed in the Planning Supporting Statement), this currently requires a minimum on-site reduction in Regulated CO_2 emissions of 25% over Building Regulations (2010).

xi. BREEAM: It is intended that all non-residential buildings will be built to the 'Very Good' standard.

xii. Building Regulations: A substantial proportion (currently expected to be 65%) of Phase 1 dwellings and all subsequent phases will be built to Building Regulations (2016) and any subsequent revisions. This will take account of the Government's final decision on low/zero carbon requirements including the proposed Fabric Energy Efficiency Standard, Carbon Compliance and Allowable Solutions. This represents an exemplar standard in terms of the energy performance of dwellings and the limit of what is achievable in practice.

Energy Strategy

xiii. The energy strategy for Northstowe has been designed using the following hierarchy. It aims to minimise energy demand ahead of considering the low carbon / renewable generation of the substantially reduced energy demands: -

- Energy Efficiency
    - Use of appropriate site layout, dwelling orientation and internal layout to take advantage of solar gains. This will create a legible community with sustainability at the forefront of the design and identity of Northstowe.

- In addition to the above, to meet the exemplar standard for energy efficiency (Zero Carbon Hub Fabric Energy Efficiency standard), the following enhancements, amongst others, are proposed: -
    - Enhanced insulation (low U-Value glazing, walls, roofs, floors)
    - Low air permeability
    - Reduced heat loss through thermal bridges
    - 100% low energy lighting
    - High efficiency gas boilers
    - Best practice heating controls
    - Low energy ventilation
    - Appropriate use of thermal mass
    - Passive measures to minimise risk of summer overheating and therefore eliminate the need for active cooling systems
- Detailed consideration will be given to critical building details (such as thermal bridges) to ensure that the enhanced energy efficiency performance is delivered without compromising other performance issues.
- Ventilation measures (such as MVHR) will also be carefully considered to ensure that the high levels of energy efficiency that are proposed do not have a negative impact on the health and wellbeing of occupants.

- Onsite low carbon/renewable energy
    - Phase 1 is envisaged to focus on a **microgeneration** strategy based on individual dwelling technologies principally the use of solar thermal and PV panels, supplemented by high efficiency gas boilers. Due to the relatively low density of Phase 1, the widespread utilisation of district heating is not considered to be economically viable: capital costs of district heating would be significantly greater than the proposed microgeneration strategy, with no increase in CO_2 performance. Furthermore, district heating on Phase 1 would increase energy costs to residents.
    - The technical and economic viability of the use of localised district heating (with a low carbon technology, e.g. CHP) for the Phase 1 non-residential areas will be fully examined on a building-by-building basis at the appropriate stage.
    - In addition to microgeneration technologies, Gallagher are keen to investigate further measures to increase the proportion of total energy provided from low carbon / renewable energy technologies. This includes the provision of medium scale **Wind Turbine(s)** in the Northstowe area. An area of search will be defined and

consultants appointed to undertake a detailed site viability study. Pending a positive outcome of this, a separate planning application will be submitted for the construction of the proposed wind turbine(s) which would increase the renewable energy generation percentage substantially above that achieved through microgeneration for each dwelling. The delivery of this technology through a community ownership model is to be explored.

  - The Joint Promoters are committed to undertaking detailed technical and economic assessment of the viability of utilising district heating (with CHP) on Phase 2 and later phases. This would meet the same Zero Carbon Home CO_2 standards as microgeneration. A Collaborative District Heating Study has been proposed by South Cambridgeshire District Council and the Joint Promoters to examine the feasibility of district heating for Phase 2 and subsequent phases.
  - The above strategy is in line with the Renewables East June 2010 Report and the Code for Sustainable Homes August 2011 Cost Review. Furthermore, it follows the trajectory used by the Zero Carbon Hub in their viability analysis.

- Allowable solutions
  - The Government has recognised that the Zero Carbon Home standard must be technically and economically viable and deliverable on the full range of dwellings. The Zero Carbon Home standard is therefore expected to include the use of allowable solutions to ensure that the CO_2 reductions that cannot be viably achieved onsite are achieved through alternative measures.
  - The Joint Promoters are keen to ensure that, wherever possible, the benefits from Allowable Solutions are gained by the local community.

Energy Performance Commitments

xiv. This Energy Statement provides a Schedule of Performance Commitments for the provision of both energy efficiency and low carbon and renewable energy technologies. These commitments are designed to ensure that the following exemplar sustainability performance standards are met:

1. Zero Carbon Hub Fabric Energy Efficiency standard. It is expected that this will facilitate an 8.6% reduction in regulated CO_2 emissions over Building Regulations (2010).
2. Dwellings from 2016 will be built to amended Building Regulations (2016) requirements and any subsequent revisions. This will take account of the Government's final decision on low/zero carbon requirements including the proposed Fabric Energy Efficiency Standard, Carbon Compliance and Allowable Solutions.

3. In excess of 10% of total energy to be provided from on-site low carbon / renewable energy technologies. Current calculations show that the low carbon / renewable energy microgeneration will be between 11% and 15%, depending on the exact mix of technologies utilised.
4. Recognising the long-term option for the use of district heating on the wider Northstowe development, to apply where appropriate and possible, on a localised basis (in the interim at least), the use of district heating infrastructure within Phase 1 for the non-residential development. This will begin to create a base load which the wider Northstowe development can build on, should it be viable to do so. The appropriateness of district heating for the non-residential areas of Phase 1 will therefore be examined at the detailed design stage of each non-residential building.

xv. Each Sub-Phase will be required to comply with the above performance standards. The opportunity for the inclusion of new or different technologies on later sub-phases is retained. With this flexible approach, the defined performance standards will be met in the most appropriate way.

Energy Efficiency

xvi. The measures detailed within this Energy Statement enable the proposed development to meet the Zero Carbon Hub Fabric Energy Efficiency standards. This has been determined by the Zero Carbon Hub to be the '*highest practical energy efficiency level realisable in all dwelling types*.' The exemplar measures proposed substantially reduce the space heating requirement of the dwellings to such a level where further improvements have little effect, and for a significantly higher cost, due to the law of diminishing returns.

xvii. By meeting this exemplar standard for energy efficiency, the Northstowe proposals represent a step-change in specification from existing good practice. The majority of past and current developments go no further than meeting Building Regulations (2010) through energy efficiency, with many not even meeting this benchmark.

xviii. The above energy efficiency proposals enable the performance of the proposed development to significantly exceed the Building Regulations (2010) baseline through energy efficiency alone. Energy modelling has shown that Phase 1 as a whole will reduce Regulated CO_2 emissions by **8.6%** over Building Regulations (2010). This is predominantly achieved through minimising the space heating demand and represents a very high level of sustainable design and construction. This is considerably in excess of policy requirements.

Renewable Energy Generation

xix. The above proposals will enable Phase 1 to generate between **11% and 15%** of total energy from low carbon / renewable energy technologies as a minimum, which exceeds the mandatory requirement of the Northstowe Area Action Plan.

xx. Should the outcome of the viability study for the medium scale Wind Turbine(s) be positive, it is estimated that this will increase the low carbon / renewable energy generation to **~35%** for Phase 1. This responds positively to, and very significantly exceeds, the aspirational 20% low carbon / renewable energy generation policy of the Northstowe Area Action Plan.

Exemplar Projects

xxi. In line with the Joint Promoters aspirations for Northstowe and the Northstowe Area Action Plan, a number of exemplar sustainability projects are proposed for Phase 1: -

- Construction of all dwellings to the Zero Carbon Hub Fabric Energy Efficiency standards.
- Dwellings from 2016 will be built to amended **Building Regulations (2016)** requirements and any subsequent revisions. This will take account of the Government's final decision on low/zero carbon requirements including the proposed Fabric Energy Efficiency Standard, Carbon Compliance and Allowable Solutions.
- Pending viability assessment, the construction of a medium scale **Wind Turbine(s)**
- Use of **local district heating and CHP** for the non-residential buildings (pending viability assessment). Low carbon / renewable energy generation for these buildings would be ~40%.

xxii. Further exemplar projects are expected on the later phases of the Northstowe development. This includes a commitment to undertake detailed technical and financial viability assessment of district heating for Phase 2 and later phases, containing the town centre commercial uses, higher density residential development, the main employment area and large consumers such as the secondary school. Substantial use of district heating in these areas would enable low carbon / renewable energy generation for the whole site to exceed **20%,** although **it should be noted that district heating does not enable a higher CO_2 standard to be met than microgeneration**. Coupled with the construction of medium scale wind turbine(s) it is expected that the low carbon / renewable energy generation would exceed **30%** for the whole development.

Economic and Social Viability Monitoring and Testing

xxiii. The flexibility in terms of the Energy Strategy for the sub-phases, which may be extended to the later phases, enables the inclusion of the most appropriate technologies at the time of construction for each sub-phase. This allows the development to adapt to the changing appropriateness of technologies as the development progresses and potentially to utilise new technologies.

xxiv. Gallagher therefore commits to undertake regular monitoring and testing of the technical, economic, environmental and social viability of emerging technologies as they become available. The use of the examined technologies has the potential to provide a significant increase in the percentage of energy generated from low carbon or renewable energy technologies from that detailed here.

xxv. The monitoring and testing of technologies will examine: -

- The environmental (CO_2) benefits of existing and new technologies
- The economics of technologies: capital cost and savings in running costs for residents
- Technological capability
- Market and public acceptance of technologies
- The level of risk a technology poses to the timely delivery of the development

Funding

xxvi. In order to maximise the provision of low carbon and renewable energy generation infrastructure, Gallagher will investigate and seek additional capital and funding from relevant bodies. Grant Shapps, the Minister of State for Housing, highlighted the Government's desire to "explore with industry the potential of a Green Deal type financing approach for new homes, as a way of offsetting some of the upfront costs"[2].

Education and Community Engagement

xxvii. In consultation with others, an energy awareness campaign will be prepared and funded in order to promote energy savings for residents and businesses. This will include the benefits in terms of the environment and the cost savings that can be achieved through behavioural enhancements. This will serve to maximise the engagement of Northstowe residents with the sustainable energy measures that are proposed.

xxviii. The option of delivering the medium scale wind turbines (the feasibility of which is to be examined) under a community ownership model will also be examined.

[2] Statement 17 May 2011

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1. Introduction

1.1. This Energy Statement (incorporating Renewable Energy Statement) has been prepared by Richard Hodkinson Consultancy (RHC), a specialist innovation, energy and sustainability consultancy, in support of the outline planning application for the proposed first phase of the Northstowe new town development.

1.2. The formulation of the energy strategy for the proposed development takes into account several important concerns and priorities. These include:

a) To meet the relevant planning policies and to seek to address local Planning Authority aspirations.
b) To be an exemplar in sustainability, whilst maintaining the technical and economic viability of the development.
c) To provide a Schedule of Commitments to ensure that the highest viable levels of sustainable design and construction and the maximum viable reduction in energy demand and associated CO_2 emissions are achieved with a technically and economically deliverable strategy.
d) To minimise the negative impact of the proposed development on both the local and wider climate and environment.
e) To ensure that Phase 1 of the development will seamlessly integrate with the wider Northstowe development.

1.3. This Statement first details the planning policy and expected Building Regulations requirements to which the development will be constructed. It then establishes a baseline assessment of the estimated energy demands and associated CO_2 emissions for the development based on Building Regulations (2010), before discussing the energy efficiency and renewable / low carbon energy technologies that would enable the project requirements to be met.

1.4. Whilst this Energy Statement is specifically relevant to Phase 1 of the Northstowe development, it also considers the general strategy for the whole Framework Masterplan area.

1.5. This Energy Statement provides a Schedule of Commitments for the use of energy efficiency and low carbon / renewable energy technologies. This is designed to ensure that through the application of the most appropriate renewable and low carbon energy technologies at the time of each sub-phase that the following exemplar sustainability standards are met:

- Dwellings from 2016 will be built to amended Building Regulations (2016) requirements and any subsequent revisions. This will take account of the Government's final decision on low/zero carbon requirements including the proposed Fabric Energy Efficiency Standard, Carbon Compliance and Allowable Solutions. In line with Government Policy, this Framework is designed to ensure that building to the highest sustainability standards remains viable.
- In excess of 10% of total energy to be provided from on-site low carbon / renewable energy technologies. Current calculations show that the low carbon / renewable energy microgeneration will exceed 10% and approach 20%.
- Recognising the long-term option for the use of district heating on the wider Northstowe development, to apply where appropriate and possible, on a localised basis (in the interim at least), the use of district heating infrastructure within Phase 1 for the non-residential development. This begins to create a base load which the wider Northstowe development can build on, should it be viable to do so. To ensure that CO_2 reductions would be achieved, the district heating would require renewable or low carbon energy generation (e.g. a CHP engine). Each building would require its own ground floor/basement Plant Room appropriate to the size of each building. The appropriateness of district heating for the non-residential areas of Phase 1 will therefore be examined and explored at the detailed design stage of each non-residential building.

1.6. A Glossary of terms used in this Energy Statement is attached as Appendix E.

2. Development Overview

2.1. The proposed Northstowe new town development is located 10km northwest of Cambridge, within South Cambridgeshire District. The site is east of Longstanton and north of Oakington. The site is bounded to the east by a disused railway line, which is being used as the route of the Cambridgeshire Guided Busway.

2.2. Northstowe is identified in the South Cambridgeshire Core Strategy as the site for a sustainable new town with a target size of up to 10,000 dwellings and associated facilities and non-residential areas.

2.3. This Energy Statement is in support of the outline planning application for Phase 1 of Northstowe, which comprises of up to 1,500 dwellings; a primary school; a mixed-use local centre (including a community building, and provision for non-residential institutions, financial and professional services, shops, cafes and restaurants, drinking establishments, and hot food take-aways); leisure, community, residential institutions, cultural, health, and employment provision (business, general industry and storage & distribution) including a household recycling centre; formal and informal recreational space and landscaped areas; and infrastructure works including site re-profiling and associated drainage works, foul and surface water pumping stations, two flood attenuation ponds on land east of Hattons Road; and associated works including the demolition of existing buildings and structures.

2.4. Careful consideration has been given to the incorporation of sustainable design features into the layout and form of Northstowe in order to create a legible and functional development, with energy efficiency at the forefront

2.5. This Planning Application and Energy Statement are specifically for Phase 1 of the Northstowe development, which is proposed to comprise of 1,500 dwellings and 12,740m^2 of non-residential areas. Phase 1 forms the northern section of the Northstowe Masterplan. The Framework and Phase 1 Masterplans are attached as Appendix A.

2.6. Table 1, below, shows the illustrative outline accommodation schedule for Phase 1 of the development.

Table 1: Illustrative Accommodation Schedule

Unit Type	1/2 Bed Mid-Terrace	3 Bed Semi-Detached	4+ Bed Detached	Non-Residential
Average Dwelling Area (m^2)	70	100	150	12,740
Proportion of Units	25%	46%	29%	

2.7. It is currently expected that the development of the site infrastructure will commence in 2013, with the construction of dwellings starting in 2014. An illustrative development programme for Phase 1 is shown in Table 2, below.

Table 2: Illustrative Development Programme

Construction Start	2014	2015	2016	2017	2018	2019	2020	2021	Total
Number of Dwellings	100	175	275	360	350	160	60	20	**1,500**

Phase 1 and its Context to Northstowe

2.8. A Development Framework Document (DFD), including a Framework Masterplan has been prepared which refreshes the Masterplan for Northstowe and provides place making principles and guidance for individual phases of development. The DFD defines the rationale and structure for Northstowe's planning and delivery as a comprehensive development enabling Phase 1 to come forward as part of an integrated whole.

2.9. The spatial planning and urban design principles of the Framework Masterplan are founded on the vision, development principles and policies of the Northstowe Area Action Plan (NAAP), which was adopted by South Cambridgeshire District Council in July 2007. Given the passage of time since the NAAP was adopted the DFD has taken into account more recent and emerging changes in national and local planning policy and of the impact of current and likely future economic events to ensure that the Masterplan is future proofed and remains relevant.

2.10. As a consequence, the Masterplan and development principles for Northstowe have been strengthened and brought up-to-date to ensure a viable scheme for creating a sustainable community. The new town is to be built to high standards of design and layout within a framework of green infrastructure comprising formal and informal open space and wildlife habitat corridors.

3. Planning Policy and Project Requirements

3.1. This section details the requirements and aspirations of national, regional and local planning policy as well as national Building Regulations requirements. In addition to quoting excerpts from the relevant documents, explanations are provided where necessary. In general, the minimum Building Regulations requirements have been increased since the adoption of the relevant planning policy documents. Therefore, when 'current' is used in this Energy Statement, it is taken to mean the policy as originally adopted.

3.2. Due to the age of the Planning Policy documents, many of the relevant policies will be substantially exceeded by the proposals for Northstowe Phase 1, which will attain exemplar standards in sustainability.

3.3. The general direction of planning policy under the Coalition Government is towards the dominance of local policy and decision making over national and regional policy. This is elucidated in the 'Localism Act' and Draft National Planning Policy Framework.

3.4. The relevant energy related planning policies are detailed within this section. Details of where other Planning Polices are addressed are contained within the '*Review of proposal against relevant policies of the SCDC Core Strategy and Development Control Policies DPD*' and '*Review of proposal against Northstowe Area Action Plan*' which are appended to the Planning Statement.

Climate Change Act (2008)

3.5. The Climate Change Act (2008) requires the UK Government to "*ensure that the net UK carbon account for the year 2050 is at least 80% lower than the 1990 baseline*."

3.6. This legal commitment sets the overriding objective for sustainability: the reduction of CO_2 emissions. It is therefore the minimisation of **CO_2** emissions that must be given primacy over the maximisation of low carbon / renewable **energy** generation: a focus on the latter restricts the strategies available to most effectively meet the former.

Building Regulations (Part L: Conservation of Fuel & Power)

3.7. The reduction of the UK's CO_2 emissions is being facilitated within the built environment through escalating Building Regulations requirements. The Government's proposed trajectory for Building Regulations Part L1A (new build residential) is set out in *Building a Greener Future: A Policy Statement* (2007). This sets the following reductions in Regulated CO_2 emissions compared to a Building Regulations (2006) baseline:

- Building Regulations (2010): 25% improvement
- Building Regulations (2013): 44% improvement (~incremental 25% improvement over 2010 Regulations)
- Building Regulations 2016: 'Zero Carbon' Home – a 100% reduction in Regulated CO_2 emissions over 2006 Regulations.

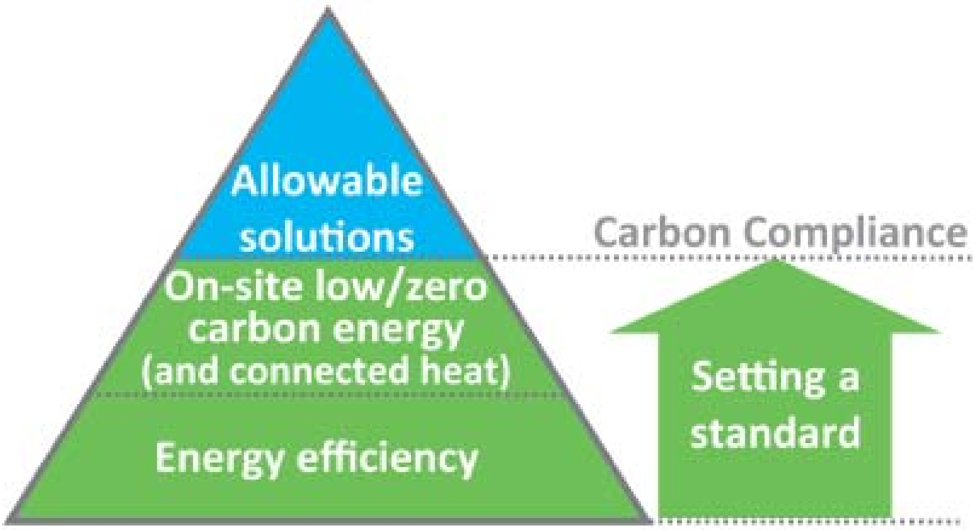
3.8. The Standard Assessment Procedure (SAP) is used to show compliance with Building Regulations for dwellings. Revisions are expected to the SAP methodology concurrently with changes to Building Regulations in 2013 and 2016.

Definition of 'Zero Carbon Home'

3.9. The 'Zero Carbon Home' represents the exemplar standard for energy performance of dwellings and also provides a coherent approach and hierarchy to the formulation of energy strategies.

3.10. The Government began consulting on the definition of the 'Zero Carbon Home' in 2008[3]. The proposed approach was designed to "*achieve large reductions in carbon emissions from all new homes*" and "*allow a range of solutions for dealing with the remaining carbon emissions that will be workable for the full range of housing developments that will be needed*". This approach recognises that "some homes would not be able to meet the Zero Carbon standard through onsite energy solutions alone".

3.11. As from the 2011 Budget, a 'Zero Carbon' home requires a 100% reduction in Regulated CO_2 (space heating, hot water and fixed electrical items – pumps fans, lights) emissions over Building Regulations (2006) through use of the following Framework:



3.12. The Framework involves: -

- Mandatory Fabric Energy Efficiency (FEE) Level
- Mandatory onsite Carbon Compliance Level
- 'Allowable Solutions' for the remainder

3.13. The above Framework provides a coherent hierarchy for the formulation of the energy strategy. As such, it is intended to utilise this hierarchy throughout the development of Northstowe, thus providing a consistent approach to all phases.

3.14. Work is currently being undertaken by the Zero Carbon Hub to advise the Government on the levels that the Fabric Energy Efficiency[4] and Carbon Compliance[5] should be set at, as well as providing a

[3] DCLG: Definition of Zero Carbon Homes and Non-Domestic Buildings Consultation, December 2008.
[4] Defining a Fabric Energy Efficiency Standard for Zero Carbon Homes (Nov. 2009)

framework for Allowable Solutions[6]. It should be noted that the contents of these documents, other than the general framework detailed above, are currently only advisory and are not yet Building Regulations requirements. This viability work focuses on a strategy of insulation enhancements and PV panels.

3.15. As stated above, the 2011 Budget reduced the requirement for Allowable Solutions to remove the unregulated energy demands of appliances and cooking. Grant Shapps, the Minister of State for Housing, expanded on the reasons for this in his statement of 17th May 2011, stating that:

> *"A fundamental principle of environmental regulations is that the 'polluter pays'. Previous approaches to zero carbon homes policy have sought to hold house builders responsible for abating the carbon emissions from household appliances, such as computers or televisions, is not influenced by the design or structure of their home and is therefore beyond the control of the house builder. Asking house builders to put in place measures to reduce the emissions from appliances is unfair; we have decided therefore that the regulatory threshold for zero carbon should be set to cover only those emissions which are within the scope of the Building Regulations."*

3.16. The above very much represents the direction of Government policy in that it outlines a route whereby the house-builder is responsible for providing a highly efficient dwelling, but leaving the resident responsible for their use of appliances. Furthermore, it also represents the Government desire to ensure that building to the highest sustainability standards "*protects the viability of development*"[7].

Zero Carbon Non-Domestic Buildings

3.17. The definition of 'Zero Carbon' for non-domestic buildings has not been developed to the same level as that for dwellings. However, it is expected that a similar framework (energy efficiency, on-site carbon compliance and allowable solutions) will be developed as that for dwellings, reaching 'Zero Carbon' in 2019, with public sector buildings in 2018. The Government began consulting on policy options in 2009[8]. It is not yet currently known at what levels energy efficiency and carbon compliance will be set at.

[5] Carbon Compliance: Setting an Appropriate Limit for Zero Carbon New Homes (Feb. 2011)
[6] Allowable Solutions for Tomorrow's New Homes (July 2011)
[7] Grant Shapps Statement, 17 May 2011
[8] Zero-carbon for new non-domestic buildings: consultation on policy options (Nov. 2009)

National Planning Policy

Planning Policy Statements

3.18. Planning Policy Statements (PPS) set out the Government's national policies for different aspects of land use planning in England. PPS policies should be taken into account in the preparation of regional spatial strategies and by local planning authorities in the preparation of local development documents.

3.19. **Planning Policy Statement 1** (PPS1): *Delivering Sustainable Development* (published 2005) sets the overarching planning policies on the delivery of sustainable development through the planning system. This set out to ensure that the Government's four aims for sustainable development are achieved:

- Social progress which recognises the needs of everyone
- Effective protection of the environment
- The prudent use of natural resources
- The maintenance of high and stable levels of economic growth and employment

3.20. The **PPS1 Supplement**: *Planning and Climate Change* (published 2007) expands on this, stating that:

> *"Regional planning bodies and all planning authorities should apply the following principles:*
>
> - *The proposed provision for new development, its spatial distribution, location and design should be planned to limit carbon dioxide emissions*
> - *New development should be planned to make good use of opportunities for decentralised and renewable or low carbon energy*
> - *New development should be planned to minimise future vulnerability in a changing climate"*

3.21. **Planning Policy Statement 22** (PPS22): *Renewable Energy*, was published in 2004 and states that:

> *"Local planning authorities and developers should consider the opportunity for incorporating renewable energy projects in all new developments. Small scale renewable energy schemes utilising technologies such as solar panels, biomass heating, small scale wind turbines, photovoltaic cells and combined heat and power schemes can be incorporated"*

3.22. Furthermore:

"Local planning authorities may include policies in local development documents that require a percentage of the energy to be used in new residential, commercial or industrial development to come from on-site renewable energy developments. Such policies:

i. *Should ensure that requirement to generate on-site renewable energy is only applied to developments where the installation of renewable energy generation equipment is **viable** given the type of development proposed, its location, and design;*
ii. *Should not be framed in such a way as to place an undue burden on developers" (Author's emphasis)*

Draft National Planning Policy Framework

3.23. This was published for consultation in July 2011 as part of the Government's reforms for the planning system. This will replace the Planning Policy Statements in due course and should currently be seen as a material consideration. It states:

"The National Planning Policy Framework sets out the Government's economic, environmental and social planning policies for England. Taken together, these policies articulate the Government's vision of sustainable development, which should be interpreted and applied locally to meet local aspirations."

3.24. "*The purpose of the planning system is to contribute to the achievement of sustainable development*."

3.25. "*At the heart of the planning system is a presumption in favour of sustainable development...Local planning authorities should plan positively for new development, and approve all individual proposals wherever possible. Local planning authorities should: -*

- *Prepare Local Plans on the basis that objectively assessed development needs should be met, and with sufficient flexibility to respond to rapid shifts in demand or other economic changes*
- *Approve development proposals that accord with statutory plans without delay*
- *Grant permission where the plan is absent, silent, indeterminate or where relevant policies are out of date.*"

3.26. "*The Government's objective is that planning should fully support the transition to a low carbon economy in a changing climate...[T]he planning system should aim to:*

- *Secure, consistent with the Government's published objectives, radical reductions in greenhouse gas emissions, through appropriate location and layout of new development...and the delivery of renewable and low-carbon energy infrastructure*"

3.27. "*To help increase the supply of renewable and low-carbon energy, local planning authorities should recognise the responsibility on all communities to contribute to energy generation from renewable or low-carbon sources. They should:*

- *Have a positive strategy to promote energy from renewable and low carbon sources*"

Regional Policy

East of England Plan (2008)

3.28. The Localism Bill was enacted in November 2011, thereafter becoming the Localism Act. Different parts of the Act will however come into effect at different times over the coming months. The Act enables Regional Spatial Strategies, including the East of England Plan to be abolished but this will be undertaken by statutory order by the Government in due course (it is currently understood that this will be around March/April 2012), subject to consultation. Whilst the East of England Plan remains part of the development plan until it is formally abolished, the government has advised that the proposed abolition of Regional Strategies should be regarded as a material consideration by local planning authorities when deciding planning applications. It should therefore be afforded limited weight in the determination of this planning application. Reference is included to relevant policies within the core strategy, which takes account of regional policy.

3.29. Policy ENG1: *Carbon Dioxide Emissions and Energy Performance* states:

"To meet regional and national targets for reducing climate change emissions, new development should be located and designed to optimise its carbon performance. Local authorities should:

- *Encourage the supply of energy from decentralised, renewable and low carbon energy sources and through Development Plan Documents set ambitious but viable proportions of the energy supply of new development to be secured from such sources...new development...should secure at least 10% of their energy from decentralised and renewable or low-carbon sources, unless this is not feasible or viable."*

3.30. This policy relates to total energy. That is the Regulated energy associated with space heating, hot water and fixed electrical items (fans, pumps and lights) and also the unregulated energy associated with appliances and cooking.

Local Policy

South Cambridgeshire District Council Core Strategy (2006)

3.31. This Development Plan Document (DPD) forms part of the Local Development Framework.

3.32. The Core Strategy allocates Northstowe to be developed as a new town of up to 10,000 new homes, with a town centre providing additional commercial areas. This proposal is the subject of a separate Area Action Plan.

3.33. Objective ST/g states:

> "To ensure development addresses sustainability issues, including climate change mitigation and adaptation issues"

South Cambridgeshire District Council Local Development Framework Development Control Policies (2007)

3.34. More detailed local policy guidance, which is applicable to all developments, is provided in this document.

3.35. **Policy DP/1**: Sustainable Development states:

> *"Development will only be permitted where it is demonstrated that it is consistent with the principles of sustainable development, as appropriate to its location, scale and form. It should:*
>
> *f. Where practicable, minimise use of energy and resources;*
>
> *g. Where practicable, maximise the use of renewable energy sources"*

3.36. **Objective NE/a** states:

> *"To address climate change mitigation and adaptation issues including the need to ensure that new developments are 'climate proofed'"*

3.37. **Policy NE/1**: Energy Efficiency states:

> *"Development will be required to demonstrate that it would achieve a high degree of measures to increase the energy efficiency of new and converted buildings, for example through location, layout, orientation, aspect, and external design.*

Developers are encouraged to reduce the amount of CO_2 m^3 (sic) / year emitted by 10% compared to the minimum Building Regulation requirement when calculated by the Elemental Method in the current building regulations for a notional building of the same size and shape as that proposed"

3.38. There are a number of issues within this policy that require clarification:

- The standard metric for CO_2 in terms of Building Regulations compliance is $kg/m^2/yr$ rather than $kg/m^3/yr$. The former has been used for compliance throughout this Energy Statement.
- The 'Elemental Method' was an option for showing compliance with Building Regulations (2002), but was omitted from all subsequent revisions of Building Regulations. This method required the use of limiting building fabric energy efficiency measures (u-values), which are measured in $W/m^2.K$. Since Building Regulations (2006), the only allowable method for compliance has been through the CO_2 emission rate (measured in $kg/m^2/yr$).
- 'Current' Building Regulations are those applicable at the time of publication of this document, which was Building Regulations (2006). This policy therefore requires a 10% improvement over Building Regulations (2006) using the CO_2 emission rate ($kg/m^2/yr$). This Energy Statement takes as the baseline Building Regulations (2010) (25% reduction in regulated CO_2 emissions over Building Regulations 2006) which is met through energy efficiency measures alone.

3.39. **Policy NE/3**: Renewable Energy Technologies in New Development states:

"All development proposals...will include technology for renewable energy to provide at least 10% of their predicted energy requirements"

3.40. This policy refers to total energy (regulated space heating, hot water and fixed electrical items and unregulated appliances and cooking).

3.41. This policy only allows for renewable energy technologies to meet the 10% standard rather than the renewable or low carbon[9] technologies that are allowed by the Regional East of England Plan and in the National PPS1 Supplement and the Draft National Planning Policy Framework. However, as an informative to Policy NE/3 references East of England Plan Policy ENV8 (replaced by ENG1 in the adopted version), this Energy Statement will use the wider measure of renewable or low carbon

[9] Technologies such as gas Combined Heat and Power (CHP)

technologies. This enables greater flexibility in the selection of the most appropriate technologies to meet this standard.

3.42. **Policy NE/16**: Emissions addresses air quality issues. This states:

> *"Development proposals will need to have regard to any emissions arising from the proposed use and seek to minimise those emissions to control any risks arising and prevent any detriment to the local amenity by locating such development appropriately. Where significant increases in emissions covered by nationally prescribed air quality objectives are proposed, the applicant will need to assess the impact on local air quality by undertaking an appropriate modelling exercise to show that the national objectives will still be achieved. Development will not be permitted where it would adversely affect air quality in an Air Quality Management Area."*

South Cambridgeshire District Council Northstowe Area Action Plan (2007)

3.43. This document provides site specific policy for Northstowe, which has been identified as the site for a sustainable new town with a target size of 10,000 dwellings and associated development.

3.44. It is intended that Northstowe will be a "*sustainable and vibrant new community*" (**Policy NS/1**: The Vision for Northstowe). With regard to the character and design of Northstowe, it is intended that it be will be developed to a "*flexible design which will be energy efficient, and built to be an exemplar of sustainable living with low carbon and greenhouse gas emissions and able to accommodate the impacts of climate change*" (**Policy NS/2**: Development Principles).

3.45. **Section D13** sets out the sustainability objectives for Northstowe:

- *"**D13/a**: To include within Northstowe, projects which are an exemplar in terms of the use of the earth's resources, including energy water and materials*
- ***D/13/b**: To contribute to the achievement of medium and long term emissions targets that move towards the Government's ambition of zero carbon development country-wide, with proposals seeking to achieve significant improvements sought by the Code for Sustainable Homes and significantly exceeding national standards set by Building Regulations subject to wider economic, viability and social testing*
- ***D13/c**: To use energy efficiently*
- ***D13/d**: To make greater use of renewable energy sources."*

3.46. **Policy NS/23**: An Exemplar in Sustainability states:

"Northstowe will include within the development exemplar projects in sustainable development, including energy efficient measures. This could be achieved by:

a. Providing an increased level of sustainability across the development as a whole above current requirements to a material extent

b. Building a proportion of the development to advanced practice which fully addresses sustainability issues and minimises any environmental impact by pushing at the boundaries of the proven technology available at the time of the development."

3.47. Building Regulations (2006) were 'current' at the time of adoption of this document. As the first dwellings are not expected to begin construction until 2014, the minimum requirement will therefore be Building Regulations (2013), which represent a 44% reduction in Regulated CO_2 emissions over Building Regulations (2006).

3.48. The core concept of sustainability is that environmental, economic and social aspects are considered together. Exemplar environmental targets are therefore subject to economic viability.

3.49. It is considered that the Government's definition of 'Zero Carbon Homes' represents exemplar in terms of energy sustainability.

3.50. An informative to Policy NS/23 states that Northstowe proposals should seek to exceed the 10% renewable energy requirement of Development Control Policies DPD Policy NE/3, aiming towards a target of 20%.

Code for Sustainable Homes

3.51. The Code for Sustainable Homes is an environmental assessment method for rating and certifying the performance of new homes. The current (Nov. 2010) version has the following mandatory energy requirements:

- Ene.1: Dwelling Emission Rate: -
  - Level 4: 25% improvement over Building Regulations (2010).
  - Level 5: 100% improvement over Building Regulations (2010).
  - Level 6: 100% + unregulated energy (appliances and cooking)
- There are also mandatory Ene.2: Fabric Energy Efficiency requirements for Levels 5 and 6, which vary depending on dwelling type.

3.52. Other than at Code Level 6, the Code is only concerned with Regulated energy demands.

3.53. The current version of the Code for Sustainable Homes requires that all reductions in CO_2 emissions are achieved onsite or directly connected to the dwellings by 'Private Wire' (i.e. electricity fed from the generating technology, e.g. medium scale wind turbine, to the dwellings rather than to the national grid). It is expected that the Code will be updated in the future to align with the legislation defining 'Zero Carbon', however, no proposals for this have yet been published.

3.54. It is the Applicant's intention that all dwellings will attain at least Code Level 4, which currently requires a minimum on-site reduction in Regulated CO_2 emissions of 25% over Building Regulations (2010).

3.55. Further details regarding the attainment of Code Level 4 are to be found in the Planning Supporting Statement.

BREEAM for Non-Residential Buildings

3.56. BREEAM is an environmental assessment method and rating scheme for non-domestic buildings.

3.57. BREEAM (2011) has the following mandatory energy requirements:

- Excellent: 25% improvement over Building Regulations (2010)
- Outstanding: 40% improvement over Building Regulations (2010)

Summary of Policy Requirements

3.58. The policy and Building Regulations requirements that the development is subject to are summarised below.

Table 3: Policy and Building Regulations Requirements Summary			
	Requirement	**Policy Target**	**Encouragement to Achieve**
National Planning Policy	-	Consideration of incorporating renewable energy technologies	
Regional Planning Policy	-	- Energy Efficient measures - 10% low carbon or renewable energy	
Local Planning Policy	-	- 10% improvement in energy efficiency measures over Building Regulations 2006 - 10% renewable energy generation - Flexible and exemplar design	- Aim for 20% renewable energy generation
Building Regulations	- **2013**: 25% reduction in regulated CO2 over Building Regulations 2006 - **2016**: 'Zero Carbon Home' using Zero Carbon Hub Framework - **2019**: Expected 'Zero Carbon Non-Domestic Buildings'		

4. Methodology and Baseline Energy Demands and CO_2 Emissions

Methodology

4.1. To enable an energy assessment to be undertaken, this Statement first establishes a baseline based on Building Regulations (2010). Despite the fact that the estimated construction programme for the development will ensure that the 2013 and 2016 revisions of Building Regulations are utilised for compliance, it is appropriate to use Building Regulations (2010) as the assessment methodology for this Energy Statement because it is the most up-to-date approved tool for compliance with Building Regulations. There is considerable uncertainty as to the exact details of 2013 and 2016 Building Regulations and also the SAP assessment methodologies to be used to show compliance.

4.2. The estimated annual energy demand for the proposed residential portion of the Development has been calculated using Standard Assessment Procedure (SAP 2009) methodology. SAP calculates the Regulated energy demands associated with hot water, space heating and fixed electrical items. The unregulated energy demands for appliances and cooking are taken from RHC practice benchmarks, which are drawn from analysis of NHER total energy demand calculations. Calculations have been performed on representative dwelling types.

4.3. Table 4, below, shows the Fabric Energy Efficiency (FEE) and onsite Carbon Compliance levels proposed by the Zero Carbon Hub for 'Zero Carbon' Homes. The 'Zero Carbon' standard has three stages, two of which are included in Table 4 below: Stage 1, Fabric Energy Efficiency; and Stage 2 Carbon Compliance. These standards represent the Zero Carbon Hub's assessment of what is viable to achieve. The third Stage is the Allowable Solutions. The standard at each Stage must be met before addressing the subsequent Stage.

Table 4: Zero Carbon Hub Recommended Standards

	Stage 1: Fabric Energy Efficiency	Stage 2: Carbon Compliance
	Fabric Energy Efficiency (FEE) ($kWh/m^2/yr$)	Proposed 2016 Carbon Compliance ($kg.CO_2/m^2/yr$)
Flats	39	14
Mid-Terrace	39	11
End-T / Semi-D	46	11
Detached	46	10

4.4. Fabric Energy Efficiency is measured in kilowatt hours of energy per square metre ($kWh/m^2/yr$).

4.5. Carbon Compliance is measured in kilograms of carbon dioxide per square metre ($kg.CO_2/m^2/yr$).

4.6. It should be noted that the Carbon Compliance levels proposed by the Zero Carbon Hub are based on assumptions by the Zero Carbon Hub regarding 2016 CO_2 emissions factors and are therefore not directly comparable to Building Regulations (2010) analysis. To show compliance with these standards, the calculations within this Energy Statement are based on Building Regulations (2010), as the most recent approved methodology, with appropriate conversions[10] where necessary for showing compliance with the Zero Carbon Hub advised 'Zero Carbon' standards framework.

4.7. Interim Fabric Energy Efficiency standards are expected to be included as part of Building Regulations (2013), although the precise figures have not yet been set.

4.8. The estimated energy demand and associated CO_2 emissions for the non-residential portions of the Development have been calculated using the Simplified Building Energy Model (SBEM 2010).

Building Regulations (2010) Baseline

4.9. The baseline case provides that the building just meets the Building Regulations (2010) Target Emissions Rate (TER). Two measures are required for policy/Building Regulations compliance: total

[10] Zero Carbon Hub, *Modelling 2016 using SAP2009 Technical Guide*

energy (for Planning Policy compliance) and Regulated CO_2 (for Building Regulations compliance). These are shown in Table 5, below.

Table 5: Building Regulations (2010) Baseline		
	Regulated CO_2 (kg/yr)	**Total Energy (kWh/yr)**
Residential	2,749,300	13,139,700
Non-Residential	279,300	1,170,300
Total	**3,028,600**	**14,310,000**

5. Energy Efficiency Measures

5.1. The first step in any sustainable energy strategy is the specification of energy efficiency measures, thereby reducing energy demand in the first instance, before the consideration of renewable / low carbon energy generation. This is also in line with planning policy.

5.2. The specification of energy efficiency measures serves two key development goals, thereby increasing the environmental, economic and social sustainability of Northstowe: -

- Enhancement of environmental performance by reducing energy demand and CO_2 emissions
- Increased affordability of energy bills for residents through a reduction in energy demand.

5.3. It is proposed to meet in full the Fabric Energy Efficiency requirements that are expected to be required by 2013 and 2016 Building Regulations. The latter of these is to be the ‘Zero Carbon Home’ standard and therefore represents an exemplar standard in terms of energy efficiency.

5.4. The brief to the Task Group led by the Zero Carbon Hub from the Government was to:

> *“Examine the energy efficiency metrics and standards which will realise our ambition of the highest practical energy efficiency level realisable in all dwelling types.”* (Ministerial Statement by John Healey)

5.5. The Zero Carbon Hub have determined that the Fabric Energy Efficiency standards detailed in Table 4 meet this brief and set “*a challenging but realistic increase in dwelling performance*” (Zero Carbon Hub). As such, these standards represent the exemplar in the energy efficiency of dwellings.

5.6. The Zero Carbon Hub recognise that the exemplar measures necessary to meet this standard substantially reduce the space heating requirement of the dwellings to such a level where further improvements have little effect, and for a high cost, due to the law of diminishing returns.

5.7. An illustrative route to achieving this exemplar standard is detailed below. This is generally in line with the least cost options identified within the DCLG publication, *Cost of Building to the Code for Sustainable Homes: Updated Cost Review (August 2011)* and the Zero Carbon Hub viability assessment.

Insulation Standards

5.8. In order to minimise heat losses, high levels of insulation (low U-Value) constructions will be used.

5.9. The buildings will incorporate enhanced insulation in the building envelope (walls, roofs, floors and glazing) to achieve average U-Values better than those required by Part L (2010) Building Regulations. These are likely to include:

- Low Emissivity glazing with a U-Value of 1.3.
- External wall U-Values will be improved to 0.18 (350mm wall).
- Party walls will be fully insulated and sealed (achieving an effective U-Value of 0.0).
- Ground Floor U-Values will be improved to 0.15.
- Roof (joists) U-Values will be improved to 0.1.
- Roof (rafters) U-Values will be improved to 0.18.

5.10. These insulation measures will reduce space heating demands to very low levels. Lower U-Values would enable little further benefit and at a high cost, due to the law of diminishing returns.

Space Heating

5.11. The space heating requirement of the development will be reduced by the fabric insulation measures detailed above.

5.12. It is intended to take advantage of winter solar gain to reduce the space heating demands of the dwellings. This is achieved through appropriate orientation of dwellings, thus maximising winter solar gains through glazing. Furthermore, where possible, the internal layouts of the dwellings will be such that solar heat gains occur in the living areas, with less used rooms such as bedrooms and bathrooms facing north and therefore being subject to less solar gain. The benefits of this will be carefully balanced with the need to reduce the risk of excessive summer solar gains (discussed below).

5.13. Thermal mass can also be utilised to reduce space heating demands in the winter. The low level winter sun shines below any external shading and energises the thermal mass. The thermal mass is then able to slowly release the heat during the night, thus reducing space heating energy demand. Where appropriate, this strategy will be adopted.

5.14. High efficiency (SEDBUK 'A' rated) boilers will be specified in accordance with best practice. Where available and appropriate, Flue Gas Heat Recovery (FGHR) will be included with the boilers to maximise their overall efficiency. These systems extract the latent heat released in the condensation of water vapour to pre-heat the incoming water, thus reducing the energy required to heat the water to the required temperature. FGHR is available only on a limited selection of boilers and only in some cases can significant benefits be gained.

5.15. Heating controls will be specified to maximise energy efficiency in operation. This will take the form of Time and Temperature Zone Control for all dwellings.

5.16. Where available, load or weather compensation will be utilised to enhance the operational efficiency of the heating systems.

Hot Water

5.17. Hot water will be provided from the same high efficiency boiler as space heating. Where hot water cylinders are used, these will have low heat losses.

5.18. Waste Water Heat Recovery Systems (WWHRS) for showers are able to reduce the energy demand for hot water. A heat exchanger on the shower outflow takes heat from the waste water and pre-heats the incoming fresh water, thus reducing the energy required to heat it up to the required temperature. WWHRS are a relatively new technology and only appropriate for certain dwelling types. As such, they will be included only where appropriate and cost-effective to do so.

Limiting the Risk of Summer Overheating

5.19. Minimising the risk of summer overheating is important so as to ensure that dwellings are adapted to climate change and remain comfortable to occupy.

5.20. It is not intended to provide any mechanical cooling to the dwellings on the proposed development, but rather to reduce the need for active cooling as far as possible. This will be done through the specification of non-mechanical measures such as good thermal insulation and air tightness. Where appropriate, solar control glazing (low g-value) will be installed to reduce solar heat gains.

5.21. Furthermore, the green areas on the development and the deciduous trees that will be incorporated within the planting scheme across the site will facilitate localised cooling through evapotranspiration – energy which would otherwise heat the local atmosphere is instead used to evaporate water. Both these measures help to reduce the urban heat island effect. The deciduous trees provide shading in the summer and allow solar gain in the winter.

5.22. Open-able windows will be used across the development and will enable cross-ventilation, convective-ventilation and night purging. These factors will reduce the build up of heat within dwellings.

5.23. Thermal mass and external solar shading are also able to work together to reduce summer overheating and winter heating requirements. In the summer, external shading prevents the high angle sun from warming the interior of the house. Opening the windows at night allows the house to cool (night-purging). The high thermal mass then cools the dwelling throughout the next day. Where appropriate and feasible, this strategy will be followed to minimise the risk of summer overheating.

5.24. Despite the above measures, it is possible that mechanical cooling will be required in some of the non-residential areas of the proposed development. If required, this will be provided with high efficiency chillers. A Seasonal Energy Efficiency Ratio (SEER) of 4 has been used in the SBEM calculations for the non-residential areas.

Air Tightness and Ventilation

5.25. In addition to heat losses through building elements (walls, roofs, etc.), heat can be lost through uncontrolled ventilation (e.g. through little gaps between walls and roof). It is important to reduce these heat losses.

5.26. Air tightness standards will therefore conform to Approved Document Part L accredited details. These details incorporate an improvement over Building Regulations requirements by reducing air leakage loss and convective bypass of insulation. An improvement of design air permeability rate from $10m^3/hm^2$ to less than $6m^3/hm^2$ will further reduce space heating requirements.

5.27. It has been assumed in this Energy Statement that dwellings will be naturally ventilated. It may be deemed appropriate to utilise Mechanical Ventilation and Heat Recovery (MVHR) systems as a carbon compliance measure. Such systems warm the incoming fresh air through a transfer of heat from the outgoing stale air. Where MVHR is used it will be high efficiency (90%+) and low Specific Fan Power (SFP).

5.28. Ventilation in the non-residential areas will be designed to minimise energy use in operation and will therefore have a low Specific Fan Power.

Thermal Bridging

5.29. In well insulated buildings, as much as 30% of heat loss can occur through thermal bridges, which occur when highly conductive elements (e.g. metals) in the wall construction enable a low resistance escape route for heat. It is proposed that the development will meet Accredited Construction Details for thermal bridges[11], thus substantially reducing heat losses. Where possible, the requirements of Accredited Details will be exceeded. Use of Enhanced Thermal Bridging Details[12], where possible, would enable higher levels of energy efficiency.

Lighting and Appliances

5.30. Energy efficient lighting will be installed in 100% of internal fittings in the dwellings. External lighting will also be low energy lighting and controlled through presence (PIR) sensors, or daylight cut-off devices. Where viable and appropriate, LED lighting will be used to further reduce energy demand.

5.31. Kitchen and other pre-installed appliances will be A or A+ rated for energy efficiency, as a minimum.

5.32. It is very difficult to design and construct dwellings to reduce the unregulated electricity demands, because this is almost entirely dependent on the occupant of a dwelling and can vary substantially. However, the Applicant is committed to ensuring that all efforts are made to enable the residents to minimise their unregulated electricity consumption. Advice will be provided to all occupants in the form of a Home User Guide on how to minimise electricity consumption. This includes advice on purchasing low-energy devices as well as ensuring that they are used efficiently. It has been shown that the provision of such information can significantly reduce energy use.

5.33. Lighting in the non-residential areas will be low-Wattage (<$10W/m^2$), designed to CIBSE Illuminance levels and appropriate demand reducing lighting controls will be utilised.

5.34. Specification of smart electricity and gas meters would also enable residents to be aware of their energy usage and make behavioural changes to reduce demand.

[11] http://www.planningportal.gov.uk/buildingregulations/approveddocuments/partl/bcassociateddocuments9/acd
[12] http://www.energysavingtrust.org.uk/Professional-resources/Housing-professionals/New-housing/Enhanced-Construction-Details

Health and Wellbeing

5.35. The joint promoters are keen to ensure that all dwellings and buildings in Northstowe support the health and wellbeing of the residents and occupants. Due consideration is therefore to be given to ensure that the proposed high levels of energy efficiency do not negatively affect occupant health and wellbeing.

5.36. It is intended to avoid condensation accumulation within the dwellings. Condensation can lead to reduced performance of insulation, higher heating demand and to mould accumulation, which poses a risk to health. Consideration of the risk of condensation at design stage can lead to its elimination. It is therefore intended that suitable strategies will be employed to ensure that dwellings do not suffer from condensation and the impacts of this. The following will therefore be implemented: -

- The minimisation of thermal bridges that can cool internal surfaces and therefore facilitate condensation.
- Consideration of wall profiles to ensure that interstitial (within the wall) condensation is avoided.
- Provision of suitable and adequate ventilation to ensure that moisture generated within the dwelling is effectively removed before condensation accumulation occurs. This may include heat recovery.

5.37. The construction of highly airtight (low air permeability) dwellings also has the potential to lead to the accumulation of harmful substances within the dwelling, if not carefully considered. It is intended to avoid this at Northstowe by: -

- Avoiding the use of toxic substances (e.g. Volatile Organic Compounds (VOCs) & formaldehyde), within paints, glues, varnishes, timber preservatives and vinyl products. These toxins can lead to respiratory problems, asthma, an increased susceptibility to allergens and can be carcinogenic (cancer causing). Often it is not a single material which is the cause of ill health but is from the 'cocktail effect' of many chemicals present in buildings. Care will therefore be given to the selection of materials at Northstowe (this issue is considered within the Mat.1 category of the Code for Sustainable Homes).
- Providing suitable and adequate controlled ventilation to effectively remove any harmful substances that may become present. By controlling the ventilation to the needs of the dwelling and the occupants, rather than uncontrolled ventilation, energy efficiency is promoted.

Education and Community Involvement

5.38. Gallagher are keen to ensure that all residents of Northstowe are environmentally aware. Therefore, in addition to provision of energy efficiency and low carbon / renewable energy technologies, it is proposed that an energy awareness campaign will be prepared and funded. This will promote energy savings for residents and businesses through efficient use of resources and effective utilisation of energy saving devices and low carbon / renewable energy technologies. Such a campaign will highlight the benefits in terms of the environment and the cost savings that can be achieved through behavioural enhancements.

Fabric Energy Efficiency Compliance and Performance

5.39. The energy efficiency measures detailed above have been shown through the sample SAP calculations to enable compliance with the Zero Carbon Hub's recommended standards. The results are summarised within Table 6, below.

Table 6: Fabric Energy Efficiency Compliance

Unit Type	Zero Carbon Hub FEE Requirement ($kWh/m^2/yr$)	Sample SAP Calculation FEE Result ($kWh/m^2/yr$)
1/2 Bed Mid-Terrace	39	**36.3**
3 Bed Semi-Detached	46	**43.1**
4+ Bed Detached	46	**45.8**

5.40. By meeting this exemplar standard for energy efficiency, the Northstowe proposals represent a step-change in specification from existing good practice. The majority of past and current developments go no further than meeting Building Regulations (2010) through energy efficiency, with many not even meeting this benchmark.

5.41. In the process of meeting these exemplar Fabric Energy Efficiency standards, the requirements of Building Regulations (2010) have been exceeded by 8.6% for Phase 1. This is shown in Table 7, below.

Table 7: Energy Efficiency

	Building Regulations (2010) Baseline ($kg.CO_2/yr$)	Proposed Specification ($kg.CO_2/yr$)	Reduction Achieved
Residential	2,749,300	2,492,400	**9.3%**
Non-Residential	290,472	287,300	**1.1%**
Total	**3,039,772**	**2,779,700**	**8.6%**

5.42. The 8.6% improvement over Building Regulations (2010) represents a 31% improvement over Building Regulations (2006), substantially greater than the 10% required by planning policy.

5.43. With regards to the non-residential buildings, it should be noted that in addition to the 25% improvement required for Building Regulations (2010) over 2006, the SBEM calculation methodologies were also substantially altered. In effect, the 25% improvement from 2006 requires a 50% reduction in CO_2 emissions. As such, the meeting of Building Regulations (2010) through energy efficiency represents an exemplar standard.

5.44. The specification detailed here therefore represents a very high level of sustainable design and construction. This is achieved through a number of measures, but predominantly focussed on the minimisation of space heating demand. The detailed measures will reduce space heating demands to very low levels, with further enhancements being limited by the law of diminishing returns. These measures will reduce CO_2 emissions and also make energy more affordable for residents by reducing their demand for it.

6. Low Carbon and Renewable Energy Technologies

6.1. After the application of energy efficiency measures, the next step in a Sustainable Energy Strategy is the consideration of onsite low carbon and renewable energy technologies. Due to the size and timescales of the proposed development, it is considered appropriate that the specific low carbon or renewable energy technologies to be adopted on each sub-phase to meet the project requirements detailed in this Statement are defined with Energy Statements for each sub-phase as they are brought forward, rather than at this Outline Stage. This retains flexibility over the expected timespan of the development for technological advancements, changes to costs and also alterations to the assessment (SAP) methodology. This Energy Statement therefore only provides a Schedule of Commitments by which to ensure that each sub-phase meets the project requirements detailed here.

6.2. The full spectrum of low carbon and renewable energy technologies and their potential applicability and appropriateness for Phase 1 of the Northstowe development has been examined. These, along with the benefits, disadvantages, limitations and funding opportunities of each are discussed in this Section and within Appendix B. Section 7 continues with providing a Schedule of Commitments for the provision of low carbon and renewable energy technologies on each sub-phase. Finally, Section 8 considers the integration of Phase 1 into the wider Northstowe development.

6.3. The following criteria will be used in the selection of low carbon or renewable energy technologies for Northstowe Phase 1: -

- Practicality and technical performance – selection of a robust technology that is proven to be effective, be easy to operate and maintain and reduce CO_2 emissions
- Value for money – selection of a technology that offers the high levels of environmental performance for a low capital cost
- Impact on affordability of energy for residents – selection of a technology that reduces the energy bills for residents

6.4. It is intended that regular monitoring and testing of the technical, economic, environmental and social viability of existing technologies and new technologies as they become available will be undertaken throughout the timespan of the development. This will help to ensure that the most appropriate technologies at the time of each sub-phase are utilised.

6.5. As a minimum, renewable / low carbon energy technologies will be specified to meet the required Building Regulations standards at the time of construction. This includes meeting the Carbon Compliance level that forms part of the 'Zero Carbon' Home for 2016 Regulations.

6.6. The available low carbon and renewable energy technologies fall into three categories: -

- Microgeneration: Individual Dwelling Technologies
- Community Scale Technologies: those that require community infrastructure
- Large Scale 'Private Wire' Technologies – generally displaced from the development site due to their size

Microgeneration: Individual Dwelling Technologies

6.7. Individual dwelling technologies are separately installed for each dwelling.

Solar Thermal (hot water) Panels

6.8. Solar thermal panels use the sun's energy to generate hot water for each dwelling. Due to the seasonality of solar radiation, solar thermal panels can provide up to ~60% of a dwellings hot water demand, with the remainder being provided as top-up by the conventional gas boiler. Oversized solar hot water cylinders are required to enable the heat input of both the solar panels and the gas boiler. By reducing the need for gas in the generation of hot water, CO_2 savings are made as well as increasing the affordability of energy for residents.

6.9. Solar thermal panels are generally installed on the roofs of dwellings, with panels facing as close to south as possible to maximise their efficiency. A $100m^2$ dwelling would have ~$4m^2$ of solar panels. Solar thermal panels are suitable for both houses and flats. However, due to the difficulty of accommodating the long pipe-run distances between the roof and dwellings in a block of flats, alternative technologies are often used for flats.

6.10. Solar thermal panels are a technology that allows significant reductions in energy and CO_2 emissions. They are therefore an option that could be used to facilitate compliance with Building Regulations 2013 and 2016. Furthermore, they are a robust technology that provides substantial benefits to residents in terms of 'free' energy.

6.11. It has been shown with sample SAP calculations summarised in Appendix D (Table 2a) that a combination of energy efficiency measures and solar thermal panels are likely to enable compliance with Building Regulations (2013). Due to the limited hot water demands of dwellings, it is expected that additional measures to energy efficiency and solar thermal panels will be required to enable compliance with Building Regulations (2016).

Solar Photovoltaic (PV) Panels

6.12. Solar PV panels generate electricity by harnessing the power of the sun. They convert solar radiation into electricity which can be used within the dwelling or exported to the grid at times of excess generation.

6.13. In addition to generating renewable electricity for use by residents thereby reducing their demand for electricity from the grid, PV panels are currently eligible for Feed-in-Tariffs[13]. Feed-in-Tariffs provide an income stream for the generation of renewable electricity. There are therefore significant benefits in terms of environmental performance and affordable energy.

6.14. Unlike solar thermal panels, the use of PV panels is not constrained by the energy demand of a dwelling. The only limitations are therefore cost of panels and the availability of suitable roofspace for the panels. Therefore, in conjunction with energy efficiency measures, solar PV panels are an option that is likely to enable compliance with Building Regulations 2013 and 2016. The calculations in Appendix D (Tables 1a and 1b) detail the likely amount of PV required for each of the sample house types.

[13] Providing panels and installer are Micro Generation Scheme (MCS) Certified.

6.15. An assessment of the practicality of accommodating the required amount of PV panels to meet the Zero Carbon Hub recommended 2016 Carbon Compliance Level has been undertaken for a range of sample dwellings. Drawings illustrating this assessment are attached as Appendix F. If PV panels are selected as the most appropriate technology for a sub-phase then the detailed design of the dwellings will be developed to ensure that sufficient PV panels can be accommodated. This will require appropriate locating of dormer and velux windows, which reduce the area available for PV panels.

6.16. Communal systems are generally used for blocks of flats, with the generated electricity being used to power the communal areas (e.g. corridors).

6.17. PV systems are measured in kilowatt peak (kWp). 1kWp requires ~8m^2 of panels and generates ~800 kilowatt hours (kWhs) of electricity a year.

Air and Ground Source Heat Pumps (ASHPs & GSHPs)

6.18. Heat pumps covert low grade heat from a large ‘reservoir’ (outside air or the ground) into higher temperature for input into a smaller space (the dwelling). Heat pumps are powered by electricity and replace conventional gas boilers. They have a seasonal ‘efficiency’ (Coefficient of Performance (CoP)) ranging from 250% to 500% and therefore use significantly less energy than conventional systems.

6.19. Heat pumps can work with oversized radiators but are most effective and efficient when underfloor heating is used.

6.20. Whilst enabling substantial reductions in energy demand, because heat pumps are powered by grid electricity, which is substantially more carbon intensive then gas, the reductions in CO_2 emissions from converting from a gas boiler to a heat pump are currently small. This may change in the future as grid electricity is decarbonised through increased national use of renewable energy generation.

6.21. As heat pumps replace gas as the heating fuel with electricity, which is substantially more expensive, heat pumps have less of a beneficial impact on affordability of energy than alternative technologies.

6.22. In conjunction with energy efficiency measures, heat pumps are an option that could be used towards meeting the requirements of Building Regulations 2013 and 2016. It is likely that additional low carbon or renewable energy measures would also be required.

Micro Wind Turbines

6.23. Small wind turbines are designed to generate electricity from the wind for use within each dwelling. Turbines would be installed above the roof of each dwelling.

6.24. A detailed analysis of the wind resource on the specific development site would be required to assess the viability of micro wind turbines. However, they are unlikely to be viable for the houses, due to the disruption to the flow of wind that is caused by the urban environment. This has been shown to reduce the output of micro wind turbines to very low levels (in some cases becoming net consumers of electricity). Turbines are more viable on the top of blocks of apartment blocks where they can be installed to operate above the level that is significantly affected by the urban environment.

6.25. The noise impact on the local area of micro wind turbines would also need to be considered and ensured to be negligible before adopting this strategy.

6.26. Micro wind turbines are also currently considerably more expensive than alternative technologies such as PV panels.

6.27. Depending on the available wind resource, micro wind turbines could be used in conjunction with energy efficiency measures to meet Building Regulations 2013 and 2016 for blocks of flats.

Summary

6.28. It is considered that individual dwelling energy strategies to meet the expected requirements of Building Regulations in 2013 and 2016 are likely to be technically and economically viable. This conclusion is in line with the DCLG Code for Sustainable Homes August 2011 Cost Review and the Renewables East June 2010 Report. Furthermore, the Zero Carbon Hub's viability assessment for 'Zero Carbon Homes' has focussed on a strategy of insulation improvements and PV panels.

6.29. The Renewables East June 2010 Report is a substantial update of the May 2009 Report and undertaken to reflect the significant changes to the Northstowe proposals and required standards since the publication of the May 2009 Report. The headline conclusion of the superseded May 2009 Report was the recommendation that the most appropriate energy strategy was for 80% of the development to be subject to district heating with the remaining 20% subject to micro-renewables. In contrast, after further consideration of the proposed Northstowe development and the required sustainability standards, the updated June 2010 Report advises that the most appropriate energy strategy for Northstowe is for 70% of the dwellings and 20% of the non-residential areas to be subject to micro-generation of low carbon or renewable energy, with only the remaining high density areas (30% of the residential and 80% of the non-residential) advised to be subject to district heating.

6.30. Solar thermal and solar PV panels are technologies expected to offer particular opportunities. They are robust and proven technologies that provide substantial benefits in terms of reducing CO_2 emissions and the provision of affordable energy for residents.

6.31. This conclusion has been reached after a thorough analysis of the available energy options.

6.32. As new technologies become available throughout the course of the development, these will be assessed for their applicability to the Northstowe development.

Community Scale Technologies

6.33. Community scale technologies require the use of a centralised Energy Centre and heat distribution network. The use of a central Energy Centre is relatively technology independent, in that it is less expensive to alternate the energy generating technology to reflect market conditions than it is with individual dwelling technologies.

6.34. There are a number of advantages and disadvantages that are common to all district heating technologies. These are discussed here, before considering the respective technologies.

6.35. SAP modelling of representative dwellings has been undertaken for all low carbon / renewable energy options. The result of this analysis is that whilst district heating with gas CHP can meet the required sustainability standards, it does not enable an increase in CO_2 performance over a micro-generation strategy. Both strategies meet can meet the Zero Carbon Hub Carbon Compliance criteria, but technical constraints (e.g. limited roofspace for PV panels or over-sizing of the CHP engine resulting in intermittent operation or heat dumping) prevent any significant increase on these standards. This can be seen in Appendix D Table 3b.

6.36. In addition to the technology flexibility of District heating systems, they offer a number of other advantages. These include: -

- Due to the centralisation of plant equipment, the overall amount of equipment can be reduced over individual boilers. This reduces plant equipment costs, maintenance costs and replacement costs as boilers, etc. reach the end of their life.
- The opportunity to take advantage of the economy of scale of bulk fuel purchase.

- The economic inclusion of low carbon and renewable energy generation technologies.
- Opportunity to utilise larger, and therefore more efficient, plant equipment.

6.37. However, these benefits can be eroded and lost completely if the specific development characteristics are not amenable to the effective utilisation of district heating. Factors that reduce the benefits of district heating include: -

- Relatively low heat demand density. This increases the amount of heat that is lost from the distribution pipes as a percentage of total heat demand. This is caused by two points: -
  - Low development density (i.e. dwellings per hectare)
    - This is the case for Phase 1 at Northstowe which is proposed as 37.5 dwellings per hectare. The Energy Saving Trust states that there is a positive economic case for district heating where development densities are above 50 dwellings per hectare[14].
  - Low dwelling heat demand
    - This is the case at Northstowe where the energy efficiency measures detailed in Section 5 will minimise space heating demands.
    - Considering the heat demand density is therefore recognised by BRE to increase the dwelling density at which district heating becomes economically advantageous[15].
- Low diversity of heat demand (i.e. few use types). This is the case for Phase 1 at Northstowe which is predominantly residential.

6.38. In summary, the BRE publication *IP 3/11* and the Energy Saving Trust publication, *The Performance of District Heating for New Dwellings* support the conclusion that the use of district heating at this density, particularly where the heat demands have been greatly reduced through specification of high levels of energy efficiency measures, is inappropriate.

6.39. In some instances, particularly on low density developments, the heat losses between the heat generators and the dwellings have been recorded to be as high as 30%. Such losses outweigh the benefits that can be gained through effective utilisation of district heating.

6.40. Additionally, large Energy Centres are required for developments the size of Northstowe Phase 1. It is estimated that Phase 1 would require an Energy Centre of ~500m^2. The capital costs of the Energy

[14] CE299: The Applicability of District Heating for New Dwellings, Energy Saving Trust
[15] IP 3/11: The Performance of District Heating in New Developments

Centre and heat distribution infrastructure on the low density Phase 1 have also been considered and have been concluded to be less affordable than a microgeneration strategy.

6.41. Some developments have been able to compensate for the high capital costs of district heating infrastructure on low density schemes through receiving funding and through capital contributions from Energy Services Companies (ESCOs) which secure a long-term concession for the running of the heat network. An example is the Cranbrook development in Devon. This received £4m from the HCA and will also have received a capital contribution from E.On likely to have been substantially in excess of that figure. This capital contribution will have to be recovered from residents through higher long-term energy charges. Whilst in the case of Cranbrook district heating can be made to be financially viable in capital cost due to the substantial external investment, a similar case cannot be made for affordability of energy for residents. The Joint Promoters of Northstowe are keen to ensure that in addition to following a capital cost effective energy strategy that this strategy does not negatively impact on the affordability or desirability of living in Northstowe.

6.42. On low heat density schemes, the above factors can combine to create running costs and therefore resident fuel bills that are higher than with conventional systems. On some developments, resident fuel bills can be 30-40% higher than conventional individual gas boilers. This is a crucial issue, which it is vital to avoid in order to maintain the social sustainability of the development. A concern for resident fuel bills is of particular relevance to the affordable housing, the residents of which would be the least able to pay the higher energy bills that inappropriate use of district heating can cause.

6.43. Market resistance to the provision of district heating systems from housing developers and residents must also be considered. Such resistance is particularly important where it cannot be demonstrated that the benefits of district heating outweigh the costs. This is likely to be the case on low density developments where the heat distribution losses increase to such an extent that the residents must pay for the energy required to heat their homes as well as that lost between the Energy Centre and the dwelling.

6.44. This Energy Statement has therefore concluded that due to the low density of Phase 1 that district heating is an inappropriate strategy to adopt.

Gas Combined Heat and Power (CHP)

6.45. CHP is a form of decentralised energy generation that generally uses gas to generate electricity for local consumption, reducing the need for grid electricity and its associated high CO_2 emissions. As the CHP system is close to the point of energy demand, it is possible to use the heat that is generated during the electricity generation process. Through the use of heat distribution pipes, the generated heat is taken from the Energy Centre to each dwelling. As both the electricity and heat from the generator is used, the efficiency of the system is increased above that of a conventional power plant where the heat is not utilised.

6.46. In addition to the sale of heat to dwellings, the electricity generated from the CHP engine can be sold to the electricity grid or local large electricity demands. The dual sale of heat and electricity makes gas CHP one of the most economic of the community scale technologies. Furthermore, gas CHP is a mature technology that has been widely used.

6.47. Gas CHP engines cause the emission of oxides of nitrogen, which are substances known to cause breathing difficulties in humans in high concentrations.

6.48. Gas CHP engines can enable substantial reductions in CO_2 emissions, providing that the development characteristics are amenable to the use of district heating. The summary of SAP energy calculations for CHP in Appendix D Table 3b shows that maximising CHP to provide 75% of the total heat demand enables the representative dwellings to meet the Zero Carbon Hub Carbon Compliance levels. This is the same CO_2 standard as met through a microgeneration strategy and represents the maximum that gas CHP can facilitate.

Renewable (biomass or biofuel) Combined Heat and Power

6.49. Renewable fuelled CHP operates in the same way as gas CHP, but utilises a renewable fuel rather than gas. In utilising a renewable fuel, higher reductions in CO_2 emissions than with gas are possible.

6.50. Despite enabling high CO_2 reductions, biofuel/biomass CHP is not yet a mature technology and there are few instances of its use in the UK, particularly in urban environments. This causes a number of issues that combine to result in the fact that renewable CHP is not currently the most favoured of the community scale technologies: -

- High emission rates of oxides of nitrogen and particulate matter, which cause respiratory and cardiovascular illnesses. Emissions are higher than with gas CHP or heat only biomass boilers.
- Higher capital cost to gas CHP
- Maintenance requirements are high, thus increasing running costs, which are passed on to residents.

6.51. Furthermore, on a development the size of Northstowe Phase 1, the fuel requirements are very high. For a biomass CHP sized to provide 70% of the Phase 1 heat demands, a 1.1MWe CHP engine would be required. The fuel inputs to this are 3,600tonnes of biomass a year. Based on a delivery vehicle size of 18tonnes, this is 200 deliveries per year. To provide the minimum storage of 14 days fuel, a fuel store of 205m^3 is required. This is a significant land requirement.

Heat Only Biomass Boilers

6.52. Biomass boilers generate heat from renewable biomass fuel, which is effectively carbon neutral.

6.53. As they generate only heat, the reductions in CO_2 possible are lower than biomass CHP and are close to what gas CHP can achieve.

6.54. Biomass boilers emit oxides of nitrogen and particulates, although in lesser quantities than biomass CHP does.

6.55. As for biomass CHP, biomass boilers will require large volumes of fuel to be delivered and therefore also large fuel storage requirements on site.

6.56. Biomass boilers are to be eligible for the 'Renewable Heat Incentive', which like the Feed-in-Tariff, is to provide payments for the generation of renewable heat. Despite this, biomass boilers are likely to remain less economically attractive than gas CHP engines as they don't produce electricity which provides a greater operational income.

Summary

6.57. Consideration has been given to the technical and economic viability of utilising district heating for Phase 1 of the Northstowe development. It has been concluded that the specific characteristics of Phase 1, particularly the relatively low density, mean that the utilisation of district heating for Phase 1 is not likely to be technically or economically viable. The low heat density would create distribution heat losses that substantially increase the capital and operational cost of the network.

6.58. This conclusion is in line with the Renewables East June 2010 report which recommends that the most appropriate strategy for Northstowe is for 30% (the high density town centre and employment areas) of the development to be subject to district heating, with the remainder (including Phase 1) subject to a microgeneration strategy.

6.59. Furthermore, this strategy is in line with the Zero Carbon Homes trajectory and the viability analysis that the Zero Carbon Hub are undertaking, which focuses on insulation improvements and the required areas of PV panels to meet the required standards.

6.60. The viability and appropriateness of utilising localised heat networks for the non-residential areas of Phase 1 will be examined on a building-by-building basis.

Large Scale 'Private Wire' Technologies

6.61. In addition to the individual dwelling technologies and the community scale technologies that provide a direct connection to each dwelling, large scale renewable energy technologies can be utilised and counted towards the development if they are connected directly to the development via a 'private wire' rather than to the national electricity grid.

6.62. Large scale technologies include Medium Scale Wind Turbines and PV arrays.

6.63. There are a number of issues common to both of these large scale technologies. The main issue is that a direct electricity connection to dwellings creates a monopoly position for the provider of the electricity. Due to the 'Citiworks' case there are concerns that private wires to dwellings are illegal under European Law. On this basis, the generated electricity must be fed to the electricity grid rather than the development. Consequently, the CO_2 reductions that they enable cannot be considered as onsite reductions.

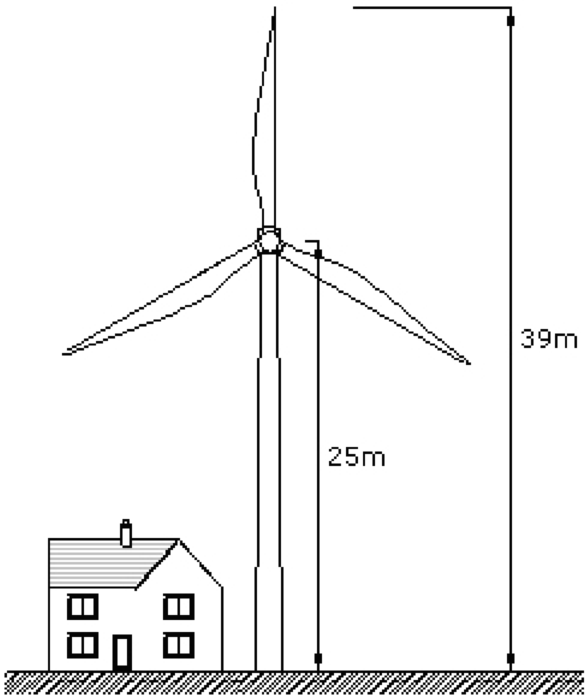
6.64. However, bilateral agreements can be made between the electricity generator and the owners of non-residential buildings. There will be potential links to the employment and community facilities within Phase 2 and also the Secondary School. Providing suitable agreements for the supply of generated electricity can be put in place, the electricity generated can therefore be counted as on-site generation.

6.65. Should it prove to not be possible to agree suitable bilateral arrangements with the non-residential buildings for the sale of generated electricity, Medium Wind Turbines and PV arrays would therefore be considered within the Allowable Solutions section of the Zero Carbon Home framework.

6.66. Of the two technologies, medium scale wind turbine(s) are likely to offer the best opportunity for the economically viable generation of a significant level of renewable energy.

6.67. In addition to the microgeneration strategy detailed above, the Joint Promoters are keen to explore the economic and technical viability of providing medium scale wind turbine(s) in the Northstowe area. An area of search will be defined and consultants appointed to undertake a detailed viability study.

6.68. Gallagher are keen to ensure that any wind turbine(s) that are to be installed are appropriate and in keeping with the landscape in and around Northstowe. It is therefore likely that medium (~300kW) turbine(s) will be deemed to be more suitable for Northstowe than large (~2MW) turbine(s). The diagram below illustrates the relative scale of a medium wind turbine in relation to a dwelling.



250kW Turbine

6.69. In addition to generating a substantial amount of renewable energy, the provision of medium scale wind turbine(s) would make an important statement in support of the Joint Promoters intention for Northstowe to be a sustainable community and would represent an exemplar project in line with the objectives of Policy NS/23 of the NAAP. The very visible statement that medium scale turbine(s) would make about the sustainability credentials of Northstowe would serve to highlight the other less visible sustainability features such as the high levels of energy efficiency that are proposed and the microgeneration strategies that will enable dwellings to meet the 'Zero Carbon Home' standard: the exemplar in energy performance for dwellings.

6.70. The Government's NOABL database provides an indication of mean annual wind speeds, which in the area are given as 5.7m/s at a 25m hub height. There is also open land to the southwest (the direction of the prevailing winds) of the Northstowe site. These features make the site a favourable one for a wind turbine(s). However, a detailed site viability analysis is required to ensure that a turbine(s) would generate sufficient electricity to be economically viable. This viability study is likely to involve the measuring of wind conditions at the proposed site over the course of a full calendar year. This study would also ensure that it was possible to locate a wind turbine(s) in such a place that did not cause adverse impacts (sound or shadow-flicker) to existing or future proposed dwellings.

6.71. Gallagher is committed to fully investigating the viability of medium scale turbine(s). Should the results of this study prove positive it is the intention of Gallagher to submit a separate planning application for a wind turbine(s).

6.72. The delivery of this technology under a community ownership model will be explored, should their construction be viable.

Education

6.73. In order to ensure that all residents are able to make the most effective use of whichever low carbon or renewable energy technologies are specified for their home, Gallagher will prepare and fund an energy awareness campaign. This will include advice on effectively using the technologies that are installed in dwellings.

7. Performance Commitments for Renewable / Low Carbon Energy Generation

7.1. Due to the expected construction timetable for Phase 1 extending over a number of years, it is expected that there will be changes in Building Regulations requirements, changes to the assessment methodologies (SAP & SBEM), technological advancements and changing costs of technologies, all of which would impact on the selection of the most appropriate low carbon and renewable energy technologies to meet the required standards. It is therefore considered appropriate at this Outline Planning Application stage to provide a Schedule of Performance Commitments by which the required CO_2 reductions and renewable / low carbon energy generation will be achieved on each of the sub-phases. This is in line with Policy NS/2 of the Northstowe Area Action Plan which looks for a flexible design.

7.2. Many of the individual dwelling and community scale technologies discussed in Section 6 are technically and economically possible and usable, or are expected to be, within the timeframe of the Phase 1 development. These commitments are designed to ensure that through the application of these technologies that the following exemplar sustainability standards are met, and thus ensure that a coherent development is created:

1. To meet the Zero Carbon Hub Fabric Energy Efficiency standard. It is expected that this will facilitate an 8.6% reduction in regulated CO_2 emissions over Building Regulations (2010).
2. Dwellings from 2016 will be built to amended Building Regulations (2016) requirements and any subsequent revisions. This will take account of the Government's final decision on low/zero carbon requirements including the proposed Fabric Energy Efficiency Standard, Carbon Compliance and Allowable Solutions.
3. In excess of 10% of total energy to be provided from on-site low carbon / renewable energy technologies. Current calculations show that the low carbon / renewable energy microgeneration will be 11-15%
4. Recognising the long-term option for the use of district heating on the wider Northstowe development, to apply where appropriate and possible, on a localised basis (in the interim at least), the use of district heating infrastructure within Phase 1 for the non-residential development. This begins to create a base load which the wider Northstowe development could build on, should it be viable to do so. The appropriateness of district heating for the non-residential areas of Phase 1 will

therefore be examined and explored at the detailed design stage of each non-residential building.

7.3. Each Sub-Phase is required to comply with the above performance standards. The opportunity for the inclusion of new or different technologies on later sub-phases is retained with this flexible approach to defined performance standards.

7.4. In order to ensure that the standards detailed above are met on all Phase 1 sub-phases, it is proposed that Energy Statements will be submitted for each sub-phase at the detailed design stage. These energy statements will include commitments on the use of particular low carbon / renewable energy technologies, with the proportion generated from these technologies illustrated and confirmed through sample SAP calculations. These specific technologies will then be delivered on each sub-phase and compliance with the performance standards detailed above shown with As Built SAP calculations.

7.5. In addition to the microgeneration technologies to be provided on each sub-phase, it is the intention of Gallagher to, pending viability assessment, to submit an application for the construction of medium scale Wind Turbine(s) to increase the proportion of energy provided by low carbon / renewable energy technologies.

8. Expected Phase 1 Overall On-site Renewable / Low Carbon Energy Generation

8.1. As stated above, it is not appropriate due to the timescales of the proposed development for this Energy Statement to stipulate the precise low carbon or renewable energy technologies that each sub-phase on Phase 1 will adopt, but rather to provide a Schedule of Commitments by which the exemplar Building Regulations standards up to 'Zero Carbon Homes' in 2016 will be met.

8.2. However, based on example low carbon/renewable energy strategies it is possible to determine the likely on-site renewable energy generation for a given strategy. Table 8, below illustrates the renewable energy generation, as a proportion of the total energy demand of the site, if the only renewable energy technology used across the site is PV panels.

Table 8: Example Renewable Energy Generation - PV Panels	
Total Energy Demand (kWh/yr)	14,310,000
Renewable Energy Generation (kWh/yr)	1,547,700
Renewable Energy Generation	**11%**

8.3. The 11% renewable energy generation exceeds the 10% policy requirement.

8.4. It can be seen in Appendix D (Option 2) that using solar thermal panels on the dwellings for Building Regulations (2013) compliance and PV panels for 2016 compliance enables the renewable energy generation to be increased to 13%.

8.5. It is stated within the Energy Strategy Schedule of Commitments that the technical and economic viability of utilising localised communal heat networks within the non-residential areas will be examined on a building-by-building basis. This strategy is represented in Appendix D with Option 3, which gives renewable energy generation of 15%.

8.6. It is therefore expected that following the Schedule of Commitments defined in this Energy Statement (Section 7) which meets the exemplar escalating Building Regulations requirements up to 'Zero Carbon Homes' in 2016, will enable a renewable energy generation on Phase 1 between 11% and 15% as a minimum, depending on the specific energy strategies to be adopted for each sub-phase and non-residential building.

Options for Increasing the Low Carbon / Renewable Energy Generation

8.7. Gallagher is committed to examining a range of options for increasing the low carbon / renewable energy generation above the 11-15% detailed above with a view to exceeding the aspiration of 20% detailed within the NAAP. One technology with particular potential is the construction of medium scale Wind Turbine(s), which was discussed in Section 6.

8.8. At this stage, prior to a full viability study, it is only possible to estimate the renewable energy generation of a wind turbine(s) for Northstowe Phase 1. On the basis of providing 1MW of wind turbine(s) and assuming a capacity factor (allows for periods of low wind conditions) of 30%, the renewable energy generation would be **2,628,000 kWh/yr**. This initiative would increase the low carbon / renewable energy generation to **34%** if the full generation of the turbine(s) was fed into Phase 1 of the development. This possible strategy is represented as Option 3b in Appendix D.

8.9. The use of emerging technologies will also be examined at the appropriate times to assess the viability of utilising these to further increase the proportion of energy generated from low carbon or renewable energy technologies.

8.10. It is envisaged that the outcome of these studies and examinations will enable the low carbon / renewable energy generation to increase substantially above the 11-15% detailed above and exceed the 20% aspiration of the Northstowe Area Action Plan for Phase 1.

9. 'Allowable Solutions'

9.1. Allowable Solutions are the third and final stage of the Government's 'Zero Carbon' Homes framework. As stated in Section 3, Allowable Solutions must cover the remaining regulated CO_2 emissions after the Fabric Energy Efficiency and Carbon Compliance levels have been met.

9.2. Whilst preference will be given to on-site reductions in CO_2 emissions and low carbon / renewable energy generation, it is recognised by the Government that it may not be technically and economically viable to achieve the full Zero Carbon onsite. Therefore, the Government's Zero Carbon framework makes provision for 'allowable solutions', enabling the CO_2 emissions that cannot be viably achieved onsite, to be achieved with alternative measures that do not form part of the SAP / SBEM assessment methodologies. These are discussed below.

9.3. The Allowable Solutions requirement for Building Regulations (2016) is the remaining regulated CO_2 emissions after the carbon compliance level has been reached. Table 9, below, shows the estimated Allowable Solutions requirement for Phase 1, based on the current Zero Carbon Hub Framework.

Table 9: Allowable Solutions

Unit Type	**Allowable Solutions (kg.CO_2/yr)**
Residential	1,049,900
Non-Residential	70,100
Total	**1,120,000**

9.4. The Zero Carbon Hub document *Allowable Solutions for Tomorrow's New Homes: Towards a Workable Framework,* published in July 2011 provides the most recent thinking on Allowable Solutions.

9.5. This document states that:

"Allowable Solutions are a new concept. The developer will make a payment to an Allowable Solutions provider, who will take responsibility and liability for ensuring that Allowable Solutions, which may be small, medium or large scale carbon saving projects, deliver the required emissions reductions. Allowable Solutions are central to ensuring that achieving zero carbon is affordable"

9.6. Evidence of Allowable Solutions will be required to be submitted as part of the Building Control approval for compliance with Building Regulations (2016).

9.7. The possible 'Allowable Solutions' have been categorised into three types by the Zero Carbon Hub, with examples of each given: -

- On-Site (but not duplicating Carbon Compliance measures)
  - Smart Appliances
  - Electric vehicle charging points
  - LED street lights
- Near-Site (within the Local Planning Authority area in which the development is built)
  - Export of heat from a district heating system to external demands
  - Large or medium scale wind turbines
- Off-Site (outside the Local Planning Authority area in which the development is built)
  - Investment in low carbon electricity generation assets up to a maximum determined scale (e.g. excluding offshore)

9.8. The proposed Framework Model provides two possible delivery routes: -

- Local Planning Authority Prescribed Allowable Solutions
  - Designed to enable the Local Planning Authority to specify the particular Allowable Solutions that best align with their strategic energy and climate change mitigation vision for their area.
  - Likely to require that the Planning Authority has developed an acceptable Allowable Solutions Policy within the Local Plan.
  - The possibility of Community Energy Funds announced by the Housing Minister, Grant Shapps in 2010 would fit within this route.
- Allowable Solutions through Private Energy Funds
  - This route is proposed as a viable default approach in the absence of an established Local Planning Authority policy on Allowable Solutions.

9.9. The Applicant is keen to ensure that, wherever possible, the benefits of Allowable Solutions are gained by the local community and would welcome discussions with a Cambridgeshire Community Energy Fund. Application of Allowable Solutions within the vicinity of Northstowe could include, as an example, energy efficiency improvements for the neighbouring villages of Longstanton and Oakington.

Near-Site Large Scale Renewable Energy Generation

9.10. If it is not possible to agree bilateral agreements for the sale of electricity to non-residential buildings (for instance employment or community facilities within Phase 2 or the Secondary School) then the development of local, near-site, large-scale renewable energy generation technologies such as medium scale wind turbines and PV arrays would be considered as Allowable Solutions rather than onsite carbon compliance measures.

9.11. As discussed in Section 8, Gallagher are committed to undertaking a full technical and economic viability study of installing a medium scale wind turbine(s) and submitting a planning application should this study prove positive.

9.12. In addition to looking at wind turbines and PV arrays, an examination will be undertaken at the appropriate time to assess the full range of Allowable Solutions with a view to selecting the most beneficial options for the Northstowe development and the local community.

10. Integration with Wider Northstowe Development

10.1. Phase 1 forms the northern part of the proposed Northstowe development and is at a lower density compared to the town centre, the main employment area and other large strategic land uses including the secondary school which will be located in later phases of development. The joint promoters are keen to ensure that a coherent approach is taken to Northstowe. It has been concluded that this coherence is best provided by following the most appropriate strategy for the specific characteristics of each phase, with the technologies used being sympathetic to each area. It is therefore appropriate that low density areas may be subject to a different low carbon / renewable energy strategy than higher density areas.

10.2. There remains the option for the utilisation of district heating networks within the wider Northstowe development, with the high density central sections offering the best opportunities. In these areas, the benefits of district heating begin to outweigh the disadvantages that are present on the lower density sections.

10.3. Work undertaken by Renewables East (*Provision of Zero Carbon Energy for the Northstowe Eco-Town Development* (dated June 2010)) suggests that the optimum technical solution for the whole Northstowe development involves the use of district heating for the central high density portion of the development (~30% of the total dwellings), with micro-generation technologies recommended for the remainder (~70% of the total dwellings) of the development. The Renewables East June 2010 report represents a substantial revision to the Renewables East May 2009 Report, which recommended that the most appropriate strategy was for 80% of the development to be subject to district heating. This revision reflects changes to the proposals for the Northstowe development and the sustainability standards to be met.

10.4. It should be noted that a number of factors have changed since the Renewables East report was published in June 2010. For instance, the former Labour Governments Eco-town concept has not been adopted by the current Government.

10.5. The Schedule of Commitments detailed within this Energy Strategy (Section 7) is therefore in line with the Renewables East Report, in that it proposes that Phase 1, in the main, follows an individual dwelling strategy, rather than community heating.

10.6. The non-utilisation of district heating on Phase 1 does not compromise the potential delivery of district heating on subsequent phases, should it be considered appropriate to provide this.

Conversely, by not utilising district heating on Phase 1, where it is considered technically and economically inappropriate, Phase 1 would not have a negative influence on the viability of district heating on later phases. These later phases may be viable for district heating as single entities, but if they had to balance out the negative impact of Phase 1, may become less viable.

10.7. Were district heating to be considered appropriate for Phase 2 or subsequent phases then the Energy Centre(s) for this would most likely be located either in the high density town centre area, where building heights are at the maximum, or in the employment area. As both of these are outside the Phase 1 area, then Phase 1 does not impact on the potential viability of bringing forward a variety of energy strategies, including district heating, on subsequent phases, nor affect the coherence of the development.

10.8. It is the Applicant's intention that the economic and technical viability of utilising district heating, including the provision of CHP, for the high density parts of the Northstowe development will be fully examined and explored. The Joint Promoters are therefore committed for Phase 2 and later phases containing the town centre commercial uses, higher density residential development, the main employment area and large uses like the secondary school to be subject to detailed technical and financial assessment. The main employment area and town centre are likely to be the optimum location for district heating Energy Centre(s) as the development progresses in stages. In the first instance the district heating network would probably include modular gas-fired CHP, but this will be subject to detailed technical and economic viability analysis.

10.9. It has been proposed that a collaborative district heating study focussed on Phase 2 and subsequent phases be undertaken by South Cambridgeshire District Council (SCDC) and the Joint Promoters. With funding for this from SCDC, the Joint Promoters welcome this study and will actively participate.

10.10. This examination will take into account all relevant factors, with a particular focus on adopting an Energy Strategy that will effectively deliver high quality and desirable 'Zero Carbon' Homes that are technically & economically viable and socially acceptable to build and to live in. This examination should therefore consider the following points: -

- The possible CO_2 reductions
- The Capital Costs
- The running costs – residents fuel bills

10.11. As one of the three pillars of sustainability, the social aspects of energy strategies must also be considered. It is recognised that there is possible market resistance to district heating from both housing developers and also prospective residents. This is particularly the case where it cannot be demonstrated that the energy costs of district heating are below that of a conventional individual gas boiler system.

10.12. It was stated in Section 10 that it is expected that Phase 1 will generate 11-15% of its total energy from low carbon or renewable energy technologies. This exceeds the planning policy requirement of 10%, but is short of the 20% that the Northstowe development is to aim for. Calculations have been undertaken to illustrate what the low carbon or renewable energy generation would be if district heating with Gas CHP was to be used for the later higher density phases. These calculations show that if district heating and CHP were to be used, that ~50% of the total energy demand of the connected dwellings/buildings would be generated from low carbon or renewable energy technologies, whilst meeting the same exemplar CO_2 standards of the Zero Carbon Home.

10.13. Therefore, it can be expected that if district heating is used on the later phases of Northstowe, that the overall percentage of the development's total energy demand that is generated from low carbon or renewable energy technologies will increase significantly from the 11-15% that is expected for Phase 1.

10.14. If the town centre areas and other large uses such as the secondary school were to be connected to district heating and CHP then it is to be expected that the **20%** low carbon / renewable energy target would be significantly exceeded for the whole site. Substantial use of district heating and CHP coupled with the construction of medium scale Wind Turbine(s) is likely to increase the low carbon / renewable energy generation above **30%** for the whole site.

11. Summary

11.1. This Energy Strategy has been prepared to ensure that Phase 1 of the Northstowe development meets the Joint Promoters sustainability aspirations and key development priorities, all Building Regulations requirements and planning targets and to provide an appropriate, deliverable and viable strategy that reflects the three aspects of sustainability: environmental, economic and social.

11.2. The headline energy requirements that the development is subject to are: -

- To be an exemplar in sustainability, whilst maintaining the viability of the development

- To generate at least 10% of total energy demand from low carbon or renewable energy technologies, and aiming for 20%.
- To meet the escalating requirements of Building Regulations
  - Dwellings from 2016 will be built to amended Building Regulations (2016) requirements and any subsequent revisions. This will take account of the Government's final decision on low/zero carbon requirements including the proposed Fabric Energy Efficiency Standard, Carbon Compliance and Allowable Solutions.

11.3. Energy efficiency measures have been prioritised. The measures detailed enable the Zero Carbon Hub Fabric Energy Efficiency Standards to be met. Furthermore, the energy efficiency measures detailed will enable Building Regulations (2010) to be substantially exceeded (3-12% depending on dwelling type) through energy efficiency alone. This exceeds policy requirements.

11.4. In line with the Renewables East June 2010 report and the August 2011 Cost Review of the Code for Sustainable Homes, this Energy Statement has concluded that it is likely that the most appropriate energy strategy for Phase 1 is to follow a microgeneration strategy based on individual dwelling gas boilers and renewable energy technologies including principally the use of solar thermal and PV panels. Due to the relatively low density of Phase 1, the widespread utilisation of district heating is unlikely to be technically and economically viable.

11.5. This Energy Statement provides a Schedule of Commitments for the provision of energy efficiency low carbon and renewable energy technologies. These commitments are designed to ensure that through the application of these technologies that the following exemplar sustainability standards are met:

1. To meet the Zero Carbon Hub Fabric Energy Efficiency standards. It is expected that this will facilitate an 8.6% reduction in regulated CO_2 emissions over Building Regulations (2010).
2. Dwellings from 2016 will be built to amended Building Regulations (2016) requirements and any subsequent revisions. This will take account of the Government's final decision on low/zero carbon requirements including the proposed Fabric Energy Efficiency Standard, Carbon Compliance and Allowable Solutions.
3. In excess of 10% of total energy to be provided from on-site low carbon / renewable energy technologies. Current calculations show that the low carbon / renewable energy microgeneration will be 11-15%.

4. Recognising the long-term option for the use of district heating on the wider Northstowe development, to apply where appropriate and possible, on a localised basis (in the interim at least), the use of district heating infrastructure within Phase 1 for the non-residential development. This begins to create a base load which the wider Northstowe development could build on, should it be viable to do so. The appropriateness of district heating for the non-residential areas of Phase 1 will therefore be examined and explored at the detailed design stage of each non-residential building.

11.6. The Joint Promoters are committed to undertaking a detailed technical and financial assessment of the potential for district heating including the provision of CHP for Phase 2 and later phases containing the town centre commercial uses, higher density residential, main employment area and large uses such as the secondary school. It is expected that such provision will increase the low carbon / renewable energy generation above 20% for the whole site.

11.7. In addition to the microgeneration strategy, the Joint Promoters are keen to explore the economic and technical viability of providing medium scale wind turbine(s) in the Northstowe area. An area of search will be defined and consultants appointed to undertake a detailed viability study. Subject to the outcome of a detailed viability study for this, a separate planning application will be made. The provision of medium scale Wind Turbine(s) and substantial use of district heating (with CHP) in the town centre and higher density residential areas and main employment areas, it is projected that the low carbon / renewable energy generation will be above **30%**.

11.8. The headline sustainability measures proposed for Northstowe are: -

- High levels of energy efficiency in line with the Zero Carbon Hub Fabric Energy Efficiency requirements for the 'Zero Carbon Home'. It is expected that Phase 1 will reduce CO_2 emissions by 8.6% over Building Regulations (2010) through energy efficiency alone.
- Dwellings from 2016 will be built to amended Building Regulations (2016) requirements and any subsequent revisions. This will take account of the Government's final decision on low/zero carbon requirements including the proposed Fabric Energy Efficiency Standard, Carbon Compliance and Allowable Solutions. This is the exemplar standard for the energy performance of dwellings.
- Generation of in excess of 10% total energy from low carbon or renewable energy technologies.

- Pending the positive outcome of a viability study, an application is to be put forward for the construction of medium scale Wind Turbine(s) to increase the low carbon / renewable energy generation proportion above 20%.

11.9. The table below summarises the project requirements and the proposals for Northstowe that address these requirements.

Summary Table: Planning Policy Compliance		
Policy Requirement		**Northstowe Proposals**
Policy Target	Energy Efficiency: **10%** Reduction in regulated CO_2 emissions over **Building Regulations (2006)**	**31%** reduction in regulated CO_2 emissions over **Building Regulations (2006)**
	Low Carbon / Renewable Energy Generation: **10%** after energy efficiency	**11%-15%** achieved on a dwelling scale
Policy Aspiration	Low Carbon / Renewable Energy Generation: **20%** after energy efficiency	In addition to the above, a viability study is to be undertaken for the provision of medium scale wind turbine(s), which increases renewable energy generation **above 20%** for Phase 1
Building Regulations Requirements	Building Regulations (2016): 'Zero Carbon Home'	Zero Carbon Hub Fabric Energy Efficiency and Carbon Compliance standards to be met, with Allowable Solutions for the remainder

Appendices

A) **Phase 1 & Framework Masterplans**

B) **Low Carbon and Renewable Energy Technologies**

C) **Feasibility Table of Low Carbon and Renewable Energy Technologies**

D) **Summary of Energy Calculations (SAP 2009 and SBEM 2010 Outputs)**

E) **Glossary**

F) **Assessment of Roofspace Practicality of PV Panels to Zero Carbon Hub Carbon Compliance for Range of Sample House Types**

Appendix A:

Phase 1 & Framework Masterplans

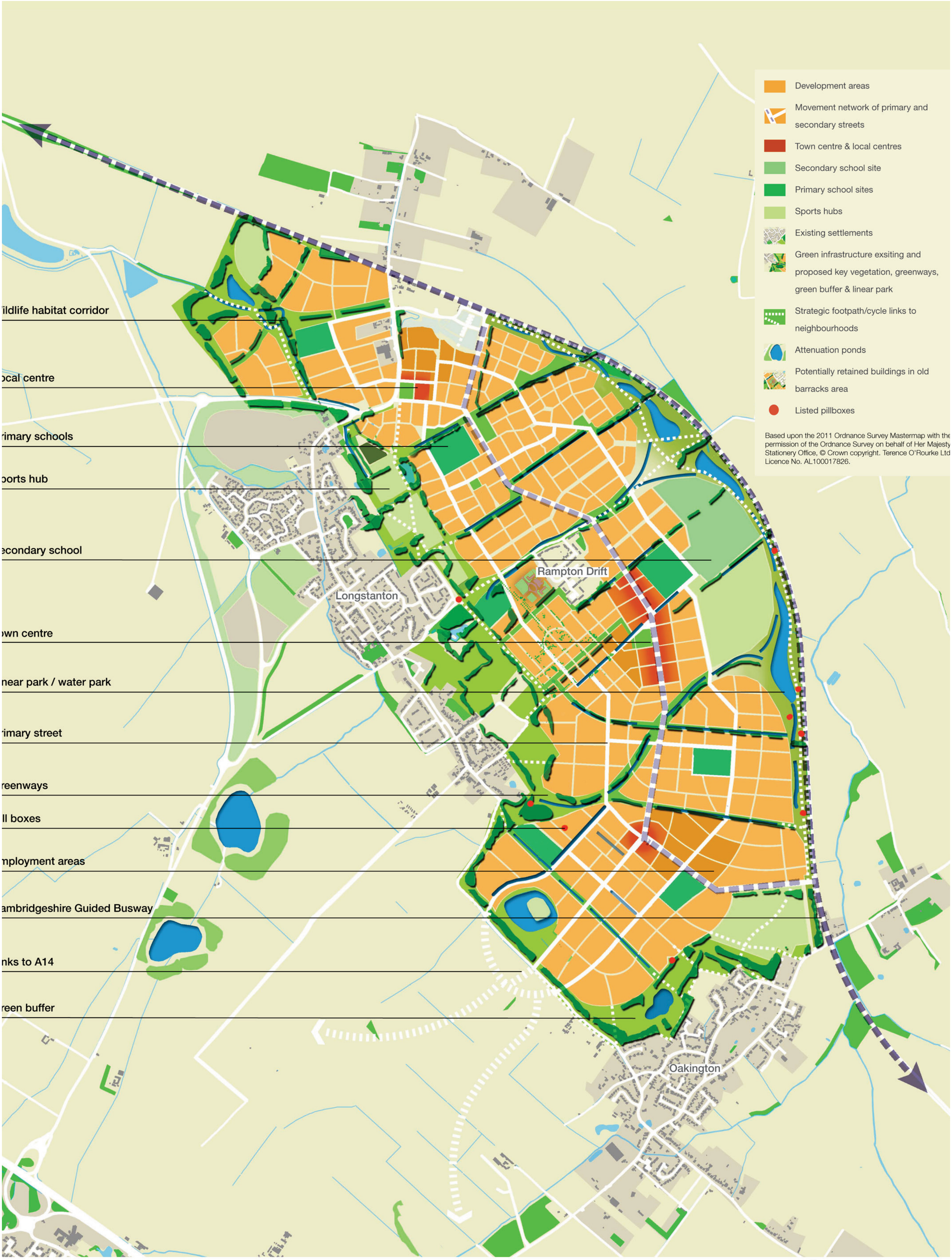
Gallagher
Northstowe

Northstowe

ILLUSTRATIVE MASTER PLAN - PHASE 1

Phase 1
Illustrative Master Plan
February 2012
Scale. 1.5000@A3

Terence O'Rourke Ltd
creating successful environments


Development areas
Movement network of primary and secondary streets
Town centre & local centres
Secondary school site
Primary school sites
Sports hubs
Existing settlements
Green infrastructure exsiting and proposed key vegetation, greenways, green buffer & linear park
Strategic footpath/cycle links to neighbourhoods
Attenuation ponds
Potentially retained buildings in old barracks area
Listed pillboxes
Based upon the 2011 Ordnance Survey Mastermap with the permission of the Ordnance Survey on behalf of Her Majesty Stationery Office, © Crown copyright. Terence O'Rourke Ltd Licence No. AL100017826.
ildlife habitat corridor
ocal centre
rimary schools
ports hub
econdary school
own centre
near park / water park
rimary street
reenways
ll boxes
mployment areas
ambridgeshire Guided Busway
nks to A14
reen buffer
Rampton Drift
Longstanton
Oakington
0m 50m 100m 200m 300m 400m 500m

Appendix B:

Low Carbon and Renewable Energy Technologies

Introduction

- This Appendix is intended to provide the background information for the low carbon and renewable energy technologies that have been considered in the formulation of this Energy Statement.

- The information provided here forms the basis for the project specific technical selection of low carbon/renewable energy technologies contained in the main section of this Energy Statement.

Combined Heat and Power (CHP)

- CHP is a form of decentralised energy generation that generally uses gas to generate electricity for local consumption, reducing the need for grid electricity and its associated high CO_2 emissions. As the CHP system is close to the point of energy demand, it is possible to use the heat that is generated during the electricity generation process. As both the electricity and heat from the generator is used, the efficiency of the system is increased above that of a conventional power plant where the heat is not utilised. However, the overall efficiency of ~80% is still lower than the ~90% efficiency of a heat only gas boiler.
- Where there are high thermal loads, CHP can be used within district heating networks to supply the required heat.
- **Performance and Calculation Methodology: -** Most commonly sized on the heat load of a development, not the electrical load. This prevents an over-generation of heat.
  - Require a high and relatively constant heat demand to be viable.
  - CHP engines are best suited to providing the base heating load of a development (~year round hot water demand) with conventional gas boilers responding to the peak heating demand (~winter space heating). CHP engines are not able to effectively respond to peaks in demand.
  - In general, CHP engines have an electrical efficiency of ~30% and a thermal efficiency of ~45%.
  - Electricity produced by the CHP engine displaces grid electricity which is given a carbon intensity of 0.529 kg per kWh.
- **Capital Cost: -** High in comparison to biomass boilers.
  - Relative cost reduces as the size of engine increases.
- **Running Costs/Savings: -** CHP engines often struggle to provide cost-effective energy to dwellings on residential schemes.
  - Running costs and maintenance are higher than for domestic gas boilers.
  - Needs Private Wire supply for economic case to be positive.
- **Land Use Issues and Space Required: -** CHP engines require a plant room, and possibly an energy centre for large residential developments.
  - CHP engines require a flue to effectively disperse pollutants. The height of the chimney required is dependent on the size of the engine installed.
  - Heat network issues.

- **Operational Impacts/Issues: -** Required to be run by Energy Services Company (ESCo) who are unenthusiastic about getting involved in small – medium scale schemes.
  - Issues with rights to dig up roads for district heating networks.
  - Emissions of nitrous oxides – ~1000mg/kWh – 20 times higher than for a gas boiler.
- **Embodied Energy: -** Comparable to that of a conventional gas boiler.
- **Funding Opportunities: -** Tax relief for businesses under the Enhanced Capital Allowances scheme.
- **Reductions in Energy Achievable: -** Can provide some reductions in effective primary energy, but when distribution losses and other local losses are included more fuel is required.
- **Reductions in CO_2 Achievable: -** Can provide greater reductions in CO_2 than energy, aided by the emissions factor of grid displaced electricity of 0.529 kg CO_2/kWh.
- **Advantages: -** Good reductions in overall primary energy and CO_2 emissions.
- **Disadvantages: -** More expensive and greater NO_x emissions than a biomass boiler.
  - Often do not supply energy cost-effectively in comparison to the market.
  - Requires Private Wire network to maximise cost effectiveness.

Combined Cooling Heat and Power (CCHP)

- CCHP is a CHP system which additionally has the facility to transform heat into energy for cooling. This is done with an absorption chiller which utilises a heat source to provide the energy needed to drive a cooling system. As absorption chillers are far less efficient than conventional coolers (CoP of 0.7 compared to >4) they are generally only used where there is a current excess generation of heat. New CHP systems are generally sized to provide the year round base heating load only.
- For this reason it is generally not suitable for new CHP systems to include cooling.
- Where there are high thermal loads, CCHP can be used within district heating and cooling networks to supply the required heat and coolth.
- **Performance and Calculation Methodology: -** Most commonly sized on the heat load of a development, not the electrical load. This prevents an over-generation of heat.
  - Require a high and relatively constant heat and cooling demand to be viable.
  - CCHP systems are best suited to providing the base loads of a development with conventional gas boilers and chillers responding to the peak demands. CCHP systems are not able to effectively respond to peaks in demand.
  - In general, CHP engines have an electrical efficiency of ~30% and a thermal efficiency of ~45%.
  - Absorption chillers have a CoP of ~0.7.

- Electricity produced by the CHP engine displaces grid electricity which is given a carbon intensity of 0.529 kg per kWh.

- **Capital Cost: -** High in comparison to biomass boilers and increased further by inclusion of absorption chiller.
  - Relative cost reduces as the size of engine increases.
- **Running Costs/Savings: -** CHP engines often struggle to provide cost-effective energy to dwellings on residential schemes.
  - Running costs and maintenance are higher than for domestic gas boilers.
  - Needs Private Wire supply for economic case to be positive.
- **Land Use Issues and Space Required: -** CHP engines require a plant room, and possibly an energy centre for large residential developments.
  - CHP engines require a flue to effectively disperse pollutants. The height of the chimney required is dependent on the size of the engine installed. Additionally the absorption chiller requires either a cooling tower or dry cooler bed for heat rejection purposes.
  - Heat network issues.
- **Operational Impacts/Issues: -** Required to be run by an ESCo who are unenthusiastic about getting involved in small – medium scale schemes.
  - Issues with rights to dig up roads for heat networks.
  - Emissions of nitrous oxides – ~1000mg/kWh – 20 times higher than for gas boilers.
- **Embodied Energy: -** Comparable to conventional gas boilers.
- **Funding Opportunities: -** Tax relief for businesses under Enhanced Capital Allowance scheme.
- **Reductions in Energy Achievable: -** Can provide some reductions in effective primary energy, but when distribution and other local losses are included, more fuel is required.
- **Reductions in CO_2 Achievable: -** Can provide greater reductions in CO_2 than energy, aided by the emissions factor of grid displaced electricity of 0.529 kg CO_2/kWh.
- **Advantages: -** Good reductions in overall primary energy and CO_2 emissions.
- **Disadvantages: -** More expensive and greater emissions of NO_x than biomass.
  - Often do not supply energy cost-effectively in comparison to the market.
  - Requires Private Wire network to maximise cost effectiveness.

Biomass Boilers

- Biomass boilers generate heat on a renewable basis as they are run on biomass fuel which is carbon neutral. Fuel is generally wood chip or wood pellets. Wood pellets are slightly more expensive than wood chips but have a significantly higher calorific value and enable greater automation of the system.

- Can be used with district heating networks or as individual boilers on a house-by-house basis.
- **Performance and Calculation Methodology: -**
  - Biomass boilers are best suited to providing the base heating load of a development (~year round hot water demand) with conventional gas boilers responding to the peak heating demand (~winter space heating).
  - Operate with an efficiency of 87-91%.
  - Small models available.
  - Conflicts with CHP they are both best suited to providing the base heating load of a development. As such they should not be installed in tandem unless surplus hot water capacity is available. Special control measures would be required in this case.
- **Capital Cost: -** Low in comparison to CHP.
  - More suitable to smaller developments than CHP as installed cost is lower.
- **Running Costs/Savings: -** Biomass fuel is more expensive than gas and as such heat being provided to dwellings is generally more expensive than the market.
- **Land Use Issues and Space Required: -** Biomass boilers require a plant room and possibly separate energy centre for large residential developments.
  - Require a flue to effectively disperse pollutants. The height of the chimney required is dependent on the size of the boiler installed.
  - Fuel store will be required. This should be maximised to reduce fuel delivery frequency.
  - Space must be available for delivery vehicle to park close to plant room.
  - Heat network issues.
- **Operational Impacts/Issues: -** Normally run on biomass, but can also work with biogas.
  - Require some operational support and maintenance.
  - Fuel deliveries required.
  - Boiler and fuel store must be sited in proximity to space for delivery vehicle to park.
  - Issues with rights to dig up roads, etc (for heat networks).
  - Emissions of nitrous oxides – ~80-100mg/kWh.
- **Embodied Energy: -** Comparable to conventional gas boiler.
- **Funding Opportunities: -** The Bio-energy Capital Grants Scheme offers grants of up to 40% of the difference between the installed cost of biomass boiler and the cost of the fossil fuel alternative to the industrial, commercial and community sectors.

- **Reductions in Energy Achievable: -** No reduction in energy demand, but energy generated from a renewable fuel. Significant long term running costs (fuel).
- **Reductions in CO_2 Achievable: -** Can provide significant reductions in CO_2, but generally limited by the hot water load (base heating load).
- **Advantages: -** Reductions in CO_2 at low installed cost.
- **Disadvantages: -** High long-term running costs.
    - Often do not supply energy cost-effectively in comparison to gas boilers.

Solar Thermal Panels

- Solar Thermal Heating Systems contribute to the hot water demand of a dwelling or building. Water or glycol (heat transfer fluid) is circulated to roof level where it is heated using solar energy before being returned to a thermal store in the plant room where heat is exchanged with water from the conventional system. Due to the seasonal availability of heat, solar thermal panels should be scaled to provide no more than 1/2 of the hot water load.
- Can also be used to provide energy for space heating in highly insulated dwellings.
- There are two types of solar thermal panel: evacuated tube collectors and flat plate collectors.
- **Performance and Calculation Methodology: -**
    - Evacuated Tube Collectors: ~60% efficiency.
    - Flat Plate Collectors: ~50% efficiency.
    - SAP Table H2 used for solar irradiation at different angles.
    - Operate best on south facing roofs angled at 30-45^0 and free of shading, or on flat roofs on frames. East/West facing panels suffer a loss in performance of 15-20% depending on the angle of installation.
    - Flat plate collectors cannot be installed horizontally as this would prevent operation of the water pump. Must therefore be angled and separated to avoid overshadowing each other.
    - SAP limits benefit to a ~12-14% reduction in regulated CO_2 over baseline.
- **Capital Cost: -** Typically £2,500 per 4m^2 plus installation. Costs higher for evacuated tubes than flat plate collectors.
- **Running Costs/Savings: -** Reduce reliance on gas and therefore reduce costs.
    - Payback period of ~20 years per dwelling.
- **Land Use Issues and Space Required: -** Installed on roof so no impact on land use.
    - Due to amount of roof space required and distance from tank to panels, less suitable for dense developments of relatively high rise flats.

- Within permitted development rights unless in a conservation area where they must not be visible from the public highways.
- Dormer and Velux windows may conflict if energy/CO_2 reduction required is large.

- **Operational Impacts/Issues: -** Biggest reductions achieved by people who operate their hot water system with consideration of the panels.
- **Embodied Energy: -** Carbon payback is ~2 years.
- **Funding Opportunities: -** none
- **Reductions in Energy Achievable: -** Reduce primary energy demand by more per standard panel area than solar PV panels.
- **Reductions in CO_2 Achievable: -** Comparable to solar PV per m^2.
- **Advantages: -** Virtually free fuel, low maintenance and reductions in energy/CO_2.
- **Disadvantages: -** Benefits limited to maximum ~50% of hot water load.

Solar Photovoltaic (PV) Panels

- Solar PV panels generate electricity by harnessing the power of the sun. They convert solar radiation into electricity which can be used on site or exported to the grid in times of excess generation.
- **Performance and Calculation Methodology: -**
  - The best PV panels operate with an efficiency approaching 20%. ~7m^2 of these high performance panels will produce 1kWp of electricity.
  - Operate best on south facing roofs angled at 30-45^0 or on flat roofs on frames. Panels orientated east/west suffer from a loss in performance of 15-20% depending on the angle of installation.
  - Must be free of any potential shading.
  - Cannot be installed horizontally as would prevent self-cleaning. Must therefore be angled and separated to avoid overshadowing each other.
  - Electricity produced displaces grid electricity which has a carbon intensity of 0.529 kg CO_2 per kWh.
- **Capital Cost: -** ~£3,500 – £4,500 per kWp depending on performance of panels.
- **Running Costs/Savings: -** Reduce reliance on grid electricity and therefore reduce running costs.
  - At current electricity prices, payback period of ~60-70 years per dwelling.
  - Feed-in tariff and Renewables Obligation Certificates (ROCs) payments required for maximum financial benefit.
- **Land Use Issues and Space Required: -** Installed on roof so no impact on land use.

- Due to amount of roof space required are less suitable for dense developments of relatively high rise flats.
- Within permitted development rights unless in a conservation area where they must not be visible from the public highways.
- Dormer and Velux windows may conflict if energy/CO_2 reduction required is large.

- **Operational Impacts/Issues: -** Proportionately large arrays may need electrical infrastructure upgrade.
  - Virtually maintenance free and panels are self cleaning at angles in excess of 10 degrees.
- **Embodied Energy: -** Carbon payback of 2-5 years.
- **Funding Opportunities: -** Financier utilising Feed-in-Tariffs.
- **Reductions in Energy Achievable: -** Reduce energy demand by less per m^2 than solar thermal panels.
- **Reductions in CO_2 Achievable: -** Provide greater percentage reductions in CO_2 than energy. Comparable to solar thermal per square metre.
- **Advantages: -** Virtually free fuel, very low maintenance and good reductions in CO_2.
- **Disadvantages: -** More expensive than solar thermal.
  - Slightly greater loss in performance than solar thermal panels when orientated away from south.

Ground Source Heat Pumps (GSHPs)

- Ground Source Heat Pumps work in much the same way as a refrigerator, converting low grade heat from a large 'reservoir' into higher temperature heat for input in a smaller space. Electricity drives the pump which circulates a fluid (water/antifreeze mix or refrigerant) through a closed loop of underground pipe. This fluid absorbs the solar energy that is stored in the earth (which in the UK remains at a near constant temperature of 12^{o}C throughout the year) and carries it to a pump. A compressor in the heat pump upgrades the temperature of the fluid which can then be used for space heating and hot water.
- **Performance and Calculation Methodology: -** System requires electricity to drive the pump. Therefore displaces gas heating with electric, which has a higher carbon intensity (gas: 0.198; electricity: 0.517).
  - As they are upgrading heat energy from the earth, GSHPs operate at 'efficiencies' in excess of 350%. This is limited in SAP unless Appendix Q rated model used.
  - Due to the lower temperature of the output of GSHPs compared to traditional gas boilers, GSHPs work best in well insulated buildings and with underfloor heating. They can,

however, also be installed with oversized radiators, albeit with a consequent reduction in performance

- **Capital Cost: -** ~£7,500 per house. Additional costs if underfloor heating is to be installed.
- **Running Costs/Savings: -** Electricity more expensive than gas, thus fuel costs not reduced as much as energy is reduced.
  - Payback period of ~20 years per dwelling.
- **Land Use Issues and Space Required: -** Require extensive ground works to bury the coils that extract the low grade heat from the earth. They therefore require a large area for horizontal burial (40-100m long trench) or a vertical bore (50-100m) which is considerably more expensive but can be used where space is limited.
  - Must be sized correctly to prevent freezing of the ground during winter and consequent shutdown of the system.
  - May require planning permission for engineering works. Once buried, there is no external evidence of the GSHPs.
- **Operational Impacts/Issues: -** Work best in well insulated houses.
  - Need immersion for hot water.
  - Highly reliable and require virtually no maintenance.
  - Problems if ground bore fails.
- **Embodied Energy: -** Low, but as gas is being replaced with the more carbon intensive electricity, carbon payback is slowed. Carbon payback depends on CoP.
- **Funding Opportunities: -** none.
- **Reductions in Energy Achievable: -** Reduce energy demand by less per m^2 than solar thermal panels.
- **Reductions in CO_2 Achievable: -** Provide greater %age reductions in CO_2 than energy. Comparable to solar thermal (esp. in SAP).
- **Advantages: -** Large reductions in Energy. Currently receives benefit from SAP of an electrical baseline rather than gas.
- **Disadvantages: -** Small reduction in CO_2. CoP limited in SAP. Only small cost savings.

Air Source Heat Pumps (ASHPs)

- Air Source Heat Pumps work in much the same way as a refrigerator, converting low grade heat from a large ‘reservoir’ into higher temperature heat for input into a smaller space. Electricity drives the pump which extracts heat from the air as it flows over the coils in the heat pump unit. A compressor in the heat pump upgrades the temperature of the extracted energy which can then be used for space heating and hot water.

- Generally ASHPs are air-to-water devices but can also be air-to-air.
- **Performance and Calculation Methodology: -** System requires electricity to drive the pump. Therefore displaces gas heating with electric, which has a higher carbon intensity (gas: 0.198; electricity: 0.517).
    - Performance defined by the Coefficient of Performance (CoP) which is a measure of electricity input to heat output. However, the concept of a CoP must be treated with caution as it is an instantaneous measurement and does not take account of varying external conditions throughout the year.
    - As they are upgrading heat energy from the air, ASHPs operate at 'efficiencies' in excess of 250%. This is limited in SAP unless an Appendix Q rated model is used.
    - British winter conditions (low temperatures and high humidity) lead to freezing of external unit. Reverse cycling defrosts the ASHP, but can substantially reduce performance when it is most needed. Performance under these conditions varies considerably between models. Vital that ASHP that has been proven in British winter conditions is installed.
    - Due to the lower temperature of the output of ASHPs compared to traditional gas boilers, ASHPs work best in well insulated buildings and with underfloor heating. They can, however, also be installed with oversized radiators, albeit with a consequent reduction in performance.
- **Capital Cost: -** ~£2,000 per house.
- **Running Costs/Savings: -** Electricity more expensive than gas, thus fuel costs not reduced as much as energy is reduced.
    - Payback period of ~10 years per dwelling.
- **Land Use Issues and Space Required: -** No need for external ground works, only a heat pump unit for the air to pass through.
    - Minimal external visual evidence.
- **Operational Impacts/Issues: -** Work best in well insulated houses.
    - Unit must be sized correctly for each dwelling.
    - Vital that ASHP model selected has been proven to maintain performance at the low temperature and high humidity conditions of the British winter.
    - May need immersion for hot water.
    - Highly reliable and require virtually no maintenance.
- **Embodied Energy: -** Low. Carbon payback longer than for GSHPs as the CoP is lower.

- **Funding Opportunities: -** none
- **Reductions in Energy Achievable: -** Large reductions in energy demand. Less so than GSHPs.
- **Reductions in CO_2 Achievable: -** Provide smaller percentage reductions in CO_2 than energy. Less than GSHPs.
- **Advantages: -** Large reductions in Energy. Currently receives benefit from SAP of an electrical fuel factor rather than a gas baseline.
- **Disadvantages: -** Small reduction in CO_2. CoP limited in SAP. Only small cost savings.

Wind Power

- Wind energy installations can range from small domestic turbines (1kW) to large commercial turbines (140m tall, 2MW). There are also different designs and styles (horizontal or vertical axis; 1 blade to multiple blades) to suit the location. They generate clean electricity that can be provided for use on-site, or sold directly to the local electricity network
- **Performance and Calculation Methodology: -** Power generated is proportional to the cube of the wind speed. Therefore, wind speed is critical.
    - Horizontal axis turbines require >~6m/s to operate effectively and vertical axis turbines require >~4.5m/s. The rated power of a turbine is often for wind speeds double these figures.
    - Wind speeds for area from BERR's Wind Speed Database.
    - Electricity produced displaces grid electricity which has a carbon intensity of 0.568 kg/kWh.
- **Capital Cost: -** ~£1,000 per kW. Smaller models are more expensive per kW.
    - Vertical axis turbines more expensive than horizontal.
- **Running Costs/Savings: -** Reduce reliance on grid electricity and therefore reduce costs.
    - Payback period of ~15-20 years per dwelling.
    - Feed-in tariff and ROC payments required for maximum financial benefit.
- **Land Use Issues and Space Required: -** Smaller models (<6kW) can be roof mounted.
    - Must be higher than surrounding structures/trees.
    - Planning permission required.
- **Operational Impacts/Issues: -** Urban environments generally have low wind speeds and high turbulence which reduce the effectiveness of turbines.
    - Vertical axis turbines have a lower performance than horizontal axis turbines but work better in urban environments.

  - Annual services required.
  - Turbines rated in excess of 5kW may require the network to be strengthened and arrangements to be made with the local Distribution Network Operator and electricity supplier.
  - Noise.
- **Embodied Energy: -** Carbon payback is ~1 year for most turbines.
- **Funding Opportunities: -** Financier utilising Feed-in-Tariffs.
- **Reductions in Energy Achievable: -** Significant reduction in reliance on grid electricity.
- **Reductions in CO_2 Achievable: -** Good. Greater reduction in CO_2 than PV for same investment.
- **Advantages: -** Virtually free fuel; reductions in CO_2.
- **Disadvantages: -** Expensive, although cheaper than PV for same return.
  - Lack of suitable sites.
  - Maintenance costs.
  - Often not building integrated.

Hydro Power

- Hydro power harnesses the energy of falling water, converting the potential or kinetic energy of water into electricity through use of a hydro turbine. Micro hydro schemes (<100kW) tend to be 'run-of-river' developments, taking the flow of the river that is available at any given time and not relying on a reservoir of stored water. They generate clean electricity that can be provided for use on-site, or sold directly to the local electricity network.
- **Performance and Calculation Methodology: -**
  - Flow rates at particular sites from National River Flow Archive held by Centre for Ecology and Hydrology.
  - Electricity produced displaces grid electricity which has a carbon intensity of 0.568 kg/kWh.
- **Capital Cost: -** £3,000 - £5,000 per kW.
  - Particularly cost effective on sites of old water mills where much of the infrastructure is in place.
- **Running Costs/Savings: -** Reduce reliance on grid electricity and therefore reduce costs.
  - Payback period of ~10-15 years per dwelling
  - Feed-in tariff and ROC payments required for maximum financial benefit.
- **Land Use Issues and Space Required: -** Require suitable water resource.

- Visual intrusion of scheme.
- Special requirements where river populated by migrating species of fish.
- Planning permission will require various consents and licences including an Environmental Statement and Abstraction Licence.

- **Operational Impacts/Issues: -** Routine inspections and annual service required.
  - Automatic cleaners should be installed to prevent intake of rubbish.
- **Embodied Energy: -** Carbon payback for small schemes of ~1 year.
- **Funding Opportunities: -** Financier utilising Feed-in-Tariffs.
- **Reductions in Energy Achievable: -** significant reduction in reliance on grid electricity.
- **Reductions in CO_2 Achievable: -** High.
- **Advantages: -** Virtually free fuel, reductions in CO_2.
- **Disadvantages: -** Expensive, but good payback period.
  - Lack of suitable sites.
  - Planning obstructions.

Appendix C:

Feasibility Table of Low Carbon and Renewable Energy Technologies

Appendix C: Feasibility Table of Low Carbon and Renewable Energy Technologies

Feasibility Study Table

Technology	Sufficient Energy Generated?	Payback	Land Use Issues	Local Planning Requirements	Noise	Carbon Payback	Available Grants	Affordability: Impact on Resident Energy Costs	Feasible?	Reason not Feasible or Selected
Combined Heat & Power (CHP)	Yes	Medium	Air quality in residential area; Large Energy Centre	None	In Energy Centre	Yes	Tax Relief - ECA	Likely to increase fuel bills	On higher density areas and non-residential only	Low density of Phase 1 means district heating is disadvantageous. Use within non-residential buildings to be examined
Biomass	Yes	None	Air quality in residential area; Large Energy Centre	Encouraged for large scale developments	In Energy Centre	Yes	Bio-energy Capital Grants Scheme	Likely to increase fuel bills	On higher density areas and non-residential only	Low density of Phase 1 means district heating is disadvantageous. Use within non-residential buildings to be examined
Solar Thermal	Yes, but other technologies required for 2016 Regulations	High	Sufficient roof space required	Encouraged	None	~2 years	None	Beneficial	Yes	Able to reach Building Regulations (2013). Additional renewable measures required for Building Regulations (2016)
Solar Photovoltaic (PV)	Yes	Very High	Sufficient roof space required	Encouraged	None	2-5 years	None	Beneficial (esp. if Feed-in-Tariff eligible)	Yes	Able to meet expected carbon compliance levels
Ground Source Heat Pumps (GSHPs)	Yes	High	Requires large area for coils or borehole	Encouraged	None	Low	None	Minor benefit	Yes	Likely to be able to contribute to Building Regulations 2013 and 2016
Air Source Heat Pumps (ASHPs)	Yes	Very High	Visual intrusion of external units	None	Low	Low	None	No difference, or negative	Yes	Likely to be able to contribute to Building Regulations 2013 and 2016
Wind Power	Requires specific site analysis and monitoring	Low -> High depending on site	Urban Area - low and turbulent wind; Visual impact; noise	Encouraged for large scale developments	Yes	~1 year -> never	None	No difference	No	Unlikely to be sufficient wind for micro turbines on houses; assessment required for flats and large scale wind (allowable solution)
Hydro Power	No	Medium	Requires suitable water resource; Visual impact	None	Low	~1 year	None	n/a	No	Not available on site

Appendix D:

Summary of Energy Calculations

Appendix D: Summary of Energy Calculations

Northstowe: Summary of Energy Options

Accommodation Schedule				
Unit Type	1/2 Bed Mid-Terrace	3 Bed Semi-Detached	4+ Bed Detached	Non-Residential
Average Dwelling Area (m^2)	70	100	150	12,740
Proportion of Units	25%	46%	29%	

Estimated Construction Programme										
Construction Start	2014	2015	2016	2017	2018	2019	2020	2021		Total
Dwellings	100	175	275	360	350	160	60	20		1,500
Non-Residential (m^2)	2,548			5,096			5,096			12,740
Sub-Total	550			950						
Residential Building Regulations Requirement	2013 Regulations: 25% Reduction over 2010			2016 Regulations: 100% Reduction over 2010 for residential (Zero Carbon Hub Carbon Compliance)						
Non-Residential Building Regulations Requirement (Consultation Scenario 2 used)	2013 Regulations: 25% Reduction over 2010			2016 Regulations: 32% Reduction over 2010			2019 Regulations: 'Zero Carbon' with 'Allowable Solutions'			
Planning Policy Target	10% / 20% Renewable Energy Requirement									

	Target	2013 Regulations: 25% Reduction over 2010	2016 Regulations: 100% Reduction over 2010 (Zero Carbon Hub Carbon Compliance)	Non-Residential	Total
Option 1: PV Panels to Escalating Building Regulations (PV for non-residential)	Detailed Data Source	Table 1a	Table 1b	Tables 6abc	-
	Dwelling Appearance	Diagrams 1a	Diagrams 1b	-	-
	CHP Heat Proportion	-	-	-	-
	PV Requirement (kWp)	394	1,313	226	1,933
	Allowable Solutions Requirement (kg.CO_2/yr)	-	1,049,920	70,070	1,119,990
	On-Site Renewable/Low Carbon Energy Generation	6%	13%	16%	11%
	Constraints	Relies on later sub-phases and non-residential for renewable energy generation	All dwellings must have sufficient suitably orientated areas of roofspace for PV		
			Roofspace for PV Panels may restrict use of dormer and velux windows		
			Need to integrate MVHR ductwork		
	Opportunities	No requirement for initial energy infrastructure	No requirement for community heating infrastructure (exc. Non-residential community facilities)	Creates base load for possible connection to Heat Network on later phases	
		Flexible Strategy across sub-phases	No allocation of space required for Energy Centre in this Phase 1		
			Possible for later sub-phases to connect to heat network that may be part of wider Development		

	Target	2013 Regulations: 25% Reduction over 2010	2016 Regulations: 100% Reduction over 2010 (Zero Carbon Hub Carbon Compliance)	Non-Residential	Total
Option 2: Solar Thermal / PV Panels to Escalating Building Regulations (PV for non-residential)	Detailed Data Source	Table 2a	Table 1b	Tables 6abc	-
	Dwelling Appearance	Diagrams 2a	Diagrams 1b	-	-
	CHP Heat Proportion	-	-	-	-
	Solar Thermal Requirement (m^2)	1419	-	-	1,419
	PV Requirement (kWp)	-	1,313	226	1,539
	Allowable Solutions Requirement (kg.CO_2/yr)	-	1,049,920	70,070	1,119,990
	On-Site Renewable/Low Carbon Energy Generation	11%	13%	16%	13%
	Constraints		Solar thermal panels unable to attain Carbon Compliance level --> PV panels used instead		
			Relies on later sub-phases and non-residential for renewable energy generation		
	Opportunities	Greater renewable energy contribution than PV	As per Option 1	Creates base load for possible connection to Heat Network on later phases	
		Flexible Strategy across sub-phases			

Appendix D: Summary of Energy Calculations

Option	Target	2013 Regulations: 25% Reduction over 2010	2016 Regulations: 100% Reduction over 2010 (Zero Carbon Hub Carbon Compliance)	Non-Residential	Total
Option 3: Solar Thermal / PV Panels to Escalating Building Regulations (CHP for non-residential)	Detailed Data Source	Table 2a	Table 1b	Tables 5abc	-
	Dwelling Appearance	Diagrams 2a	Diagrams 1b	-	-
	CHP Heat Proportion	-	-	70%	-
	Solar Thermal Requirement (m^2)	1419	-	-	**1,419**
	PV Requirement (kWp)	-	1,313	108	**1,421**
	Allowable Solutions Requirement ($kg.CO_2/yr$)	-	1,049,920	67,865	**1,117,785**
	On-Site Renewable/Low Carbon Energy Generation	**11%**	**13%**	**42%**	**15%**
	Constraints	Relies on later sub-phases and non-residential for renewable energy generation	All dwellings must have sufficient suitably orientated areas of roofspace for PV		
			Roofspace for PV Panels may restrict use of dormer and velux windows		
			Need to integrate MVHR ductwork		
	Opportunities	No requirement for initial energy infrastructure	No requirement for community heating infrastructure (exc. Non-residential community facilities)	Creates base load for possible connection to Heat Network on later phases	
		Flexible Strategy across sub-phases	No allocation of space required for Energy Centre in this Phase 1		
			Possible for later sub-phases to connect to heat network that may be part of wider Development		

Option	Target	2013 Regulations: 25% Reduction over 2010	2016 Regulations: 100% Reduction over 2010 (Zero Carbon Hub Carbon Compliance)	Non-Residential	Total
Option 3b: Solar Thermal / PV Panels to Escalating Building Regulations (CHP for non-residential) + Iconic Wind Turbine	Detailed Data Source	Table 2a	Table 1b	Tables 5abc	-
	Dwelling Appearance	Diagrams 2a	Diagrams 1b	-	-
	CHP Heat Proportion	-	-	70%	-
	Solar Thermal Requirement (m^2)	1419	-	-	**1,419**
	PV Requirement (kWp)	-	1,313	108	**1,421**
	Iconic Wind Turbine Generation (kWh/yr)	-	-	1MW Turbine	**2,628,000**
	Allowable Solutions Requirement ($kg.CO_2/yr$)	-	1,049,920	0	**1,049,920**
	On-Site Renewable/Low Carbon Energy Generation	**11%**	**13%**	**42%**	**34%**
	Constraints	Relies on later sub-phases and non-residential for renewable energy generation	All dwellings must have sufficient suitably orientated areas of roofspace for PV		
			Roofspace for PV Panels may restrict use of dormer and velux windows		
			Need to integrate MVHR ductwork		
	Opportunities	No requirement for initial energy infrastructure	No requirement for community heating infrastructure (exc. Non-residential community facilities)	Creates base load for possible connection to Heat Network on later phases	
		Flexible Strategy across sub-phases	No allocation of space required for Energy Centre in this Phase 1		
			Possible for later sub-phases to connect to heat network that may be part of wider Development		

Appendix D: Summary of Energy Calculations

Individual Dwelling Strategy (PV Panels): Zero Carbon Hub Proposed 2016 Carbon Compliance

		Table 1a – 2013 Regulations (2010 SAP) – Unit Type				Table 1b – 2016 Regulations (Modified for 2016 SAP) – Unit Type			
		1/2 Bed Mid-Terrace	3 Bed Semi-Detached	4+ Bed Detached		1/2 Bed Mid-Terrace	3 Bed Semi-Detached	4+ Bed Detached	
	Average Area (m^2)	70	100	150		70	100	150	
Fabric Energy Efficiency	2010 Baseline - TER ($kg.CO_2/m^2/yr$)	17.55	17.65	16.41		17.55	17.65	16.41	
	DER	16.98	15.96	14.49		16.98	15.96	14.49	
	Reduction Achieved	**3.2%**	**9.6%**	**11.7%**		**3.2%**	**9.6%**	**11.7%**	
	Fabric Energy Efficiency ($KWh/m^2/yr$)	**36.3**	**43.1**	**45.8**		**36.3**	**43.1**	**45.8**	
Carbon Compliance	PV Required (kWp)	0.65	0.7	0.8		1.05	1.3	1.8	
	PV Area Required (m^2)	5.2	5.6	6.4		8.4	10.4	14.4	
	2010 DER ($kg.CO_2.m^2/yr$)	13.06	13.01	12.24		9.2	9.07	8.3	-
	2016 Equivalent DER ($kg.CO_2/m^2/yr$)	-	-	-	-	**10.84**	**10.65**	**9.79**	
	Reduction Achieved (2010 TER/DER)	**25.6%**	**26.3%**	**25.4%**		-	-	-	
Allowable Solutions	**Remainder for Allowable Solutions ($kg.CO_2/yr$)**	-	-	-	-	**759**	**1,065**	**1,468**	**0**
Delivered Energy Demands	Hot Water Demand (kWh/yr)	2,372	2,652	2,836		2,404	2,683	2,861	
	Space Heating Demand (kWh/yr)	2,302	3,849	6,364		1,241	2,368	4,368	
	Regulated Electricity (kWh/yr)	509	598	681		707	881	1,108	
	Additional Unregulated Electricity (kWh/yr)	1,540	2,000	2,700		1,540	2,000	2,700	
	Total (kWh/yr)	**6,723**	**9,099**	**12,581**		**5,892**	**7,933**	**11,037**	
Low Carbon / Renewable	Renewable Energy Generation (kWh/yr)	518	558	638		837	1,037	1,436	
	Onsite Renewable / Low Carbon Generation	**8%**	**6%**	**5%**		**14%**	**13%**	**13%**	

Zero Carbon Hub Recommended Standards

	FEE ($kWh/m^2/yr$)	Proposed 2016 Carbon Compliance ($kg.CO_2/m^2/yr$)
Flats	39	14
Mid-Terrace	39	11
End-T / Semi-D	46	11
Detached	46	10

Zero Carbon Hub 2016 CO_2 Emissions Factors

Fuel	CO_2 Factor ($kg.CO_2/kWh$)
Grid Electricity	0.527
Electricity: On-Site Generation	0.527
Mains Gas	0.227
Wood Pellets	0.037
Wood Chips	0.015
Biomass Community Heating	0.019

Zero Carbon Hub Carbon Compliance CO_2 Factor Conversion

2010 SAP Line	1/2 Bed Mid-Terrace: Energy (kWh/yr)	1/2 Bed Mid-Terrace: 2016 Equivalent CO_2 (kg/yr)	3 Bed Semi-Detached: Energy (kWh/yr)	3 Bed Semi-Detached: 2016 Equivalent CO_2 (kg/yr)	4+ Bed Detached: Energy (kWh/yr)	4+ Bed Detached: 2016 Equivalent CO_2 (kg/yr)
261	1,241	282	2,368	538	4,368	992
264	2,404	546	2,683	609	2,861	649
267	373	197	458	241	602	317
268	334	176	423	223	506	267
269	-837	-441	-1,037	-546	-1,436	-757
Dwelling Area (m^2)	70		100		150	
2016 DER ($kg.CO_2/m^2/yr$)	-	**10.84**	-	**10.65**	-	**9.79**

Reference Documents for the Above

Defining a Fabric Energy Efficiency Standard for Zero Carbon Homes, Zero Carbon Hub Task Group Recommendations, November 2009

Carbon Compliance: Setting an Appropriate Limit for Zero Carbon New Homes - Findings & Recommendations, Zero Carbon Hub, Feb. 2011

Modelling 2016 using SAP 2009 Technical Guide, Zero Carbon Hub

Base Specification			
External Wall U-Value	0.18	Allow 350mm Walls	
Party Wall U-Value	0.0	Fully Insulated and effectively sealed	
Ground Floor U-Value	0.15		
Roof (joists) U-Value	0.1	400mm mineral wool insulation	
Roof (rafters) U-Value	0.18		
Glazing U-Value	1.3	Double Glazed	
Air Permeability	4.5		
Heating System	Combi for 1/2 Bed; Boiler for larger		SEDBUK 'A' Rated
Thermal Bridging	0.07	Slight enhancements over Accredited Details	
Energy Efficiency Lights	100%		
Renewable Energy	PV Panels	Amount as per above table	

Additional Measures for 2016 Regulations			
Ventilation	Mechanical Ventilation and Heat Recovery (MVHR)	Efficiency	>90%
		Specific Fan Power	<0.65 W/l/s (<0.7W/l/s for larger dwellings)
Air Permeability	3		

Appendix D: Summary of Energy Calculations

Individual Dwelling Strategy (Solar Thermal) to 2013 Building Regulations

Table 2a

		2013 Regulations (2010 SAP)			
		Unit Type			
		1/2 Bed	3 Bed	4+ Bed	
		Mid-Terrace	Semi-Detached	Detached	
	Average Area (m^2)	70	100	150	
Fabric Energy Efficiency	2010 Baseline - TER ($kg.CO_2/m^2/yr$)	17.55	17.65	16.41	
	DER	16.98	15.96	14.49	
	Reduction Achieved	**3.2%**	**9.6%**	**11.7%**	
	Fabric Energy Efficiency ($KWh/m^2/yr$)	**36.3**	**43.1**	**45.8**	
Carbon Compliance	Solar Thermal Area Required (m^2)	2	2	4	
	2010 DER ($kg.CO_2.m^2/yr$)	13.02	13.15	11.62	
	2016 Equivalent DER ($kg.CO_2/m^2/yr$)	-	-	-	-
	Reduction Achieved (2010 TER/DER)	**25.8%**	**25.5%**	**29.2%**	
Allowable Solutions	**Remainder for Allowable Solutions ($kg.CO_2/yr$)**	-	-	-	-
Delivered Energy Demands	Hot Water Demand (kWh/yr)	2,007	2,181	2,285	
	Space Heating Demand (kWh/yr)	1,287	2,691	4,808	
	Regulated Electricity (kWh/yr)	782	956	1,183	
	Additional Unregulated Electricity (kWh/yr)	1,540	2,000	2,700	
	Total (kWh/yr)	**5,616**	**7,828**	**10,976**	
Low Carbon / Renewable	Renewable Energy Generation (kWh/yr)	735	987	1,022	
	Renewable / Low Carbon Generation	**13%**	**13%**	**9%**	

Zero Carbon Hub Recommended Standards

	FEE ($kWh/m^2/yr$)	Proposed 2016 Carbon Compliance ($kg.CO_2/m^2/yr$)
Flats	39	14
Mid-Terrace	39	11
End-T / Semi-D	46	11
Detached	46	10

Zero Carbon Hub 2016 CO_2 Emissions Factors

Fuel	**CO_2 Factor ($kg.CO_2/kWh$)**
Grid Electricity	0.527
Electricity: On-Site Generation	0.527
Mains Gas	0.227
Wood Pellets	0.037
Wood Chips	0.015
Biomass Community Heating	0.019

Zero Carbon Hub Carbon Compliance CO_2 Factor Conversion

	1/2 Bed Mid-Terrace		3 Bed Semi-Detached		4+ Bed Detached	
2010 SAP Line	**Energy (kWh/yr)**	**2016 Equivalent CO_2 (kg/yr)**	**Energy (kWh/yr)**	**2016 Equivalent CO_2 (kg/yr)**	**Energy (kWh/yr)**	**2016 Equivalent CO_2 (kg/yr)**
261	1,241	282	2,368	538	4,368	992
264	2,404	546	2,683	609	2,861	649
267	373	197	458	241	602	317
268	334	176	423	223	506	267
269	-837	-441	-1,037	-546	-1,436	-757
Dwelling Area (m^2)	70		100		150	
2016 DER ($kg.CO_2/m^2/yr$)	-	**10.84**	-	**10.65**	-	**9.79**

Reference Documents for the Above

Defining a Fabric Energy Efficiency Standard for Zero Carbon Homes, Zero Carbon Hub Task Group Recommendations, November 2009

Carbon Compliance: Setting an Appropriate Limit for Zero Carbon New Homes - Findings & Recommendations, Zero Carbon Hub, Feb. 2011

Modelling 2016 using SAP 2009 Technical Guide, Zero Carbon Hub

Base Specification

External Wall U-Value	0.18	Allow 350mm Walls	
Party Wall U-Value	0.0	Fully Insulated and effectively sealed	
Ground Floor U-Value	0.15		
Roof (joists) U-Value	0.1	400mm mineral wool insulation	
Roof (rafters) U-Value	0.18		
Glazing U-Value	1.3	Double Glazed	
Air Permeability	4.5		
Heating System	Combi for 1/2 Bed; Boiler for larger		SEDBUK 'A' Rated
Thermal Bridging	0.07	Slight enhancements over Accredited Details	
Energy Efficiency Lights	100%		
Renewable Energy	PV Panels	Amount as per above table	

Additional Measures

Ventilation	Mechanical Ventilation and Heat Recovery (MVHR)	Efficiency	>90%
		Specific Fan Power	<0.65 W/l/s (<0.7W/l/s for larger dwellings)
Air Permeability	4		

Appendix D: Summary of Energy Calculations

District Heating (CHP): Zero Carbon Hub Proposed 2016 Carbon Compliance

		Table 3a				Table 3b			
		2013 Regulations (2010 SAP)				2016 Regulations (Modified for 2016 SAP)			
		Unit Type				Unit Type			
		1/2 Bed	3 Bed	4+ Bed		1/2 Bed	3 Bed	4+ Bed	
		Mid-Terrace	Semi-Detached	Detached		Mid-Terrace	Semi-Detached	Detached	
	Average Area (m^2)	70	100	150		70	100	150	
Fabric Energy Efficiency	2010 Baseline - TER ($kg.CO_2/m^2/yr$)	17.55	17.65	16.41		17.55	17.65	16.41	
	DER	16.98	15.96	14.49		16.98	15.96	14.49	
	Reduction Achieved	**3.2%**	**9.6%**	**11.7%**		**3.2%**	**9.6%**	**11.7%**	
	Fabric Energy Efficiency ($KWh/m^2/yr$)	**36.3**	**43.1**	**45.8**		**36.3**	**43.1**	**45.8**	
Carbon Compliance	Percentage Total Heat Required from CHP	30%				75%			
	2010 DER ($kg.CO_2.m^2/yr$)	12.87	12.28	11.34		8.84	9	8.02	-
	2016 Equivalent DER ($kg.CO_2/m^2/yr$)	-	-	-	-	**10.96**	**10.42**	**9.57**	
	Reduction Achieved (2010 TER/DER)	**26.7%**	**30.4%**	**30.9%**		-	-	-	-
Allowable Solutions	**Remainder for Allowable Solutions ($kg.CO_2/yr$)**	-	-	-	-	**767**	**1,042**	**1,435**	**0**
End-Use Energy Demands	Hot Water Demand (kWh/yr)	2,369	2,276	2,458		2,369	2,276	2,458	
	Space Heating Demand (kWh/yr)	1,873	3,602	5,927		1,873	3,602	5,927	
	Regulated Electricity (kWh/yr)	379	485	594		379	485	594	
	Additional Unregulated Electricity (kWh/yr)	1,540	2,200	3,300	0	1,540	2,200	3,300	0
	Total (kWh/yr)	**6,161**	**8,562**	**12,279**		**6,161**	**8,562**	**12,279**	
Low Carbon / Renewable Energy	CHP Generation (kWh/yr)	1,273	1,763	2,515		3,182	4,408	6,289	
	Renewable / Low Carbon Generation	**21%**	**21%**	**20%**		**52%**	**51%**	**51%**	

Specification			
External Wall U-Value	0.18	Allow 350mm Walls	
Party Wall U-Value	0.0	Fully Insulated and effectively sealed	
Ground Floor U-Value	0.15		
Roof (joists) U-Value	0.1	400mm mineral wool insulation	
Roof (rafters) U-Value	0.18		
Glazing U-Value	1.3	Double Glazed	
Air Permeability	4.5		
Heating System	Combi for 1/2 Bed; Boiler for larger		SEDBUK 'A' Rated
Thermal Bridging	0.07	Slight enhancements over Accredited Details	
Energy Efficiency Lights	100%		
Renewable Energy	PV Panels	Amount as per above table	

Zero Carbon Hub Recommended Standards	FEE ($kWh/m^2/yr$)	Proposed 2016 Carbon Compliance ($kg.CO_2/m^2/yr$)
Flats	39	14
Mid-Terrace	39	11
End-T / Semi-D	46	11
Detached	46	10

Zero Carbon Hub 2016 CO_2 Emissions Factors	
Fuel	**CO_2 Factor ($kg.CO_2/kWh$)**
Grid Electricity	0.527
Electricity: On-Site Generation	0.527
Mains Gas	0.227
Wood Pellets	0.037
Wood Chips	0.015
Biomass Community Heating	0.019

Zero Carbon Hub Carbon Compliance CO_2 Factor Conversion

2010 SAP Line	1/2 Bed Mid-Terrace		3 Bed Semi-Detached		4+ Bed Detached	
	Energy (kWh/yr)	2016 Equivalent CO_2 (kg/yr)	Energy (kWh/yr)	2016 Equivalent CO_2 (kg/yr)	Energy (kWh/yr)	2016 Equivalent CO_2 (kg/yr)
363	3,536	803	6,798	1,543	11,187	2,539
364	-1,283	-676	-2,466	-1,300	-4,058	-2,139
365	4,472	1,015	4,296	975	4,640	1,053
366	-1,622	-855	-1,559	-821	-1,683	-887
368	1,237	281	1,714	389	2,446	555
372	45	23	62	33	88	46
379	334	176	423	223	506	267
Dwelling Area (m^2)	70		100		150	
2016 DER ($kg.CO_2/m^2/yr$)	-	**10.96**	-	**10.42**	-	**9.57**

Reference Documents for the Above

Defining a Fabric Energy Efficiency Standard for Zero Carbon Homes, Zero Carbon Hub Task Group Recommendations, November 2009

Carbon Compliance: Setting an Appropriate Limit for Zero Carbon New Homes - Findings & Recommendations, Zero Carbon Hub, Feb. 2011

Modelling 2016 using SAP 2009 Technical Guide, Zero Carbon Hub

Appendix D: Summary of Energy Calculations

Non-Residential Energy Calculations: PV Panels

Accommodation Schedule	
Use Type	**Area (m^2)**
B1: Office, R&D, Light Industry	6,370
B2: General Industrial	5,096
B8: Storage & Distribution	1,274

Table 6a: 2013 Building Regulations

Use Type	CO_2 ($kg/m^2/yr$)			Reduction Achieved	Energy Demand - No Renewables ($kWh/m^2/yr$)							CHP Provision		PV Required (kWp/m^2 of non-residential)	Renewable / Low Carbon Energy Generation ($kWh/m^2/yr$)	Renewable / Low Carbon Energy Generation	Allowable Solutions ($kg/m^2/yr$)
	TER	BER - no LZC	BER - CHP + PV		Space Heating	Cooling	Auxiliary	Lighting	Hot Water	Unregulated Electric	Total	Space Heating	Hot Water				
B1: Office, R&D, Light Industry	26.1	25.7	19.5	25%	12.84	11.85	10.28	20.9	2.95	40.3	99	0%	0%	0.01	12	12%	-
B2: General Industrial	19.5	19.4	14.4	26%	25.81	0	5.28	19.51	4.3	29.7	85	0%	0%	0.01	10	12%	-
B8: Storage & Distribution	19.5	19.4	14.7	25%	25.81	0	5.28	19.51	4.3	29.7	85	0%	0%	0.01	10	12%	-

Table 6b: 2016 Building Regulations

Use Type	CO_2 ($kg/m^2/yr$)			Reduction Achieved	Energy Demand - No Renewables ($kWh/m^2/yr$)							CHP Provision		PV Required (kWp/m^2 of non-residential)	Renewable / Low Carbon Energy Generation ($kWh/m^2/yr$)	Renewable / Low Carbon Energy Generation	Allowable Solutions ($kg/m^2/yr$)
	TER	BER - no LZC	BER - CHP + PV		Space Heating	Cooling	Auxiliary	Lighting	Hot Water	Unregulated Electric	Total	Space Heating	Hot Water				
B1: Office, R&D, Light Industry	26.1	25.7	17.5	33%	12.84	11.85	10.28	20.9	2.95	40.3	99	0%	0%	0.02	16	16%	-
B2: General Industrial	19.5	19.4	13.2	32%	25.81	0	5.28	19.51	4.3	29.7	85	0%	0%	0.01	12	14%	-
B8: Storage & Distribution	19.5	19.4	13.2	32%	25.81	0	5.28	19.51	4.3	29.7	85	0%	0%	0.01	12	14%	-

Table 6c: 2019 Building Regulations ('Zero Carbon')

Use Type	CO_2 ($kg/m^2/yr$)			Reduction Achieved	Energy Demand - No Renewables ($kWh/m^2/yr$)							CHP Provision		PV Required (kWp/m^2 of non-residential)	Renewable / Low Carbon Energy Generation ($kWh/m^2/yr$)	Renewable / Low Carbon Energy Generation	Allowable Solutions ($kg/m^2/yr$)
	TER	BER - no LZC	BER - CHP + PV		Space Heating	Cooling	Auxiliary	Lighting	Hot Water	Unregulated Electric	Total	Space Heating	Hot Water				
B1: Office, R&D, Light Industry	26.1	25.7	15.7	40%	12.84	11.85	10.28	20.9	2.95	40.3	99	0%	0%	0.02	19	19%	15.7
B2: General Industrial	19.5	19.4	11.8	39%	25.81	0	5.28	19.51	4.3	29.7	85	0%	0%	0.02	15	17%	11.8
B8: Storage & Distribution	19.5	19.4	11.8	39%	25.81	0	5.28	19.51	4.3	29.7	85	0%	0%	0.02	15	17%	11.8

Notes

Energy Demands are based on SBEM Calculations

Proposals for what constitutes 'zero carbon' for non-domestic buildings are less advanced than for dwellings. Consequently, the above framework is based on: -

1. Energy Efficiency: reaching Building Regulations (2010) through energy efficiency alone
2. On-Site Carbon Compliance (based on Scenario 2 on the 2009 Consultation on Policy Options for Zero Carbon for New Non-Domestic Buildings. Scenario 2 balances on- and off-site strategies)
3. 'Allowable Solutions' for remainder to Building Regulations Requirement

Scenario 2 Requires the following Carbon Compliance Levels: -

- 2013 Regulations: 25% Reduction over 2010 Regulations
- 2016 Regulations: 32% Reduction over 2010 Regulations
- 2019 Regulations: 39% Reduction over 2010 Regulations

Allowable Solutions' assumed to be required only for 2019 Regulations

Appendix E:

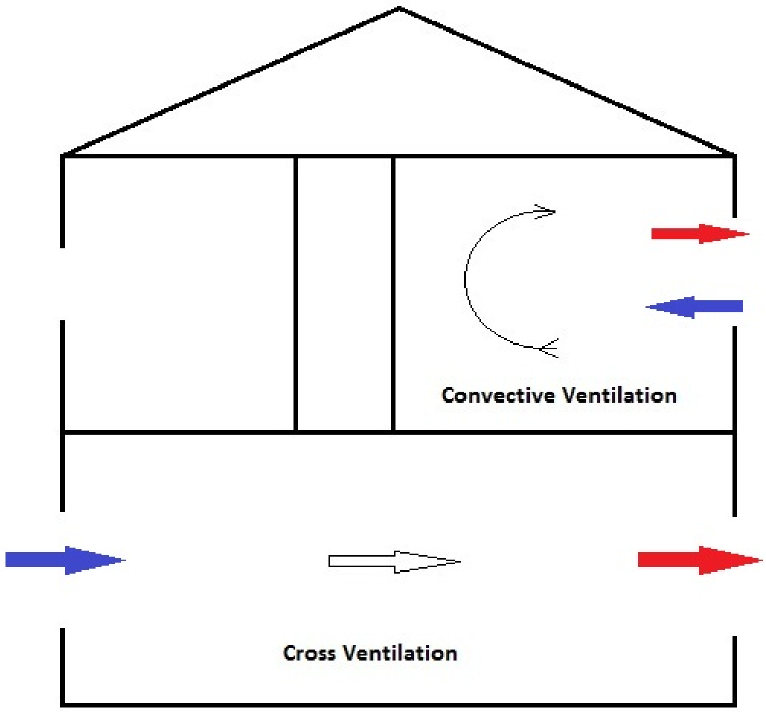
Glossary

Glossary of Terms

- **‘Citiworks’ Case:** A ruling by the European Court of Justice concerning open access to all electricity distribution networks in order to prevent monopoly of supply. Casts serious doubt on the legality of ‘Private Wire’ networks for the on-site use of large scale renewable electricity generation.
- **Allowable Solutions**: The final part of the Government’s Zero Carbon Home Framework which recognises that it is not feasible for ‘zero carbon’ to be achieved on-site. A new and not yet fully defined concept whereby payments will be made to Allowable Solutions Providers who assume the responsibility for delivering offsite, the CO_2 reductions that it is not feasible to achieve on-site.
- **Area Action Plan**: A Development Plan Document forming part of the Local Development Framework and aimed at establishing a set of proposals and policies for the development of a specific area. This is the Northstowe Area Action Plan (NAAP).
- **BREEAM:** Building Research Establishment Environmental Assessment Method. An assessment and rating system for measuring the environmental performance of buildings.
- **Building Regulations**: Set the minimum standards for design and construction. Part L provides the requirements for the Conservation of Fuel and Power. Current version is Building Regulations (2010). Further revisions expected in 2013 and 2016.
- **Carbon Compliance**: The second step in the Zero Carbon Homes Framework after Fabric Energy Efficiency. Mandatory CO_2 levels to be achieved through use of energy efficiency and onsite low carbon or renewable energy generation.
- **Greenhouse Gas**: An atmospheric gas that absorbs and emits solar radiation. An increase in greenhouse gas concentrations causes a warming effect on Earth.
- **Carbon dioxide (CO_2)**: A naturally occurring gaseous chemical compound which acts as a greenhouse gas. Atmospheric concentration increasing as it is a by-product of the combustion of fuels.
- **Carbon Neutral**: Achieving net zero carbon emissions by balancing the carbon released with the carbon sequestered. An example being biomass which sequesters carbon as a tree grows and then releases the same amount carbon when it is burnt for the generation of heat.
- **CO_2 Emission Rate**: Calculated output of SAP. Target Emission Rate (TER) and Dwelling Emission Rate (DER) measured in kilograms of $CO_2/m^2/yr$.
- **Code for Sustainable Homes (CfSH)**: An environmental assessment method for the rating and certifying the performance of new homes.
- **Coefficient of Performance (CoP):** Defines the energy performance of heat pumps. The ratio of the heat output to the electricity input.
- **Convective-Ventilation**: Passive method that enables the movement of air within a space by utilising the natural tendency of hot air to rise. Windows openable at the top and

bottom enable cool air to flow in at the bottom and hot air to flow out of the building through the top. Shown in diagram below.

- **Cross-Ventilation**: Airflow through a building from windows on one side to windows on the other, cooling the indoor space. Requires a path for the free flow of air across a house. Shown in diagram below.



- **Department for Communities & Local Government (DCLG or CLG):** The Government Department responsible for the Building Regulations, Code for Sustainable Homes, and the Planning Policy Framework.
- **Development Plan Document**: Planning policy documents that outline the key development goals of the Council.
- **District Heating (DH) or Community Heating:** Heating provided to dwellings or buildings from a central Energy Centre through the use of heat distribution pipes. Used as an alternative to individual gas boilers in each dwelling.
- **Elemental Method**: A method previously allowed for showing compliance with Building Regulations (2002) which required the meeting of limiting u-value standards. Omitted from subsequent versions of Building Regulations which now require that the DER is below the TER.
- **Emissivity:** The ability of a material to emit energy by radiation
- **Energy Efficiency:** Methods for reducing energy demand.
- **Evapotranspiration**: The movement of water from land surface and plants to the air. Energy is required to drive this process.
- **Fabric Energy Efficiency (FEE)**: The first part of the Government's Zero Carbon Home Framework which provides mandatory energy efficiency levels. Measured in $kWh/m^2/yr$.

- **Feed-in-Tariff**: Money paid for the generation of renewable electricity.
- **G-value**: A measurement of the solar heat gain allowed by glazing. The higher the G-Value, the greater the amount of heat transmittance through the glass.
- **Homes and Communities Agency (HCA)**: The national housing and regeneration delivery agency for England. The non-departmental public body that funds new affordable housing in England.
- **Joint Promoters**: Gallagher and Homes and Community Agency (HCA)
- **Kilowatt hour (kWh):** A unit of energy demand. Power usage in kilowatts multiplied by the time used for.
- **Localism Bill**: A Government proposal to devolve greater powers to councils and neighbourhoods and give local communities more control over housing and planning decisions.
- **Low Carbon Energy Technology**: Highly efficient heat generating technologies that use significantly less electrical energy than the heat output. For example, heat pumps.
- **Microgeneration:** The small-scale generation of low carbon or renewable heat or power on an individual dwelling or building basis.
- **MWe:** Megawatt electrical. Power rating of an electrical appliance or engine.
- **Draft National Planning Policy Framework (NPPF):** Sets out the Government's economic, environmental and social planning policies for England, articulating the Government's vision of sustainable development.
- **Night Purging:** The use of open windows at night to enable the release of heat built up through the day, thus ensuring that the space is cool at the start of each day.
- **Off-Site Technologies**: Low Carbon or Renewable energy technologies outwith the development boundaries. Fall into two categories: -
  - With direct connection to development (private wire)
  - Without direct connection to development and therefore only eligible as Allowable Solutions
- **On-site Technologies**: Low Carbon or Renewable energy technologies that are within the development area and directly connected to the dwellings or blocks of flats. E.g. microgeneration technologies.
- **Party Wall:** A dividing partition between two adjoining buildings
- **Private Wire:** Localised electricity grid that provides a direct connection of renewable electricity generation to a development rather than to the national electricity grid. Legality of Private Wires is subject to the 'Citiworks Case'.
- **Regulated Energy**: Those energy demands covered by Building Regulations: Space heating; hot water; fixed lights & pumps.
- **Renewable Energy Technology**: Technology that generates energy from a naturally-replenishing resource, e.g. wind or solar energy.
- **Renewable Heat Incentive:** Proposal to provide payments for the generation of renewable heat. Similar to a feed-in-tariff.

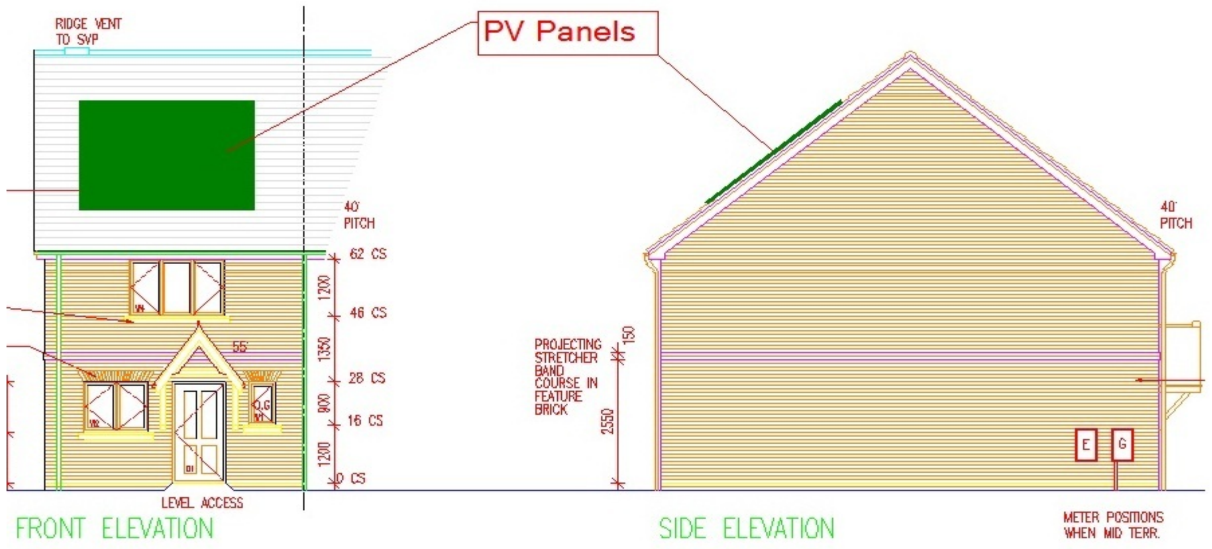
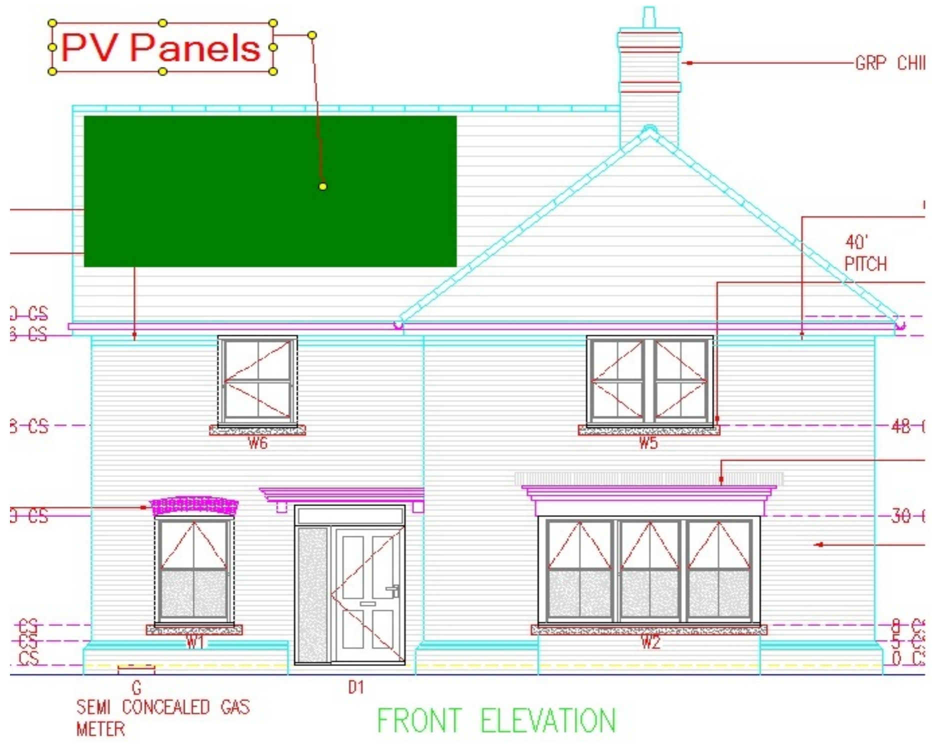
- **Renewables East**: Not-for-profit publicly funded organisation, whose objective is to 'bring the benefits of renewable energy to the East of England.'
- **Seasonal Energy Efficiency Ratio (SEER):** The cooling output as a ratio of electricity used over the course of a year. The higher the SEER, the more energy efficient.
- **SEDBUK:** Seasonal Efficiency of Domestic Boilers in the UK. Provides a standardised basis for the fair comparison of the energy performance of different boilers.
- **Simplified Building Energy Model (SBEM):** The Government's defined method for the assessment of the energy performance of non-dwellings. Provides the Target Emission Rate (TER) and Building Emission Rate (BER). Current version is SBEM 2010, which assesses performance against Building Regulations (2010).
- **Solar Gain:** The increase in temperature in a space that results from radiation from the sun.
- **Specific Fan Power (SFP):** The parameter that quantifies the energy efficiency of fan air movement for ventilation systems.
- **Standard Assessment Procedure (SAP):** The Government's defined method for the assessment of the energy performance of dwellings. Provides the Target Emission Rate (TER) and Dwelling Emission Rate (DER). Current version is SAP 2009, which assesses performance against Building Regulations (2010). Revisions to SAP are expected for Building Regulations 2013 and 2016.
- **Sustainability:** The capacity to endure economically, socially and environmentally.
- **Sustainable Development:** The path to Sustainability. Development that meets the needs of the present without compromising the ability of future generations to meet their needs. Interrelation of environmental, economic and social aspects.
- **Thermal Bridging:** A fundamental of heat transfer where a penetration of the insulation layer by a highly conductive or non-insulating material in a building element (e.g. wall) allows the flow of heat along this path of least thermal resistance.
- **Transmittance:** The fraction of radiation (light or heat) that is able to pass through a material (e.g. glass).
- **Unregulated Energy**: Those energy demands covered by Building Regulations plus the unregulated demands of electrical appliances and cooking.
- **U-Value**: Overall heat transfer coefficient. Measures the rate of heat transfer through a building element (e.g. wall or roof) over a given area, under standardised conditions. Unit: $W/m^2.K$. The lower the U-Value, the more energy efficient.
- **Zero Carbon Dwelling**: A reduction of 100% of the regulated CO_2 emissions of a dwelling. Expected to be a requirement of Building Regulations (2016). To be met through a 3-step process with mandatory requirements: Fabric Energy Efficiency; onsite Carbon Compliance; and offsite Allowable Solutions.
- **Zero Carbon Hub (ZCH)**: A public/private partnership which has day-to-day operational responsibilities for co-ordinating delivery of Zero Carbon Homes.

- **Zero Carbon Non-Domestic Buildings**: A reduction of 100% of the regulated CO_2 emissions of a building. Expected to be a requirement of Building Regulations (2019). To be met through a 3-step process with mandatory requirements: Fabric Energy Efficiency; onsite Carbon Compliance; and offsite Allowable Solutions.

Appendix F:

Assessment of Roofspace Practicality of PV Panels to ZCH Carbon Compliance for Range of Sample House Types

Appendix F: Assessment of Roofspace Practicality of PV Panels to ZCH Carbon Compliance for Sample House Types

Diagrams 1b: PV Panels to 2016 Zero Carbon Hub Carbon Compliance		
Small Mid-Terrace	**Medium Semi-Detached**	**Large Detached**
		

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