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Report

Sustainable Energy Study for the Joint Core Strategy for Broadland, Norwich and South Norfolk Councils

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Executive Summary

HOUSING GROWTH PLANS FOR THE GNDP AREA

The Greater Norwich Area is scheduled to see considerable development over the next 20 years. 23,000 new homes are proposed for the GNDP area between now and 2026 (in addition to the 14,000 new homes that already have planning permission). The new developments will consist of a mixture of rural infill, urban infill, urban extensions and a potential new town at Rackheath. These developments will benefit from different energy supply solutions depending on their scale, density and mix, and energy resource available, with the larger development typically finding it easier to achieve low to zero carbon standards.

This report assesses the capacity for supplying this new development with low carbon energy, and considers appropriate 'carbon standards' for the area's emerging Joint Core Strategy and subsequent Local Development Framework documents. In undertaking this analysis the study:

- Specifies suitable low carbon solutions and requirements for different development types;
- Assesses the characteristics of the housing growth plans for the area, and provides indicative energy supply strategies that help inform potential carbon standards for the new development;
- Assesses the resource potential for renewable energy generation within the GNDP area and relates this to the energy demand of the housing growth proposals;
- Outlines potential carbon standards for new development and the policy options for supporting low to zero carbon development within the area.

SETTING A LOCAL CARBON STANDARD FOR NEW DEVELOPMENT?

Zero Carbon Standards in Advance of National Requirements?

The Government has set a timetable for tightening carbon standards in the building regulations to achieve zero carbon housing in 2016 and zero carbon non-residential buildings in 2019. When considering carbon requirements within the GNDP JCS, the key question is whether the proposed Building Regulation improvements are considered adequate or whether the GNDP would like to set zero carbon requirements for its new developments in advance of 2016.

Our analysis of the renewable energy resource within the GNDP area has demonstrated that the local renewable energy resource can amply meet the energy demands of the planned new development, and that it would therefore be technically possible for the larger scale developments to achieve zero carbon standards from now onwards (assuming that the proposed new definition of zero carbon development is adopted which allows offsite local renewable energy to supply zero carbon developments – see below). 70% of the new development within the GNDP area will consist of large scale developments that will be suitable for communal energy systems which are more capable of achieving low to zero carbon standards than smaller developments.

Renewable Energy Resource within the GNDP Area

The total technical potential for renewable energy within the GNDP area is 7.7 Million MWh or 129% of the area's current energy consumption. This technical potential is the total resource that is available if all opportunities for renewable energy development are exploited regardless of commercial and institutional considerations. The study has undertaken a technical assessment of the renewable energy potential and has not considered the wider planning issues such as: cumulative landscape and nature conservation impacts; grid connection and shadow flicker. These issues would need to be addressed at the application stage and/or through a specific policy in Local Development Frameworks (LDFs).

Two specific technologies dominate this renewable energy technical potential – large wind turbines and biomass. 36% of the resource is from large wind turbines, and 43% is from woody biomass (for CHP plant). However, only a proportion of this resource would be exploited in practice, and the GNDP and partner councils should consider where they would be most interested in encouraging wind and biomass development.

Table 1: Technical Potential of Renewable Energy in the GNDP Area

Renewable Energy Technology	Offsite technologies				Onsite technologies					
	Large Wind	Anaerobic Digestion	Energy from Waste	Hydro	Woody Biomass	PV	Small Wind	Ground Source Heat Pump	Solar Thermal	Totals
No. of turbines	748						2,500			
Electrical Capacity (MWe)	1,870	18	3.9	0.3	170	364	212	-132	0.0	**2,507**
Thermal Capacity (MWth)	0.0	32.9	7.1	0.0	343.3	0.0	0.0	460.5	283.0	**1,127**
Carbon reduction potential for GNDP area	**93%**	6%	1%	0.03%	**55%**	7%	6%	5%	3%	**177%**

This renewable energy technical potential could supply far more energy than the energy requirements of the planned new housing – illustrating that the local renewable resource can support zero carbon development in the GNDP area. If the new GNDP developments were delivered to zero carbon standards then utilising the cheapest approach of large scale wind turbines to meet all their energy needs would require 23 large turbines. However, if a balance of biomass CHP and wind turbines are used to meet the energy needs of the new development then 7 large wind turbines and biomass requirements equating to 880,000 tonnes of landfilled garden/food waste (>800% of total available) would meet the need. Alternatively this biomass fuel could be sourced from 23,000 hectares of managed forestry (158% of total available) or 2,300 hectares of farm land managed for energy crops (3% of total available). The alternative option is to rely on microgeneration technologies such as PV to meet the energy needs of the new developments which would cost up to three times as much. (see Development Viability section below and table 6 in section 4.3 of the report).

A Local Standard For Different Areas Or Developments Within The GNDP?

Combined heat & power (CHP) systems, with a district heating network, enable significant carbon reductions within new developments. Character area definitions, such as 'city centre', 'edge of centre' or 'suburban' can be used to carve up and define key characteristics of certain geographical areas across the area. However, applying general energy solutions to character areas will only provide generic guidance regarding the applicability of communal energy systems versus specific types of individual renewable energy technology, such as PV or wind. The ability to set and achieve higher carbon standards is determined by the specific characteristics of a development rather than the general area in which it is located, and whether it can support CHP energy systems which can enable better carbon standards to be achieved. In addition, the two key renewable energy resources of biomass and large scale wind do not need to be located in the same locality as the development – biomass resources can be transported to where they are needed and wind turbines can be contractually linked to developments located some distance away.

Setting Differential Carbon Standards Across Developments Based on Building Types, Scale and Density

The renewable energy evidence base and our assessment of the proposed new developments, does not necessarily support the argument for tighter carbon standards for specific development sites or specific areas within the GNDP. The main renewable energy resource are wind and biomass, which can potentially supply energy to all the larger developments. Accurate carbon standards, with an understanding of costs, can only be developed for specific developments when detailed information is available about the development, in terms of densities, numbers of units, and breakdown of housing/ building types.

It may instead be most appropriate to set carbon standards for particular parts of a development site, based on the building types, density and scale, due to the fact that there will be differences across a development site. This is the approach that the Government's new definition of a zero carbon home is taking, with the potential to set different on-site carbon standards for the different types of development within a specific site. The GNDP could consider setting a minimum onsite carbon standard of 44% across all developments, and then set higher onsite standards for those areas of a development with higher density and scale, and greater mix of building types. A mixture of energy efficiency measures and renewable energy technologies are used to deliver carbon reductions in new housing. The optimum balance between energy efficiency and renewable energy is specific to a particular development – there is no one-size-fits-all solution – but typically the energy efficiency measures will contribute 10% to 20% carbon reductions with renewables providing the remaining reductions. The 44% CO_2 reduction target may be difficult to achieve for constrained urban infill sites where CHP, biomass and ground source heat pumps are not possible, and at these locations the 25% target under Code for Sustainable Homes Level 3 may be more appropriate. Therefore both policy and masterplanning must be used to require appropriate energy provision depending on the scale and character of developments.

Although density is vitally important in determining the practicality and viability of CHP and district heating, average density thresholds recommendations are indicative only, and other characteristics of specific schemes such as scale and building mix are equally important in determining whether CHP is a suitable option. The general criteria for a communal system are a scale of 500 units and a density of 50 units per hectare – the number of units could be lower if non-domestic buildings are in the mix or if appropriate high density existing development is adjacent. Therefore, GNDP could set higher carbon standards for those developments, or areas of development sites, which are at these higher densities.

Illustrative Energy Strategies for the New Development

Without detail on the density and housing mix of the new developments it is not possible to provide definitive zero carbon strategies. However, in order to give an indication of the carbon standards that the development might be able to achieve, we have modelled three alternative illustrative energy supply strategies for achieving zero carbon standards in this proposed new housing, based on:

- microgeneration technologies – these include individual building-integrated low carbon technologies such as photovoltaics, solar water heating and ground sourced heat pumps;
- communal energy systems - combined heat & power (CHP) systems, with a district heating network fuelled with biomass or biogas (contribution of offsite local large scale wind turbines is also considered in this scenario); and,
- balance of microgeneration, communal energy systems and local offsetting measures – local offsetting measures include insulation measures in existing local housing.

These illustrative energy supply strategies demonstrate the technical and financial implications of the different approaches, and the much lower cost of achieving a zero carbon development through a communal energy system for whole developments rather than installing microgeneration technologies on individual housing units.

COST IMPLICATIONS OF DEVELOPMENTS BUILT TO HIGHER CARBON STANDARDS

The illustrative energy supply strategies outline the key technical and financial options to achieving a zero carbon development. They demonstrate that the cheapest way of delivering a zero carbon development is to contractually link it with a large scale wind turbine in the local area, and this approach could potentially enable all new development to be zero carbon at a cost as low as £5,000 per dwelling. However, it should be noted that currently very few housing developments in the UK have established a contractual arrangement with a wind turbine in this way. The cost would be £13.5k per unit if communal energy systems are installed. The smaller infill developments and lower density areas of the larger sites would face very high costs of approximately £30 to £40k per unit to achieve very low to zero carbon standards under the current definition of zero carbon homes through the use of individual microgeneration renewable energy systems, such as PV.

These costs provide a useful marker with regard to the impact on the development of achieving zero carbon standards. These costs will also change substantially under the new definition of a zero carbon home and we have provided an indication of this in section 4. Development costs and land values are changing all the time, and these changes are particularly severe under the current economic conditions. A specific assessment of the deliverability of the development would vary significantly from today to next year to the year after. Developers can work in partnership with an Energy Services Company (ESCo) to finance, maintain and operate the energy system for a new development and therefore reduce the costs and the level of burden that they face. There are a number of commercial ESCos in existence which can support developers in designing, installing and operating a communal energy system for a new development. These ESCos may either operate the energy system entirely themselves or enter into an arrangement with the developer and other entities in order to establish a new ESCo specifically designed to operate the energy infrastructure of the new development. These development specific ESCos tend to be arranged so that they are part, or wholly, owned by the residents of the development, and are therefore often referred to as 'community ESCos'.

Changing Definition of Zero Carbon Development

The current definition of a zero carbon development requires that all energy requirements of the development are met from onsite renewable energy generation. The Government recently consulted on a new definition of zero carbon homes so as to define the necessary standard for all new homes built from 2016. The proposed new definition consists of a required proportion of offsite generation (referred to as 'carbon compliance') in conjunction with an allowed proportion of offsite or local carbon offsetting that will ease the technical and financial challenge of achieving zero carbon status for the remaining emissions. The final definition of what exactly constitutes a zero carbon home will be crucial to the designation of carbon standards within LDFs, as any local carbon standard/ requirement will need to be based upon the national definition of a zero carbon home. This changing policy backdrop to what is meant by a low or zero carbon development, has profound implications for the development of a local carbon standard for the GNDP. This study includes consideration of the new elements within the proposed new definition of zero carbon development to inform the potential form of a local GNDP carbon standard.

FACILITATING THE DEVELOPMENT OF SHARED INFRASTRUCTURE AND RENEWABLE ENERGY

In terms of achieving low to zero carbon standards, the GNDP should outline that developers should focus on communal energy infrastructure rather than just opting for the smaller, less complex building integrated renewables to achieve nearer term "lower" carbon standards. This will ensure that developers do not opt for cheaper strategies in the earlier phases which jeopardise the ability of the development to achieve significant carbon savings in the longer term. The GNDP could also establish a ring fenced 'carbon investment fund' to provide upfront capital for communal infrastructure such as CHP and district heating networks that can supply phased developments. The carbon investment fund would bring forward the value of staged developer contributions to early stage investment and would be reimbursed through payments from private sector developers as their developments are rolled out.

POTENTIAL ROLE OF A LOCAL ESCO IN STIMULATING LOW CARBON DEVELOPMENT

Planning policy alone will not be able to deliver low carbon and renewable energy within the GNDP area, and a range of policy measures covering economic development to council initiated energy projects will also be required. Managing and financing energy infrastructure for long term, phased development projects is extremely challenging. The partner councils have a great opportunity to directly progress renewable energy installations and decentralized energy generation by taking forward projects on their own buildings and land. The public sector could establish a local ESCO to help implement these low carbon energy projects. There is a particular opportunity in terms of using public buildings as an anchor heat load around which to establish CHP and district heating networks.

An ESCO or special purpose vehicle led by a public sector organisation may help in taking forward low carbon projects that are not being implemented by the market place due to financial or technological risks. An ESCO can be designed so as to manage these risks and enable a project to proceed. Nonetheless, a local authority or community group should only go down the path of establishing an ESCO if the energy project they wish to pursue is of no interest to an existing ESCO or if certain market risks cannot be reduced through other actions by the public sector, such as guaranteeing revenue streams for the heat or electricity generated by a renewable energy installation.

KEY POLICY CHOICES FOR THE GNDP

1. Set a zero carbon standard in advance of the Government's 2016 timetable?
2. A zero carbon requirement for GNDP developments in advance of 2016 can be best justified through encouraging developers to adopt the lowest cost solution – namely the use of large wind turbines. Should the GNDP encourage housing developers to work in partnership with wind developers?
3. Require new developments to utilise local biomass and wind resources from within the GNDP area or source biomass from anywhere?
4. Set differing carbon standards for different parts of the development sites, with stricter onsite targets for higher density areas?
5. Consider what constitutes acceptable cost or burden for developers in achieving zero carbon standards. Zero carbon development costs of approximately £5k per dwelling if large scale wind turbines only are used, £13.5k per unit if communal energy systems or £30 to £40k per unit if individual microgeneration renewable energy systems, such as PV, are used.
6. If large wind turbines only are used to meet the energy needs of the new development then 23 large wind turbines would be needed. If a balance of biomass and wind turbines are used to meet the energy needs of the new development then 7 large wind turbines and biomass requirements equating to 880,000 tonnes of landfilled garden/food waste (>800% of total available in GNDP area) would be needed. Alternatively this biomass fuel could be sourced from 23,000 hectares of managed forestry (158% of total available) or 2,300 hectares of farm land managed for energy crops (3% of total available). In contrast, if smaller scale 50 kW wind turbines (with a hub height of 25 m to 40 m, compared to 120m hub height for the large turbine) were used to meet just the electricity needs of just 4,000 of the proposed new housing units then 423 of these smaller turbines would need to be constructed (taken from illustrative energy strategies outlined in table 6).
7. Whether to follow the current Government definition of low/ zero carbon which requires all carbon emissions to be addressed on site or to follow the proposed new definition which allows offsite measures to be eligible?
8. If allowing offsite measures, then should the Councils establish a 'local carbon offset fund' with distribution mechanisms to enable developers to pay to offset all the residual emissions from their developments?

KEY RECOMMENDATIONS FOR PROGRESSING LOW CARBON DEVELOPMENT

The following actions will assist the GNDP in progressing low carbon development:

1. Map the key renewable energy sources in the area, and relate these to the key development sites in the area (spatial correlation of energy demand and local energy supply) to aid the realisation of low & zero carbon development;
2. The JCS and subsequent LDFs should indicate the low carbon energy systems that it expects developments of particular scales, density and mix, to incorporate and encourage developers to install communal systems, where applicable;
3. Ensure that the master plans for the key growth sites contain comprehensive zero carbon methodologies addressing buildings and low carbon infrastructure;

4. Ensure that developers produce detailed zero carbon energy strategies for the key development sites, with the onus on them proving why zero carbon standards are not possible;
5. Set differing carbon standards for particular parts of a development site, with higher carbon standards for areas with higher density, scale and a mix building types.
6. Develop rules to ensure that 'off site' renewables are additional to any commercial renewable energy developments that would occur anyway within the districts (and support the development of a delivery mechanism);
7. Encourage developers to work with wind turbine developers so as to establish contractual relationship with 'off site' wind turbines that are located within the area;
8. Encourage developers to work with expert ESCOs to design, finance and build energy supply systems within their developments;
9. Undertake heat mapping in the most densely populated areas and appraise possible heat infrastructure projects linked to major new developments and the existing major heat loads and major heat waste opportunities;
10. Establish a 'local carbon offset fund' with distribution mechanisms to enable developers to pay to offset all the residual emissions from their developments. This facility might also be needed to support the operation of the 'allowable solutions' proposed in the Government's consultation on the definition of a zero carbon home. It will be important to consider the cost (per tonne) of the offsets and establish clear rules to determine additionality.
11. Encourage ESCO activity in the district, including the development of a public sector led energy supply project
12. Consider the establishment of a ring fenced Carbon Investment Fund to provide the upfront capital needed for financing large scale low carbon infrastructure such as CHP and district heating networks that can supply phased developments.
13. The public sector should implement renewable energy installations and decentralized energy generation projects on its own buildings and land. This can be realised by public sector buildings providing 'anchor loads' for district heating and low carbon infrastructure networks.

1 Introduction

1.1 Study Overview

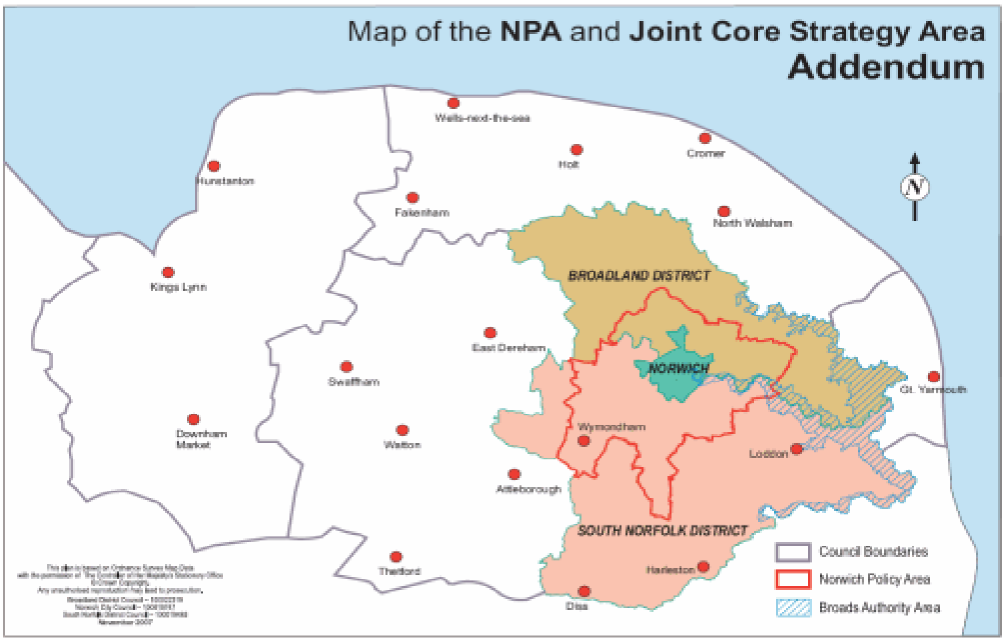
The Greater Norwich Development Partnership commissioned ESD to undertake a PPS 1 compliant sustainable energy study for Broadland, Norwich and South Norfolk to help inform policy development for the area's emerging Joint Core Strategy and subsequent Local Development Framework documents. This report presents the conclusions of this work. More specifically, the project:

- Specifies suitable low carbon solutions and requirements for different development types;
- Assesses the characteristics of the housing growth plans for the area, and provides indicative energy supply strategies that help inform potential carbon standards for the new development;
- Assesses the resource potential for renewable energy generation within the GNDP area and relates this to the energy demand of the housing growth proposals;
- Outlines potential carbon standards for new development and the policy options for supporting low to zero carbon development within the area.

1.2 Overview of Broadland, Norwich and South Norfolk Areas

The councils of Broadland, Norwich, and South Norfolk are working with Norfolk County Council to prepare a new planning strategy for the whole area up to 2026. The Greater Norwich Development Partnership are working with the councils to oversee the production of the Joint Core Strategy. Figure 1 shows the map of the area and the key Norwich Policy Area where the majority of the housing growth is planned.

Figure 1: Map of the Joint Core Strategy Area



The area measures 1,495 sq km (149,572 hectares) and extends from Foulsham in the north-west, Blickling and Aylsham in the north, Halvergate and Burgh St Peter in the east, Diss and Harleston in the south and Hingham in the west. At its heart lies Norwich, the pre-eminent centre of population, employment, business, culture and heritage for Norfolk and the

East of England. The population of the three districts is 365,000, living in about 150,000 households. The Norwich Policy Area has a population of 230,000 with projections to rise to 280,000 by 2025. A larger proportion of older people live in Broadland and South Norfolk, while more young people aged between 15 and 44 live in the city. Most people (58%) live within the Norwich urban area and fringe parishes. The economy is relatively stable, diversified and growing at a sustainable pace. The area has a successful and growing economy, with a buoyant jobs market. With Norwich as the driver of the Norfolk economy, the city has the largest concentration of jobs in the East of England, supporting 43% of Norfolk's jobs.

The Norwich area has strong environmental credentials as a very green place with parks, open green spaces and woodland, riverside walks and a network of historic urban spaces. In recent years a track record has been established in planning and delivering projects that champion environmental sustainability. Norfolk's landscape is very diverse. The countryside includes heathland, ancient grassland, wetland, farmland, marshland, mudflats and reedbeds that all provide the habitats for a wide variety of birds, animal and plant life.

2 Low Carbon Policy Background

2.1 Climate Change Act

The UK has introduced a long term legally binding framework to reduce greenhouse gas emissions. The Bill was introduced into Parliament on 14 November 2007 and became law on 26th November 2008, putting into statute the UK's targets to reduce carbon dioxide emissions through domestic and international action by at least 80 per cent by 2050 and at least 26 per cent by 2020, against a 1990 baseline. A new Committee on Climate Change has been established as a new independent, expert body to advise Government on carbon budgets and cost effective savings. A key part of the Climate Change Act is the establishment of a carbon budgeting system capping emissions over five year periods. The first three carbon budgets -to be set by 1 June 2009- will cover five years periods from 2008 until 2022. It will be a Government obligation to report to Parliament the policies envisaged to meet the budgets. This will happen as soon as practical after 1 June 2009.

2.2 UK Renewable Energy Strategy

Having completed its consultation period on 26 September 2008, the Renewable Energy Strategy is likely to call for 15% of the UK's electricity, heat and transport fuel to come from renewable sources by 2020. This is likely to comprise a 35% target for electricity and a 14% target for heat. The strategy is expected to be published in spring 2009.

2.3 Planning Policy Statement on Planning and Climate Change Supplement to PPS 1

PPS1 requires new development to be planned to make good use of opportunities for decentralised and renewable or low-carbon energy. The supplement to Planning Policy Statement 1 'Planning and Climate Change' highlights situations where it could be appropriate for planning authorities to anticipate levels of building sustainability in advance of those set nationally. This could include where:

- there are clear opportunities for significant use of decentralised and renewable or low carbon-energy; or
- without the requirement, for example on water efficiency, the envisaged development would be unacceptable for its proposed location.

Most importantly for this study, PPS 1 requires local planning authorities to develop planning policies for new developments that are based on:

"an evidence-based understanding of the local feasibility and potential for renewable and low-carbon technologies, including microgeneration".

The PPS1 supplement also states that:

"alongside any criteria-based policy developed in line with PPS22, consider identifying suitable areas for renewable and low-carbon energy sources, and supporting infrastructure, where this would help secure the development of such sources, but in doing so take care to avoid stifling innovation including by rejecting proposals solely because they are outside areas identified for energy generation".

2.4 Planning Policy Statement on Renewable Energy PPS22

Planning Policy Statement 22 (PPS22) sets out the Government's policies for renewable energy, which planning authorities should have regard to when preparing Local Development Documents and when taking planning decisions.

Local policies should reflect paragraph 8 of PPS22 which says:

> *8. 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 developments 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, for example, by specifying that all energy to be used in a development should come from on-site renewable generation.*
>
> *Further guidance on the framing of such policies, together with good practice examples of the development of on-site renewable energy generation, are included in the companion guide to PPS22.*

2.5 Regional and Local Planning Policy

Policy ENG1 within the East of England Plan[1] recommends carbon reduction and renewable energy standards for new development. These policies have been incorporated within the Development Plan for the GNDP authorities. It requires a minimum of 10% of energy to be supplied from decentralised renewable or low-carbon energy sources above a threshold of 10 dwellings or 1000m² for non-residential development. This is considered an interim measure, ahead of local policies being set through Local Development Frameworks.

POLICY ENG1: Carbon Dioxide Emissions and Energy Performance

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 and the development thresholds to which such targets would apply. In the interim, before targets are set in Development Plan Documents, new development of more than 10 dwellings or 1000m2 of non-residential floorspace should secure at least 10% of their energy from decentralised and renewable or low-carbon sources, unless this is not feasible or viable; and*
- *promote innovation through incentivisation, master planning and development briefs which, particularly in key centres for development and change, seek to maximise opportunities for developments to achieve, and where possible exceed national targets for the consumption of energy. To help realise higher levels of ambition local authorities*

[1] *East of England Plan - The Revision to the Regional Spatial Strategy for the East of England, May 2008*

should encourage energy service companies (ESCOs) and similar energy saving initiatives.

Policy ENG2 within the East of England Plan outlines the renewable energy targets for the East of England. Although the renewable energy generation for the new developments will help in contributing towards these overall renewable energy targets, the housing growth within the GNDP area will add to the existing energy demand of the area and therefore increase the amount of renewable energy that is needed in order to achieve the overall target.

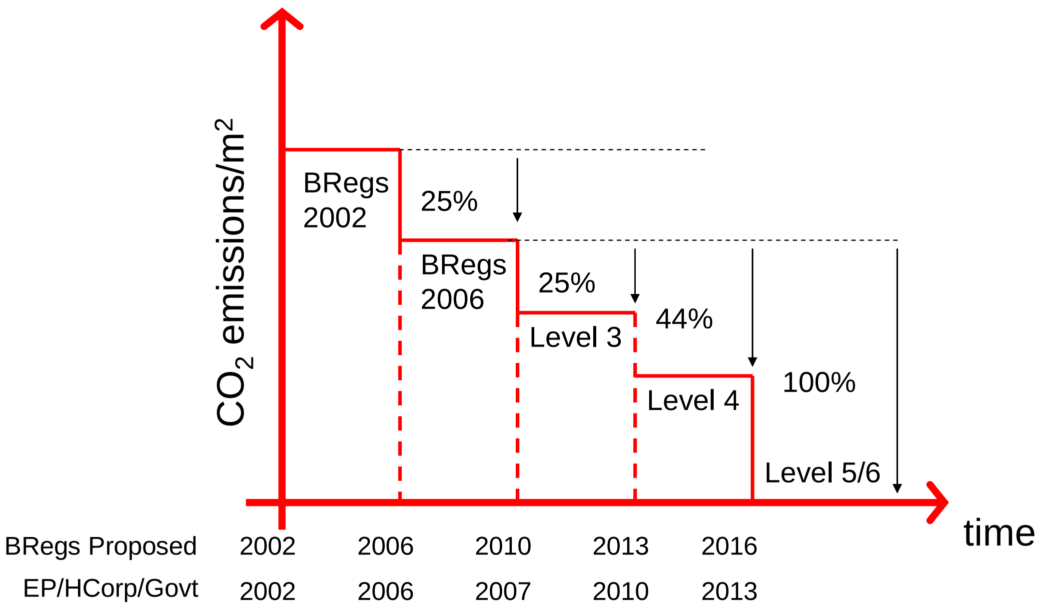
POLICY ENG2: Renewable Energy Targets

The development of new facilities for renewable power generation should be supported, with the aim that by 2010 10% of the region's energy and by 2020 17% of the region's energy should to come from renewable sources. These targets exclude energy from offshore wind, and are subject to meeting European and international obligations to protect wildlife, including migratory birds, and to revision and development through the review of this RSS.

2.6 Building Regulation Requirements

The Government has set out its intentions for improving the carbon performance of new developments into the future with its announcement of the tightening of Building Regulations for new homes along the following lines:

- 2010 – a 25% carbon reduction beyond current (2006) requirements (CSH Level 3);
- 2013 – a 44% carbon reduction beyond current (2006) requirements (CSH Level 4); and,
- 2016 – a 100% carbon reduction beyond current (2006) requirements (CSH Level 5/ 6).



In the March 2008 budget Government also announced its intentions for all non-domestic buildings to be zero carbon by 2019. Therefore, the various phases of development in the district will face stricter and stricter mandatory requirements, and all housing development after 2016 is likely to need to be zero carbon. However, the aspiration for zero carbon development by 2016 is very challenging and will require innovative approaches from both the public sector as well as the development industry.

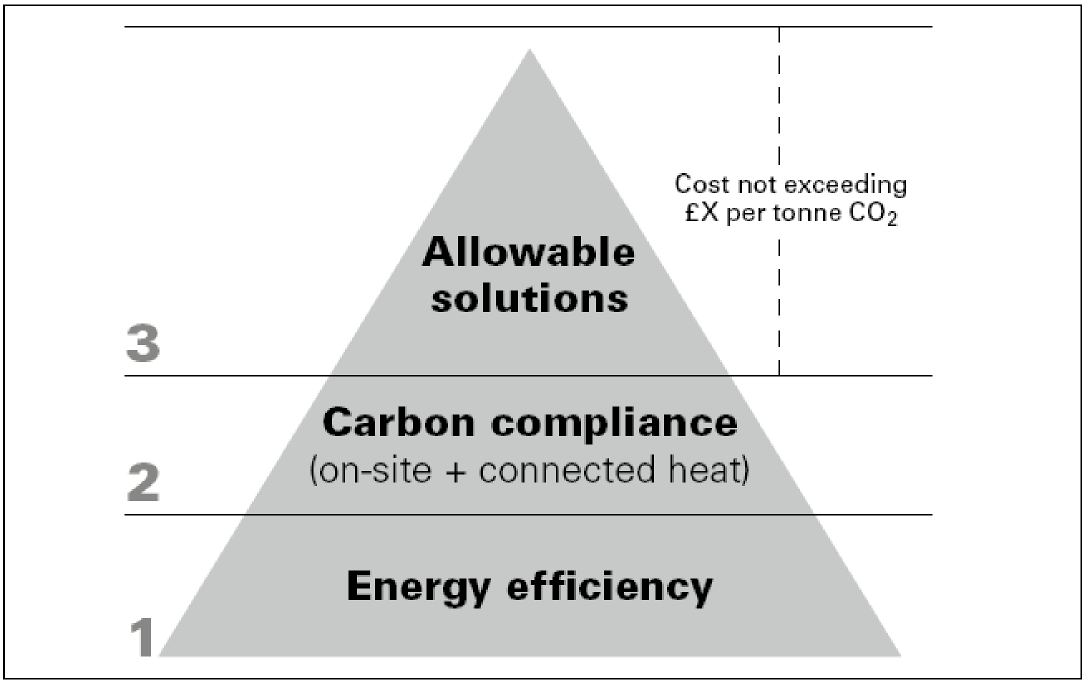
The carbon standards outlined above are taken from the **Code for Sustainable Homes (CSH)** which specifies tightening carbon reduction standards up to Level 6 which corresponds with a zero carbon development. These CSH carbon standards therefore set the benchmark for all new developments, and the evaluation of specific carbon standards for particular developments will need to relate to the CSH carbon standards – ie 25%, 44% and a 100% reduction in carbon emissions beyond Building Regulations. The key question for local planning authoritie's LDFs is whether to specify carbon standards in advance of those set out above by central Government. If a local planning authority is to require zero carbon standards for new development in advance of 2016 then it needs to illustrate that zero carbon development is possible within the locality.

2.7 Proposed New Definition of Zero Carbon Homes

The Department of Communities and Local Government recently consulted on the definition of a zero carbon home that will define the necessary standard for all new homes built from 2016. There are a number of challenges involved in the delivery of zero carbon homes and it is both technically and financially difficult to achieve zero carbon status across all types of development. The CLG consultation ran from December 2008 until March 2009, and considered whether it may be too onerous to expect all types of development to meet all energy needs from onsite generation, and if offsite energy generation or even local carbon offsetting should also be allowed within the definition of a zero carbon home.

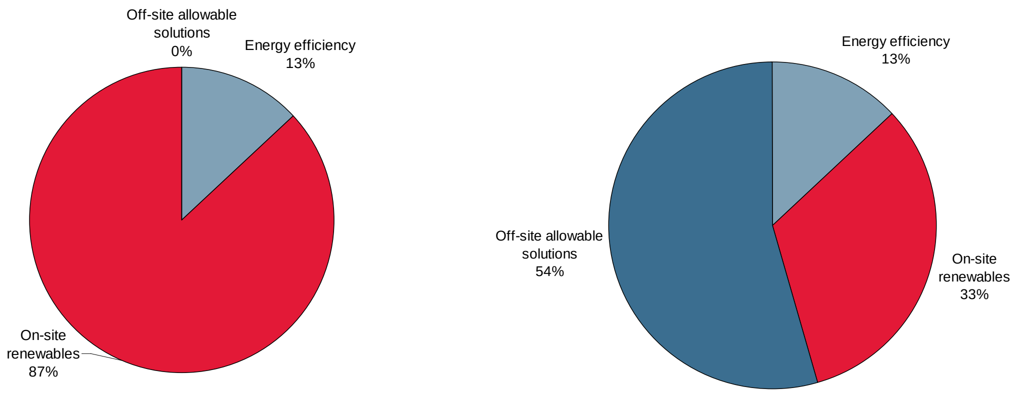
The consultation document proposed that the definition of a zero carbon development follow the preferred hierarchy outlined in Figure 2 with high minimum levels of energy efficiency, minimum levels of onsite energy generation and then the residual carbon emissions offset through offsite generation or investment in other carbon reduction measures. The key question is what minimum standards should be required for energy efficiency and onsite generation?

Figure 2: Government's preferred hierarchy for a zero carbon housing development



The definition of what constitutes a zero carbon home will be crucial to the designation of carbon standards within LDFs, as any local carbon standard/ requirement will need to be based upon the national definition of a zero carbon home. Under the current definition, which requires all energy for the development to be generated onsite, the costs of building zero carbon homes are very high and there are enormous technical difficulties for smaller scale and low density developments. Under a new definition the issue of what constitutes undue burden on developers will also change due to changes in the cost of achieving the different carbon standards under the CSH.

Although the exact definition of a zero carbon home will not be resolved until 2012, it looks very likely that 'flexible mechanisms' will be allowed within the definition, and that some proportion of offsite generation will be acceptable. The consultation document errs towards enforcing a minimum 70% of regulated[2] emissions to be abated through energy efficiency and carbon compliance. This enables 'allowable solutions' to meet the remaining 30% of regulated and 100% of unregulated[3] emissions. Figure 3 illustrates the difference between this and the current zero carbon definition.



(a) **(b)**

Figure 3: Indicative methods for meeting zero carbon, (a) under the current definition; and (b) under a possible future definition of a minimum 70% regulated emissions via energy efficiency and on-site renewables

We have therefore included some offsite generation within our energy supply modelling to outline indicative alternative approaches to achieving low to zero carbon standards in the housing growth plans for the GNDP area. In fact, the use of offsite, but locally situated, renewable energy is essential to the achievement of zero carbon development as it is very difficult to meet all the energy needs of new development through onsite generation only. In particular, the contribution of the local wind resource with the GNDP area to meeting the energy needs of the new development requires the eligibility of offsite local renewables to the definition of zero carbon development. Our analysis will also consider the effect of utilising the carbon offsetting measures proposed under the 'allowable solutions' which are likely to be the cheapest means of reducing carbon emissions – these are measures at the top of the triangular hierarchy where the residual emissions can be offset at a lower cost. The likely cost, or the minimum cost of carbon reductions from these measures that Government will deem acceptable, is currently up for debate, but it will be cheaper than the onsite solutions.

[2] Regulated emissions arise from space heating, domestic hot water, lighting, fans and pumps.
[3] Unregulated emissions arise from the use of appliances and other electrical items

In addition, local planning authorities might wish to form their own opinions on the types and scale of carbon offsetting that that they can or wish to support within their local areas.

3 Current Energy Consumption and Carbon Emissions

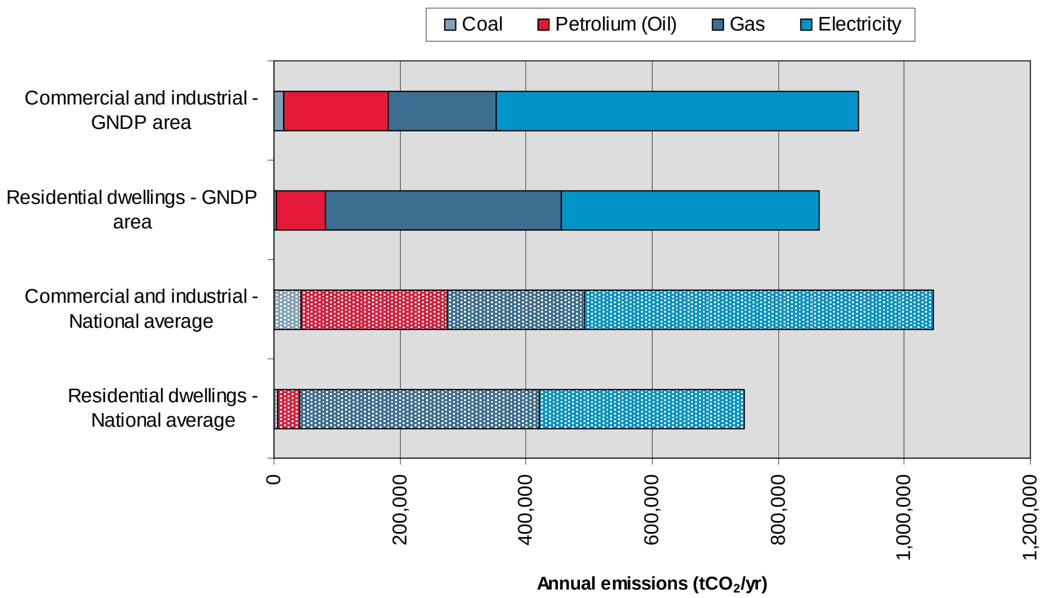
3.1 GNDP Area's Energy Demand and CO_2 Emissions

3.1.1 Current carbon footprint of the area

The total annual emissions for the GNDP area (Broadland, Norwich and South Norforlk councils) was 1,792,120 tonnes of carbon dioxide per year (tCO_2/yr) for 2006. This represents the most recently available data. The breakdown between commercial/industrial and residential dwellings, as well as fuel sources, is illustrated in Figure 4. The graph also sets out the national average as a comparison.

This shows that commercial/industrial emissions account for 52% of the total CO_2 emissions, slightly lower compared to the national average of 58%. Electricity is the overwhelming source of emissions for commercial/industrial buildings for the GNDP area, with coal, oil and gas consumption being below the national average. Residential dwellings, on the other hand, account for 48% of the GNDP area's emissions – significantly larger than the national average of 42%. Local oil consumption for dwellings is almost double the national average.

Figure 4: Breakdown of the GNDP area's carbon dioxide emissions for 2006 (source: BERR and DECC)

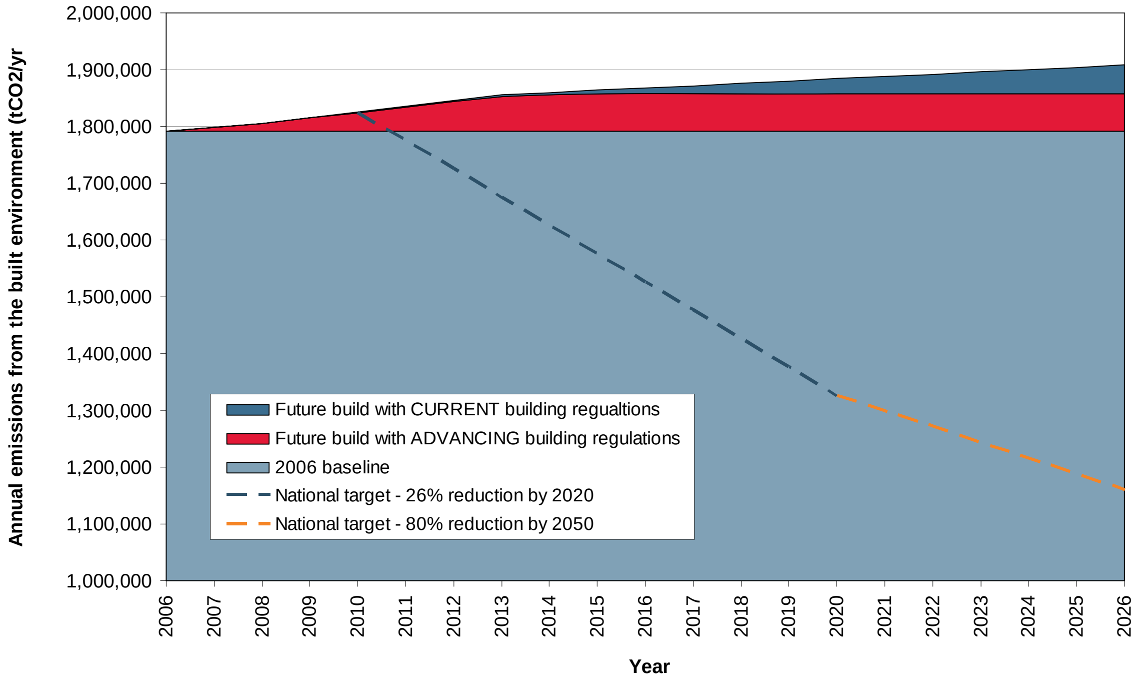


3.1.2 Future carbon emissions forecast

The Regional Spatial Strategy requires the construction of 37,000 dwellings between 2009 and 2026. These new homes will add to the sub-region's energy demand. At the same time, national and international impetus is attempting to set a trend for the reduction in CO_2 emissions.

Figure 5 shows a prediction of the future emissions for the three districts under the GNDP. The light blue area shows the 2006 baseline emissions of circa 1.8 $MtCO_2$/yr. The red area estimates the additional emissions that the 37,000 new dwellings will create, taking into consideration the current road map for advancing Building Regulations[4]. Of the 37,000 dwellings, 14,000 have already gained planning permission and hence are assumed to be constructed to Part L 2006 standards. The remaining 23,000 dwellings are assumed to be built evenly between 2009 and 2026, and achieve the Building Regulations applicable to that year. After 2016 the red area plateaus, in recognition that from this point all residential buildings will be zero carbon.

Figure 5: Emissions forecast resulting from future new build residential dwellings.



The dark blue area indicates the emissions that would take place if the current Building Regulations were to continue, instead of the advancing standards. This would see a 6.5% rise in the annual emissions arising from the three district's built environment.

To put the projected increase in emissions into context, the recently adopted national targets are included. The government recently pledged to reduce the UK's total emissions by 26% in 2020. This target includes transport, which is outside the scope of this analysis, and a proportion of the emissions reductions are expected to come from cleaner grid electricity. None the less, there is an onus upon local government to assist in reaching this target, as well as the equivalent 80% by 2050.

The gap between the 2020 target and the projected emissions for that year is over 500,000 tCO_2, and is 30% of the 2006 baseline. Hence, two key conclusions can be drawn. Firstly, new buildings should add minimally to the existing energy demands of the region. Secondly, it is essential that large, renewable, decentralised energy generation technologies are commissioned to help plug this gap.

[4] At present, Building Regulations will require Code for Sustainable Homes level 3 for all residential dwellings by 2010, which stipulates a 25% reduction in regulated emissions compared to Part L 2006. In 2013, CSH level 4 (44%) will be required, followed by CSH level 6 (true zero carbon homes) as of 2016.

4 Assessing the Potential for a Local Carbon Standard for the GNDP

4.1 Approaches to Low Carbon Development

4.1.1 Communal energy supply systems

Combined heat & power (CHP) systems, with a district heating network, typically enable the greatest carbon reductions in new developments. However, the viability and effectiveness of CHP is dependent on the scale, density and mix of development. In general, CHP requires large numbers of units at high density with a good mix of building types and a good spread of daily and seasonal energy demand. The recent guide 'Community Energy: Urban Planning for a Low Carbon Future' produced by the CHPA and TCPA[5] provides a useful overview of the types of development that suit CHP and district heating and the range of issues that need to be considered in the development of CHP and district heating networks. In fact, the practical achievement of very low to zero carbon developments through an onsite approach tends to require a communal energy system as the basis of the energy strategy. Thresholds for density & scale:

Although density is vitally important in determining the practicality and viability of CHP and district heating, average density thresholds recommendations are indicative only, and other characteristics of specific schemes such as scale and building mix are equally important in determining whether CHP is a suitable option. Any specific development will have different densities across the site, and a communal system may be appropriate for various pockets within the development (for example in the central areas). In addition, the communal systems could link to existing high density development next to the site, and this will be encouraged under the proposed new definition of a zero carbon scheme.

The general criteria for a communal system are at a scale of 500 units and a density of 50 units per hectare – the number of units could be lower if non-domestic buildings are in the mix or if appropriate existing development is located nearby.

In our analysis of the potential technical solutions for achieving zero carbon standards in the proposed new developments, we have modelled communal CHP systems for the larger scale development sites – and these communal systems represent a low cost energy supply solution to delivering zero carbon development within the GNDP area. Large scale wind turbines also represent a typically lower cost means of achieving a very low to zero carbon development, and will be a key ingredient of a lower cost zero carbon supply strategy. Large scale wind can be linked to larger development sites where the overall electricity demand can support a supply contract with a wind developer, whereas a smaller development will not have a large enough energy demand to support a large turbine .

4.1.2 Microgeneration energy supply systems

Individual building-integrated low carbon technologies such as photovoltaics, solar water heating, ground sourced heat pumps and improved energy efficiency standards can deliver substantial carbon reductions in new developments, but will struggle to achieve the very low carbon requirements of Code for Sustainable Homes Levels 4, 5 and 6. Individual systems can achieve the 44% carbon reduction under CSH Level 4, but it would constitute a very expensive approach, particularly if rolled out over a large number of units. Taking into account current proven technologies, an individual system approach would not achieve zero

[5] *Community Energy: Urban Planning for a Low Carbon Future, TCPA & CHPA 2008*

carbon status for new developments due to the space requirements and extensive renewable energy installations that would be needed on each and every building. The current definition of a zero carbon home is not yet set. Government consultation is still out[6], which appears to be moving towards requiring at least 70% of a zero carbon dwelling's 'regulated'[7] emissions to be abated on-site. Even if the remaining emissions were abated through investment in remote wind farms or local energy efficiency schemes for existing buildings, the reduced scale of on-site microgeneration would still not offer a financially nor technically viable solution to achieving zero carbon.

In our analysis below, we have modelled the microgeneration measures for each of the main developments, to illustrate the difficulty involved in achieving zero carbon standards and the high cost.

4.1.3 Incorporating allowable solutions within a zero carbon standard

The Government's proposed new definition of zero carbon housing allows flexibility through offsite measures, such as offsetting through investment in energy efficiency measures in existing homes. In our analysis we have considered the use of these cheaper offsite measures as a means of offsetting residual measures from the new developments. Under this definition, it would be easier to achieve zero carbon status, both technically and financially. We have assumed a carbon cost for these offset measures based on the current price of a Renewables Obligation Certificate which is approximately £100 t/CO_2.

4.2 Assessing the Housing Growth Plans for GNDP Area

4.2.1 Preferred option for housing growth in the JCS

At a meeting of the GNDP policy group on 18th December 2008, the preferred option for the housing growth locations was agreed, and this favoured option is presently being consulted on. The proposed housing growth locations are illustrated in table 1, and amount to 23,000 new housing units between now and 2026. In addition, 14,000 additional housing units are already committed through the planning system, which adds up to a total of 37,000 new homes that will be built by 2026. However, as these 14,000 housing units already have planning permission or are allocated in existing local plans, only the carbon standards of the future 23,000 can definitely be influenced by the Joint Core Strategy.

Table 2: Housing growth plans for the GNDP area

Location	Preferred Option (Option 2a)	Development category allocated (for carbon standard modelling)8
Norwich	3,000	Urban infill
Broadland smaller sites	2,000	Rural infill
South Norfolk smaller sites	1,800	Rural infill

[6] *http://www.communities.gov.uk/publications/planningandbuilding/zerocarbondefinition*
[7] *Regulated emissions arise from fuel consumption for space heating and hot water, as well as electricity for lighting, fans and pumps. Electricity consumed by appliances are not included, and are known as 'unregulated' emissions sources*
[8] *The five indicative development categories are urban infill, rural infill, settlement extension, urban extension and large urban extension/ new settlement.*

Location	Preferred Option (Option 2a)	Development category allocated (for carbon standard modelling)8
North East (Sprowston/Rackheath area)	7,000	Large urban extension/ new settlement
South West : Hethersett & Cringleford	1,000 1,200	Settlement extension
South - Mangreen	2,000 (additional allocation pre-2026)	New settlement
Wymondham	2,200	Urban extension
West (Costessey/Easton area)	1,000	Settlement extension
Long Stratton	1,800	Urban extension

4.2.2 Characterising the main developments and modelling indicative energy supply strategies

The precise nature of the technical solution for a specific development will vary depending on the scale, density and mix of the development. However, in order to assess the potential carbon standards that could be appropriate for the proposed new development in the GNDP area, it is necessary to identify the characteristics of the developments and their suitability for installing low to zero carbon technologies. To enable this analysis we have characterised each of the main development locations into one of five development types:

- Urban infill;
- Rural infill;
- Settlement extension;
- Urban extension;
- Large urban extension/ new settlement.

The smaller developments that constitute urban and rural infill are typically not appropriate for communal systems and therefore the optimum energy strategy will consist of highly energy efficient buildings with individual building integrated technologies. The urban extensions are at the larger size and density necessary to support a communal system in some or all of their development areas, and are large enough to potentially establish a long term power purchase agreement with a wind turbine developer or justify the creation of a local community owned ESCo on behalf of the future development.

These are general rule of thumb categorizations and there will often be overlap between these development types within the characteristics of any specific development site. The specific characteristics of the site will also determine the technical and financial suitability of CHP and district heating systems, and the unit numbers and densities in table 2 are indicative only. Although high density developments are generally needed to reduce the costs of district heating systems, lower density developments can still install communal systems but at a higher cost per housing unit.

Table 2 below outlines the general principles regarding the most appropriate energy supply strategies for different development types, and relates these approaches to the key development sites proposed for the GNDP area. The analysis also demonstrates that 70% of the new development will consist of large scale developments that will be suitable for communal energy systems which are more capable of achieving low to zero carbon standards. 30% of the new dwellings will be in a single large development – the proposed new town in the Sprowston/ Rackheath area – which aims to follow eco-towns standards and install large communal energy systems that can facilitate zero carbon status. Table 2 could be referred to as a 'pick & mix' energy technology supply table – as it illustrates the most appropriate technical solutions for different development types.

Table 3: Pick & mix Table of typical low carbon energy strategies for different development types in the GNDP area

Category	Description	Proportion of future dwellings	Scenario for renewables testing[9]	Options for low carbon/ renewable energy supply and carbon reduction potential
Urban Infill	Small numbers of typically around 10-100 housing units integrated into existing urban environment/settlement framework - few other building types. High density (50 dwellings/ha).	13%	3,000 dwellings, the majority of which are in Norwich	• Individual rather than communal systems – with building integrated micro-renewables, such as SWH, PV, GSHP. Ultra energy efficient passive house design would compliment these technologies. Difficult to achieve very low or zero carbon development. • Option for linking new buildings with existing buildings via a communal system, with potentially good mix of building types in town centre environment. Would need community ESCO to be established.
Rural infill	Small numbers of housing units situated within existing settlement framework - ranging from 1 to 100 Medium density (30 - 40 dwellings/ha).	17%	3,800 dwellings, set in main villages and smaller villages.	• Individual rather than communal systems – with building integrated micro-renewables, such as SWH, PV, GSHP and biomass / wood stove. • These same technologies could equally be applied to existing homes, particularly those off the gas network, to deliver significant carbon savings. • Ultra energy efficient passive house design would compliment these technologies well. • Difficult to achieve very low or zero carbon development.
Settlement extension	Up to 1,000 dwellings adjoined to existing town or village with limited mix of other building types. Medium density (40 dwellings/ha).	14%	3,200 dwellings. Consists of three large developments (Hethersett, Cringleford, West [Costessey/Easton area]).	• Currently more suited to communal biomass heating rather than current biomass CHP technology due to scale and mix of uses, although biogas (from anaerobic digestion) CHP starts to become more suitable at the larger end of this development type. In the future biomass CHP is likely to become more feasible as the technology matures. • If outer area is less dense, individual systems may become

[9] *A scenario has been developed for indicative purposes only to illuminate suitable energy supply strategies for the new development.*

Category	Description	Proportion of future dwellings	Scenario for renewables testing[9]	Options for low carbon/ renewable energy supply and carbon reduction potential
				favoured for the lower density development. • Potential contribution from medium to large scale wind. • Potential to achieve low carbon development. Harder to achieve zero carbon unless a medium to large scale wind turbine is viable.
Urban extension	Over 1,000 housing units adjoined to existing town and mix of other building types. Medium density (40 dwellings/ha).	26%	6,000 dwellings. Consists of three large developments (Mangreen, Wymondham, Long Stratton).	• Meets indicative criteria for biomass/biogas CHP in terms of size and mix. • Should have good enough mix and high enough density to support efficient communal systems with smaller CHP system based on gas or liquid biofuel, sourced from anaerobic digestion. • Also potential contribution from medium to large scale wind and possibly hydro. • Good potential to achieve very low carbon developments
Large urban extension / new settlement	Large number of housing units adjoined to existing town - up to 4,000 dwellings - and good mix of other building types. High density (50 dwellings/ha).	30%	7,000 – consists of one large development (North East - Sprowston/Rackheath area).	• Communal systems based on biomass / biogas CHP supported by high density & good building mix, with contributions from micro-renewables such as PV & small scale wind • Also potential contribution from medium to large scale wind and possibly hydro. • Good potential to achieve very low or zero carbon developments.

4.3 Indicative Energy Supply Strategies for the Planned New Development

4.3.1 Modelling energy supply options

In modelling appropriate technical solutions for delivering zero carbon standards in the new developments, we have assessed two fundamental variables:

a. Appropriate scale of renewables installed – this is fundamentally the choice between individual microgeneration systems and communal systems (including wind).

b. Whether the solutions should be exclusively on-site, or whether a proportion of off-site emissions abatement should be permitted (following the discussions outlined in section 4.1.3),

The outline methodology for modelling the supply options is

- Estimations of the annual electrical and thermal energy demands for each dwelling was generated using benchmarks.
- These benchmarks were converted into carbon dioxide emissions, enabling emissions abatement targets to be established.
- The targets were broken-down into three parts: energy efficiency, on-site technologies, and off-site 'allowable solutions'.
- A wide variety of low- and zero-carbon technologies were assessed to establish their ability to achieve the CO_2 targets. Indicative costs for these systems were calculated.
- Considering both the category and scale of development (refer to Table 3), the most appropriate mix of technologies were chosen for each site.

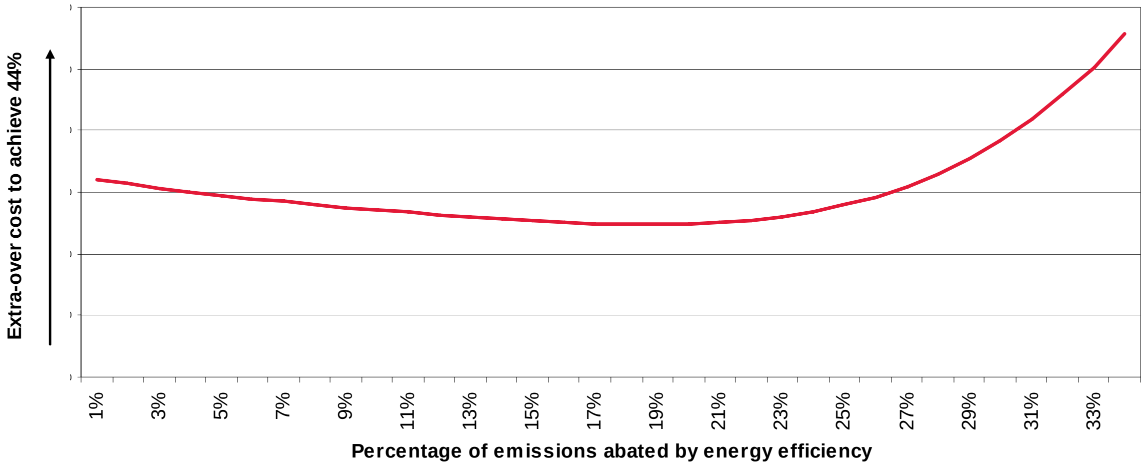
4.3.2 Energy efficiency levels

Making a building more energy efficient fits with the first step of the energy hierarchy, and should always be considered before looking to introduce renewable or low carbon energy sources. There comes a point, however, where energy efficiency becomes a more expensive option than renewables, particularly for more advanced low carbon construction. Figure 6 illustrates an example of a marginal abatement cost curve, which looks to establish the most cost effective method for achieving a 44% reduction in emissions (Code for Sustainable Homes level 4). This demonstrates that the lowest cost option is for 18% by energy efficiency, and hence the remaining 26% by renewable energy. The optimum balance between energy efficiency and renewable energy is specific to a single dwelling – there is no one-size-fits-all solution.

For this analysis, the following energy efficiency levels have been applied, which currently represent the most cost effective solution for a standard semi-detached dwelling:

Code Level	Energy efficiency as proportion of regulated emissions
3	15%
4	18%
6 (true zero carbon)	20%

Figure 6: An example of finding a cost effective scenario for achieving emissions targets such as the Code for Sustainable Homes (illustrative purposes only)



4.3.3 Indicative energy supply strategies for the key development locations

After energy efficiency is taken into consideration, low- and zero-carbon technologies must be installed to achieve the required emissions reduction target.

For the development scenarios described in Table 3, illustrative energy strategies have been applied according to the category of development (infill, urban extension etc.) and the scale of the development (number of dwellings). Note that both the development scenarios and the illustrative energy strategies are for demonstration purposes only, intended inform broad conclusions rather than prescriptive site strategies. Outline assumptions for the development sites have been agreed between ESD and GNDP, and are not based on detailed site information. **In order to illustrate the different costs associated with alternative energy supply strategies we have used the housing growth plans to model three different energy supply scenarios for achieving zero carbon status. We have also considered the impact of large scale wind on reducing compliance costs through a random allocation of large wind turbines to certain of the proposed new development sites.**

Table 7 describes the illustrative energy strategies. Three scenarios have been quantified for achieving zero carbon: through microgeneration, communal energy strategies, and finally allowing off-site solutions.

Scenario 1: Microgeneration

In section 4.1.2, it was stated that microgeneration technologies were not capable of achieving zero carbon. This was due to technical issues (such as insufficient roof space to mount sufficient photovoltaic panels, or limits to the technology's effectiveness) and the high cost of technologies at the scale required. For the sake of this analysis, it is assumed that the developments provide sufficient space to enable microgeneration to abate all of the emissions relating to a zero carbon dwelling. The rationale for the choice of technologies is demonstrated in Table 4.

Table 4: Outline rationale for the choice of microgeneration technologies

Technologies	Rationale
Photovoltaics (PV)	Large array of PV panels will provide all or part of the energy required to heat and power the dwelling. Surplus electricity exported to the grid will equal the

Technologies	Rationale
	electricity drawn from the grid.
Ground source heat pumps (GSHP) + PV	PV powers GSHP, which provides a significant proportion of space heating and/or cooling. Hot water heated electrically.
Ground source heat pumps (GSHP) + small wind	Small wind powers GSHP, which provides a significant proportion of space heating and/or cooling. Hot water heated electrically.
Biomass boiler + PV	Biomass boiler provides all heating and hot water demand. Smaller PV array provides electricity.
Solar thermal + PV	Solar thermal panels provide a proportion of the hot water demand. Remaining hot water and space heating is electrical.
GSHP + small wind	As for 'GSHP + PV', except electricity provided by small wind turbine.[10]

Scenario 2: Communal energy

The second scenario sees microgeneration technologies replaced with communal systems where this is practicable. Section 4.1.1 highlights the key factors which dictate the viability of a communal system. In brief, communal energy strategies are most suitable for a development that is large, dense, and has a good mix of residential and non-residential. The rationale for the choice of technologies is demonstrated in Table 5.

Table 5: Outline rationale for the choice of communal technologies

Technologies	Rationale
Large wind	Large wind turbine(s) will generate the same amount of energy as required to heat and power the dwelling. Surplus electricity exported to the grid will equal the electricity drawn from the grid.
Renewable CHP + large wind	The CHP is 'heat-following', which means that it is sized to meet the heat load of the development and provide a proportion of the electricity demand. A thermal store is installed to almost completely negate heat dumping. The CHP does not generate at night when demand is low, and hence running hours are low at around 2,500 hrs/yr. Wind turbines generate electricity to meet the remaining electrical demand.

Scenario 3: Off-site abatement

Section 2.7 refers to the likely change in definition of zero carbon homes. It is expected that the future definition will enable off-site solutions to be allowed as part of a zero carbon solution. The current consultation documents appear to suggest that a minimum 70% of regulated emissions must be abated on-site. The remaining emissions may be abated through a suite of off-site 'allowable solutions', including local energy efficiency projects. It is envisaged that these allowable solutions will offer a significantly lower cost compared to on-site measures.

For this analysis, an off-site scenario follows the 70% concept described above (based on the communal scenario). It assumes that the remaining 30% of regulated plus all unregulated emissions are abated through investment in local energy efficiency projects. Such projects are modelled to cost £100 per tonne CO_2, approximately equal to the price of

[10] Air source heat pumps are less efficient than ground source heat pumps and typically offer similar carbon performance to gas condensing boilers (based on current carbon content of the national electricity grid)

Renewable Obligation Certificates (ROCs). This value is significantly lower than the cost of investment in on-site renewables, and hence the scenario is expected to demonstrate the lowest cost option for smaller, infill developments.

4.3.4 Indicative costs of achieving zero carbon standards in the new development

The financial costs of achieving low to zero carbon developments refer to the additional costs associated with going beyond the 2006 Building Regulation energy requirements. The comparison between the three scenarios in Table 7 illustrates that the microgeneration solution has the highest overall cost at £762m. This is followed by communal at £421m and off-site at £247m. Compared to the microgeneration scenario, the communal scenario offers a 45% cost reduction, and the off-site scenario 64%.

Per dwelling, a microgeneration solution of a biomass boiler (£7,400/unit) and PV (£27,600/unit) creates a marginal cost of £35,000. However, a communal biomass CHP network (£12,400/unit) plus large wind (£900/unit) has a marginal cost of £13,300. By installing large wind turbines and powering the site electrically, this marginal cost falls as low as £3,000 per dwelling, however this assumes a good site for wind speed, with the location of one or more large wind turbines on or near to the development site.

Overall, communal energy strategies offer a significant capital cost saving compared to microgeneration systems. Note, however, that it is not possible to install communal systems for infill developments (see section 4.1.1). Off-site solutions enable the lowest capital cost, but as yet there are uncertainties regarding the nature of the ‘allowable solutions’ to deliver carbon savings.

To understand the scale of the communal energy systems to achieve zero carbon, Table 6 identifies the estimated number of large scale wind turbines and quantities of biomass sources which would need to be diverted. If the entire energy needs of the new GNDP developments were met through large scale wind turbines then 23 turbines would be required (approximately 1 turbine for every 1,000 homes).

Table 6: Estimated scale of communal energy systems in tangible terms

<table>
<tr><th>Category of Development</th><th>Development Site</th><th>No. of Units</th><th>Communal Technology</th><th>No. of wind turbines</th><th>Quantity of biomass waste to divert</th></tr>
<tr><td rowspan="3">Settlement Extension</td><td>Hethersett</td><td>1,000</td><td>Large wind</td><td rowspan="7">7 x 2.5 MW wind turbines (hub height approx 120 m)</td><td rowspan="7">2,300 hectares of farm land managed for energy crops (3% of total available)
OR
23,000 hectares of managed forestry (158% of total available)
OR
880,000 tonnes of landfilled garden/food waste (>800% of total available)</td></tr>
<tr><td>Cringleford</td><td>1,200</td><td>Large wind</td></tr>
<tr><td>West (Costessey/ Easton)</td><td>1,000</td><td>Renewable CHP + large wind</td></tr>
<tr><td rowspan="3">Urban Extension</td><td>Mangreen</td><td>2,000</td><td>Renewable CHP + large wind</td></tr>
<tr><td>Wymondham</td><td>2,200</td><td>Renewable CHP + large wind</td></tr>
<tr><td>Long Stratton</td><td>1,800</td><td>Renewable CHP + large wind</td></tr>
<tr><td>New Settlement</td><td>North East (Sprawston/ Rackheath Area)</td><td>7,000</td><td>Renewable CHP + large wind</td></tr>
</table>

Table 7: Illustrative zero carbon energy strategies for the housing growth sites – microgeneration, communal and off-site scenarios

Category of Development	Development Site	No. of Units	Microgeneration scenario			Communal scenario			% off-site
			Technologies	Marginal cost per unit (£k)	Marginal cost for site (£k)	Technologies	Marginal cost per unit (£k)	Marginal cost for site (£k)	Marginal cost for site (£k)
Urban infill	Norwich	3,000	PV	£33.9	£101,724	Not possible	Microgen (£33.9)	Microgen (£101,724)	£38,504
Rural Infill	Broadland smaller sites	2,000	GSHP + PV	£31.3	£62,686	Not possible	Microgen (£31.3)	Microgen (£62,686)	£20,540
	South Norfolk smaller sites	1,800	Biomass boiler + small wind	£29.9	£53,841	Not possible	Microgen (£29.9)	Microgen (£53,841)	£22,960
Settlement Extension	Hethersett	1,000	Biomass boiler + small wind	£29.9	£29,912	Large wind[11]	£3.0	£3,016	£1,277
	Cringleford	1,200	GSHP + small wind	£25.7	£30,809	Large wind11	£3.0	£3,619	£1,532
	West (Costessey/ Easton)	1,000	Solar thermal + PV	£28.3	£28,334	Renewable CHP + large wind	£13.3	£13,328	£11,588
Urban Extension	Mangreen	2,000	Biomass boiler + PV	£35.0	£70,015	Renewable CHP + large wind	£13.3	£26,656	£23,177
	Wymondham	2,200	Biomass boiler + PV	£35.0	£77,017	Renewable CHP + large wind	£13.3	£29,321	£25,494
	Long Stratton	1,800	Biomass boiler + PV	£35.0	£63,014	Renewable CHP + large wind	£13.3	£23,990	£20,859
New Settlement	North East (Sprawston/ Rackheath Area)	7,000	Biomass boiler + PV	£35.0	£245,054	Renewable CHP + large wind	£13.3	£93,295	£81,118
TOTALS		**23,000**			**£762,405**			**£420,650**	**£247,050**

[11] *The example of using large scale wind turbines to meet all the energy needs of a development site has been randomly allocated to Hethersett and Cringleford for illustrative purposes only.*

5 Assessing the Renewable Energy Resource Within the GNDP Area

5.1 Assessing the Technical Potential for Renewable Energy within the GNDP Area

5.1.1 Overview of technical potential

The technical potential for renewable energy within the district is the total resource that is technically available. The study has calculated the technical resource available which outlines the total renewable energy resource that could be exploited within the district if all opportunities were taken advantage of.

Definition of Technical Potential

For the purpose of this project, Technical Potential means the amount of renewable energy possible according to the constraints imposed by the:

- physical resource, that is, the wind, solar, hydro, biomass, waste resource actually available within GNDP area;
- limits of the technology and their current efficiencies at converting the renewable resource into energy;
- limits of the existing environment in the GNDP area, that is, roof space and number of buildings for building integrated technologies (solar PV, solar thermal hot water and ground source heat pumps) and, for wind energy, distance from existing buildings and infrastructure, distance from radars and air fields, distance from telecommunications links, avoidance of important ecological and archaeological features, avoidance of steep topography etc.*

The Technical Potential does not consider the likely uptake of the technologies and how the market, economics and technology may change over time. Neither does it consider any planning precedents.

*Note that for wind energy the Technical Potential does not include the constraints imposed by what might be considered acceptable on landscape and visual grounds. This important criterion has been considered for the proposed targets.

The renewable energy and low carbon technologies assessed were:

- wind energy – large scale and smaller scale turbines;
- energy from biomass and waste - both combined heat and power (CHP) and heat only;
- hydro energy;
- solar photovoltaic electricity (PV) – roof top potential only although PV on facades and PV fields may become more viable in future if prices drop;
- solar thermal hot water (STHW) – roof top potential;
- ground source heat pumps (GSHP) – that can provide low carbon heating to housing off the gas network.

The methodology for calculating the technical potential for each of the above is provided in each of the respective sections.

The technical potential was found to be significant within the GNDP area at 9.7 Million MWh or 163% of the area's current energy consumption. Figure 7 demonstrates that there are sufficient natural resources within the boundaries of the three districts to meet 297% of the electrical energy demand in 2026, and 99% of thermal. However, this requires utilisation of every identified resource as well as retro-fitting of renewable technologies to a large number of existing buildings. Details for each technology are provided in the following sections.

Figure 7: Technical Potential for Renewable Energy Technologies in the Three Councils

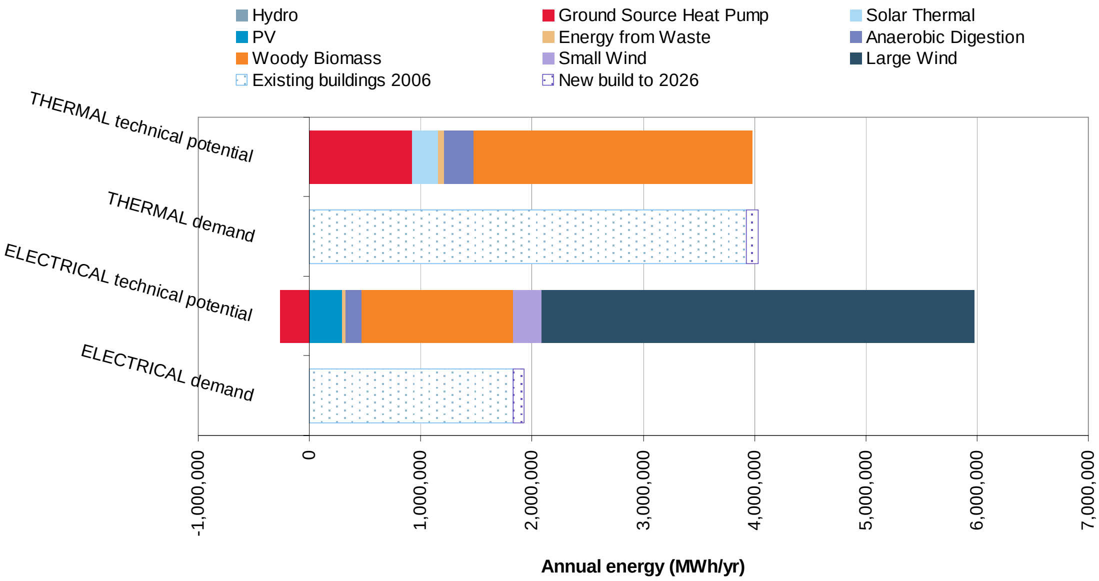


Table 8 demonstrates that 177% of the GNDP area's 2006 emissions could theoretically be abated through local renewable energy. The largest CO_2 savings can be found from biomass and large wind turbines. These two sources provide the vast majority of the technical potential. In fact, the wind resource alone if fully utilised could offset 93% of the region's annual emissions. Local wind speeds are generally above the threshold to enable viability of large turbines, and a wide range of woody biomass arisings are assumed to be available for diversion into heat and CHP facilities. Hydro makes the smallest contribution, with only small head weirs and mill sites identified for micro-hydro installations.

Table 8: Technical Potential for Renewable Energy Technologies in the Three Councils

Technology	Large Wind	Small Wind	Woody Biomass	Anaerobic Digestion	Energy from Waste	PV	Solar Thermal	Ground Source Heat Pump	Hydro	Totals
Electrical Power (MWe)	1,870.0	212.4	169.9	18.3	3.9	363.5	0.0	-131.6	0.3	**2,507**
Thermal Power (MWth)	0.0	0.0	343.3	32.9	7.1	0.0	283.0	460.5	0.0	**1,127**
Emissions abated (tCO_2/yr)	1,672,930	110,200	985,114	113,637	25,695	125,045	50,585	84,859.3	537	**3,168,602**
Proportion of emissions from the built environment 2006	93%	6%	55%	6%	1%	7%	3%	5%	0.03%	**177%**

5.2 Wind Assessment

5.2.1 Large scale wind

- For large scale wind, the assessment is based on a spatial analysis undertaken in the form of a GIS constraints analysis. The GIS mapping considered 38 constraints relevant to large scale wind turbines. The key constraints include:
  - Wind speeds which are greater than 5 metres per second at 45m above ground level
  - International, national and local designations for heritage
  - International, national and local designations for landscape
  - International, national and local designations for ecology
  - Designations for archaeology
  - Space requirements, including proximity to buildings (for noise and visual reasons) and other turbines (to avoid wind turbulence)
  - Electromagnetic interference to communications radar (TV, radio, weather, mobile phone, etc.)
- Air safeguarding zones around MOD and civil aviation interests are 'consultation zones', i.e. local planning authorities are required to consult the Civil Aviation Authority (CAA) upon any proposed developments with tall structures that would fall within safeguarding map-covered areas. This is an example of a 'less constrained zone' rather than an absolute constraint for wind development (i.e. one that would not necessarily prevent wind energy developments in the area, but which requires consultation with the respective stakeholders). The British Wind Energy Association's 'Wind energy and aviation guide' points out that the aviation community has "procedures in place to assess the potential effects … and identify mitigation measures". Furthermore, the guide states that while both wind energy and aviation are important to UK national interests, the 'overall national context' will be taken into account when assessing the potential impacts of a wind development upon aviation operations.
- Therefore, the air safeguarding zones are only considered 'consultation zones' and were therefore excluded at this stage from the wind energy constraints analysis.
- However, despite air safeguarding zones not being absolute constraints, they need to be addressed by developers early in the process of wind energy site development. It is, therefore, advised for developers to start a pre planning consultation process with the relevant aviation stakeholders early in the feasibility process.
- Distribution network and landscape and visual constraints were not part of the GIS constraints mapping (refer to Appendix 1 for further details)

- We have identified all the absolute constraints that would rule out wind turbine developments but there are a number of additional local issues and preferences that could constrain any specific wind turbine location. These include local landscape considerations (as opposed to official landscape designations such as AONBs which have already been considered as absolute constraints), access issues, contamination, private airstrips, economic issues and political decisions concerning the desirability of a wind turbine at that specific site. The identified sites for potential wind turbine developments would also need to be considered against the local landscape character assessments to ascertain their potential impact on character areas. Cumulative impact of multiple turbines would also be an important consideration for the character assessment. One issue which may cause a wind turbine development to prove uneconomic would be the proximity of the local power grid. Once wind developers have identified general sites, they analyse these further issues in greater detail before putting together an economic case and a subsequent planning application.

- The district councils may have also produced their own guidance and documents related to wind turbines which addresses some of these wider issues and constraints.

- Combining all absolute constraints resulted in the identification of 46 km^2 of 'less constrained' land, spread over 672 sites.
- At least a single wind turbine could be installed at each of the identified sites, however some of the larger sites would allow multiple turbines. Based on guidance from the Danish Wind Energy Association, a maximum of five wind turbines per square kilometre could be installed for the larger sites.
- This benchmark results in 748 large wind turbines which would be technically viable for GNDP area. The current and future market for large scale wind turbines suggests that 2.5 MW turbines can be applied as an average. Based on an industry-wide used average capacity factor for onshore large-scale wind turbines in the UK of 25%, and a 95% availability factor, these turbines would generate 8760 MWhs of electricity per year.

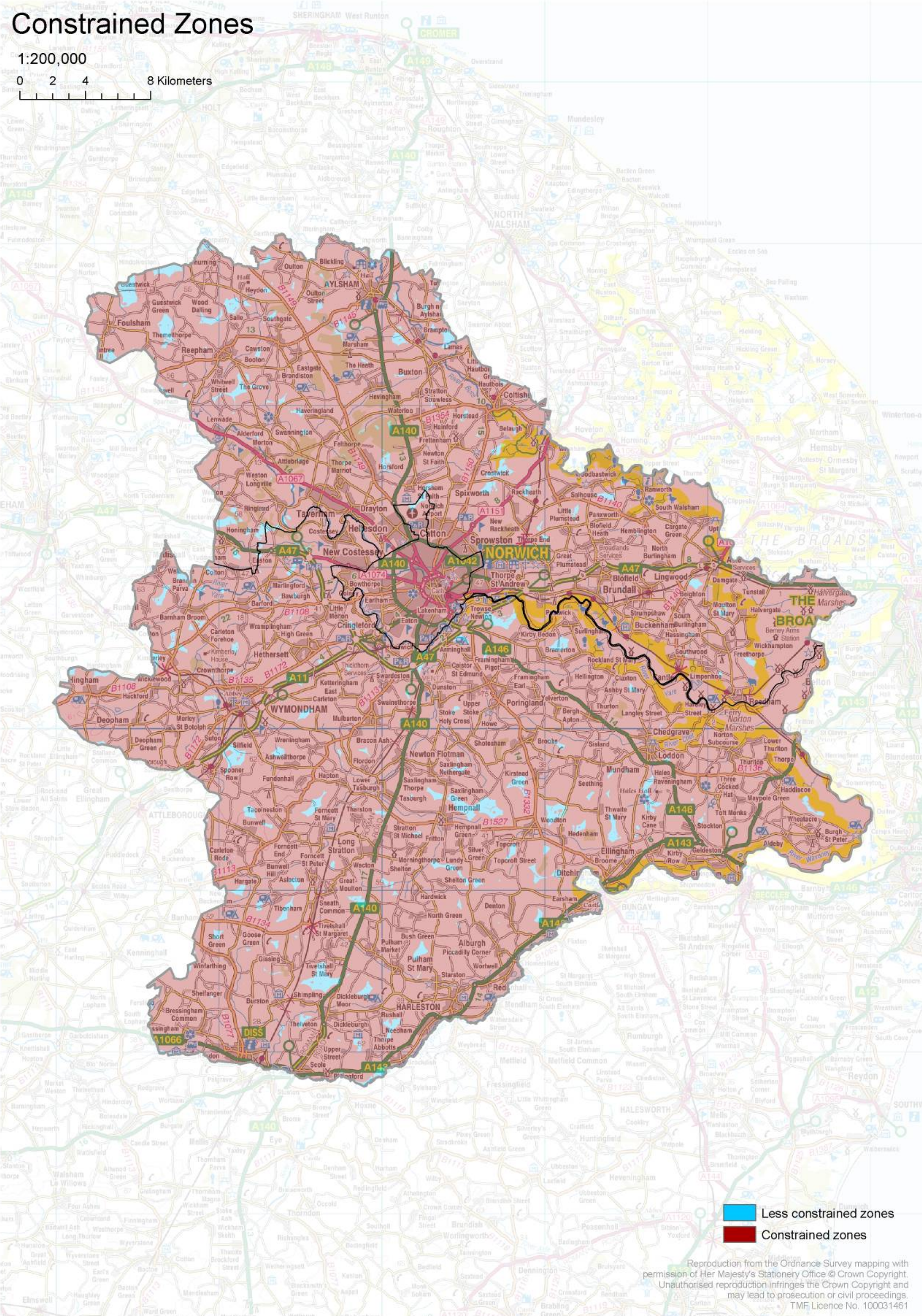
The technical potential for large wind turbines in the GNDP area is 748 installations. If 2.5 MW turbines were installed at each location, over 200% of the current electricity demand in the three districts could be met.

This scale of feasibility may seem overwhelmingly large, however refer back to the definition of 'technical potential': the scale of renewable energy which is constrained only by the limits of the physical resource, the technology, and the local environment. This does not begin to suggest the extent to which technologies should and should not be developed. Hence, a conclusion can be drawn that there are significant natural resources to allow sizable large wind development in the GNDP area. However, this many turbines is not likely to be acceptable on landscape and visual grounds (hub heights of large-scale wind turbines are usually around 60 to 80m with their maximum height to the blade tip ranging from 100 to 125m). Factors such as visual impact, but also public accessibility and topography will therefore reduce the technical potential.

Obviously, undertaking detailed site visits is beyond the scope of this study, and a **detailed landscape, visual and cumulative impact assessment would need to be undertaken for the potential turbine sites before they could be taken forward**, and it will eventually be the political will that will determine how many large-scale wind turbines will be realised in the area.

Figure 8 shows the overall constraints map, which collates all of the 38 layers and designates the 'less constrained zones' in blue. These zones, should not be immediately regarded as suitable areas for large wind turbines, but as areas of search within which suitable sites may exist. In practice, the actual uptake of these sites shall largely be dictated by political will.

Figure 8: GIS constraints analysis – constrained and less constrained zones for large-scale wind in the three council areas



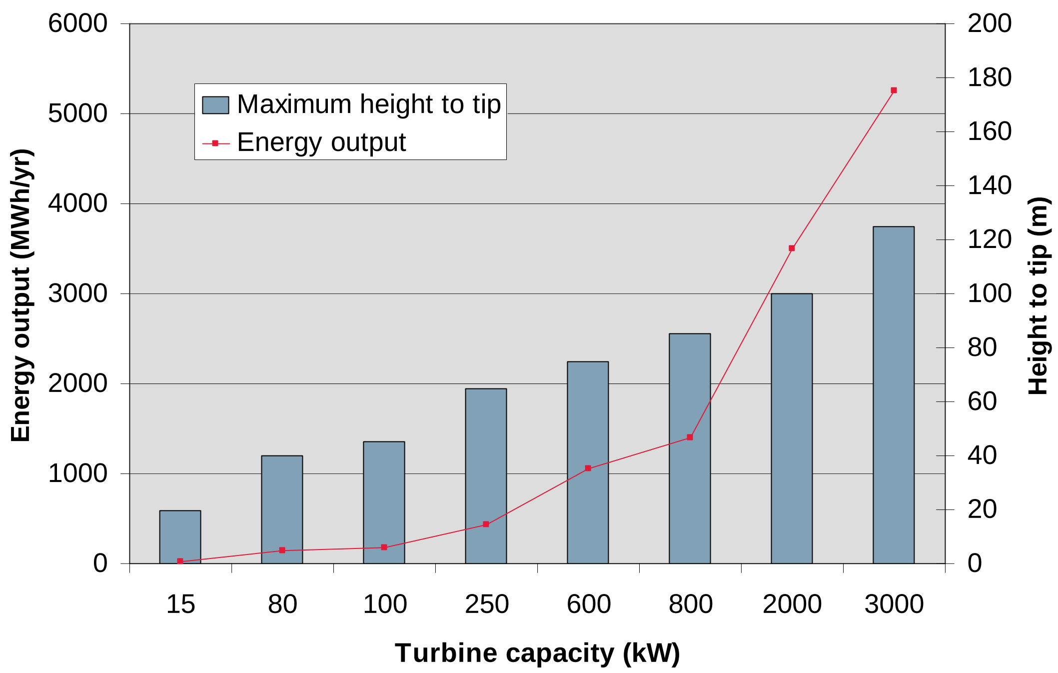
5.2.2 Small scale wind

There is no accepted definition of what constitutes 'small' and 'large' wind. For this analysis, small wind is broadly considered as everything below about 100 kW (kilowatt). Such turbines have a hub height (the height to the horizontal axis of rotation) of 25 m to 40 m, compared to around 125 m for a 2.5 MW (megawatt) turbine.

There is a significant difference in terms of electricity output based on the height and capacity of a turbine, and small scale turbines have a far lower output than large turbines. The figure below illustrates that the energy output per MW installed grows exponentially with increasing turbine height. Hence, small scale wind offers significantly less energy generation potential compared to large scale installations.

Small scale wind turbines tend to be located within immediate proximity to the energy user, as insufficient economies of scale are generated to justify long cabling lengths. This factor more often overrides the constraints within the GIS analysis for large wind (see section 5.2.1 above). Hence, the same GIS constraints are not applied in the estimations for small wind.

Figure 9: Turbine height compared to turbine output in MWh



- The methodology identified two suitable sizes of small wind turbines: 100 kW and 50 kW. It was assumed that 100 kW turbines would be suitable for out-of-town retail and industrial parks (count of 2 and 20 respectively), as well as farms over 5 hectares (count of 1,264). 50 kW turbines were assumed to be suitable for schools (58), universities (1) and farms smaller than 5 hectares (1,194).
- All of these sites were assumed to have an applicable wind turbine installed. Micro-wind was not considered due to the current poor performance, issues with vibration when attached to buildings, and hence lack of envisaged market penetration.
- As identified in the illustrative energy scenarios in Table 6, small wind is prescribed as a viable solution for some new build residential developments. To meet the electricity needs of the 4,000 housing within these specific future developments, 423 50 kW wind turbines would need to be constructed.

The technical potential for small wind turbines in the GNDP area is 1,286 installations of 100 kW turbines, and 1,252 installations of 50 kW turbines.

5.3 Biomass and Waste Assessment

5.3.1 Methodology

This resource assessment looks at the potential biomass resource from a number of different sources within the GNDP area. To undertake the assessment a variety of data sources are used. So that the data for different resources can be compared each is converted into an oven dry tonne equivalent (ODTe) resource. It is then further assumed that each oven dry tonne of material has an energy content of 5MWh/odt, so that the energy equivalence of each resource can be measured.

For the purposes of measuring resource the following assumptions are made:

- Biomass and waste within GNDP boundary were counted as the resource
- Biomass and waste energy can be derived from a diverse set of sources, but can be defined as plant materials and animal waste which are used as a fuel source.
- Dry biomass – woodchip (from managed woodland, saw mill wastes and energy crops), straw, municipal waste
- Wet biomass – silage from cattle, poultry litter, garden wastes, supermarket food wastes
- Desk based assessment using maps, statistics and assumptions as appropriate
- Local experts contacted to verify assumptions
- Resource divided into marginal markets. Two for heat: pellet and dry chip, and five for combined heat and power: wet chip, off-cuts, straw, anaerobic digestion (AD) and municipal solid waste (MSW)
- Embodied energy within these fuel sources is released through combustion or degradation. This resource assessment looks at the potential biomass resource from a number of different sources within GNDP area, including farm and waste segregation.
- Figure 10 outlines the process for converting biomass/waste sources into the technical potential. The blue table lists all of the likely sources of fuel required for biomass/waste technologies, and the raw quantity that may be available annually. This data has been collated through various local and national data sources.
- A set of conversion factors are firstly applied to identify the dry weight (oven dry tonnes) of each waste source. From this point the dry matter can be categorised into 'marginal markets' – that is the type of fuel that could be diverted from that source, to an energy facility.
- Each of these broad waste categories will either be combusted or chemically reacted to produce energy. A calorific value for each marginal market is applied to identify the 'primary energy' which is available within each biomass stream.
- Not all of this energy can be utilised – the efficiency of the technology must be taken into consideration before feeding into the red table, which shows the delivered technical potential for each of the four major technologies.
- Note that the technical potential assumes 100% diversion of these fuel sources.

This GNDP biomass resource is capable of meeting the energy needs of the new development. If a balance of biomass and wind turbines is used to meet the energy needs of the new development then 3% of the total energy crop potential within the GNDP area would be needed (2,300 hectares of farm land managed for energy crops). However, the energy demand of the new development is 800% greater than that available from landfilled garden/food waste and 150% greater than that available from managed forestry.

Figure 10: Source to technology – biomass and waste

Biomass / Waste source	Annual resource		Marginal market
Crops & bare fallow used for energy crops	79,149	Hectares of land	Dry Chip 10kW+
Set-aside used for energy crops	7,421	Hectares of land	Dry Chip 10kW+
Straw from cereals	46,810	Hectares of land	Straw 2MWe+
Silage from cattle	45,397	Number of cattle	AD Plant 500kWe+
Poultry waste	4,771,492	Number of poultry	AD Plant 500kWe+
Landfill - garden and food waste	106,558	tonnes	MSW plant 5MWe+
Landfill - paper and card	106,558	tonnes	Wet Chip 500kWe
Council Parks - green waste	0	Number of parks	AD Plant 500kWe+
Council forest/woodland residues/thinnings	0	Oven dry tonne	Wet Chip 500kWe
Forestry	14,691	Hectares of non-ancient	Dry Chip 10kW+
Joinery/Sawmills - sawdust	3	Number of Sawmills	Pellet 2kW+
Joinery/Sawmills - chip	3	Number of Sawmills	Dry Chip 10kW+
Joinery/Sawmills - offcuts	3	Number of Sawmills	Offcuts 100kWe+
Recycling centres - currently landfilled waste	10,868	tonnes	MSW plant 5MWe+
Category 1 industrial waste	170,000	tonnes	MSW plant 5MWe+
Private tree surgery wastes	93	number of tree surgery	Wet Chip 500kWe

Marginal market	Primary energy
Wood pellet	75,000
Wood chip - dry	4,776,925
Wood chip - wet	117,095
Off-cuts	75,000
Straw	468,103
Anaerobic digestion feed	584,848
Energy from waste feed	126,156

Technology	Electrical energy (MWh/yr)	Thermal energy (MWh/yr)
Biomass heating	0	56,250
Biomass heating/CHP	1,359,280	2,446,705
Anaerobic digestion	146,212	263,182
Energy from waste	31,539	56,770

This potential biomass fuel comes largely in the form of dry chip, and mainly from energy crops which have the theoretical potential to be grown on 100% of available agricultural land. There are also smaller amounts of material available for anaerobic digestion and straw based CHP plant.

5.3.2 Key actions for progressing biomass energy within the area

Policy measures needed to implement the target potential of biomass in the district include:

- Incentivisation schemes for farmers to provide farm wastes
- Incentivisation schemes to encourage woods and forests to become managed for woodchip supply - could make more former set-aside, crop and bare fallow land available for energy crop production. This could possibly be done by using an integrated agri-forestry system so that forestry and livestock or crops could be grown on the same piece of land. Such systems are commonly used in for example the permaculture type systems used by many small scale farming cooperatives where enhanced management practices enable higher yields to be obtained from the land. A yield of 10 ODT/Ha may be difficult to achieve within an agri-forestry situation, but 5 ODT/Ha should be achievable. For illustrative purposes if this yield could be achieved, then if all the 28,690 Ha of former set-aside, crop and bare fallow land were used for biomass production through an agri-forestry system then 143,450 oven dry tonnes of fuel could be produced equivalent to 717,250 MWh or about 28% of the anticipated energy use in 2026.
- Bring more woodland into management and manage as commercial forestry for woodchip production. 3,415 ha of non-ancient woodland was identified in this study. If all of this was managed as commercial forestry for the express purpose of woodfuel creation then 170,000MWh of woodfuel could be produced per year. This would be enough to meet 7% of the anticipated energy requirements of the GNDP districts by 2026. This would require

major investment in the woodland resource and increase in the number of foresters working in the area.

- Establish a biomass fuel group to help set-up a wood-fuel supply chain for the GNDP area and the promotion of agri-forestry systems which allow for food and wood production on the same land.

5.4 Solar Thermal

- Solar thermal hot water (STHW) systems (sometimes referred to as solar collectors, or active solar systems) convert solar radiation into thermal energy (heat) which can be used directly for a range of applications, such as hot water provision and low temperature heat for swimming pools.
- Census data states that there are around 134,000 houses and bungalows in the three districts, as well as 19,000 flats. There are also around 4,800 listed buildings
- The technical potential for existing residential buildings assumes that every house and bungalow in the three districts will have a standard 3 m^2 solar collector, and that a block of flats has sufficient roof space to supply one in four dwellings. Solar thermal cannot be installed on listed buildings.
- As identified in Table 6, solar thermal is prescribed as a viable solution for some new build residential developments. To meet the zero carbon needs of these future developments, 4,000 m^2 of panels would be installed in 1,000 dwellings..

The technical potential for solar thermal is over 130,000 installations of a 3m^2 system in existing buildings, and a further 1,000 installations in new build..

5.5 Photovoltaics

Solar photovoltaic (PV) panels are semi-conductor panels that convert light directly into electricity. This DC power is normally passed through an inverter which converts it into AC power which can be used to power the normal range of domestic appliances or be exported to the local electricity network. The amount of power that a PV panel will deliver is proportional to the amount of sunlight that falls upon it.

- The technical potential methodology for PV considers all houses and bungalows (134,000 dwellings), as well as one in four of the 19,000 flats.
- Given the constraints of southerly orientation, architectural unsuitability and overshading, approximately 20% of roof space is suitable for PV.
- Additionally, commercial/industrial roof space is considered. 7.6 million m^2 of non-residential floor area is assumed to be spread, on average, over three storeys to obtain an approximate roof area. Again, 20% of this is suitable for PV installations.
- No installations can occur on the 4,800 listed buildings.
- As identified in Table 6, PV is prescribed as a viable solution for some new build residential developments. To meet the zero carbon needs of these future developments, PV panels would be installed in 19,000 dwellings.

The technical potential for photovoltaics is over 364 MWp, contributing 15% of the existing baseline electricity demand in the three districts. This requires the installation of over 2 million m^2 of PV panels.

5.6 Ground Source Heat Pumps

Ground source heat pumps (GSHP) make use of the constant temperature that the earth in the UK keeps throughout the year (around 11-12 degrees a few metres below the surface). These constant temperatures are the result of the ground's high thermal mass which stores heat during the summer. This heat is transferred by (electrically powered) ground source heat pumps from the ground to a building to provide space heating and in some cases, to pre-heat domestic hot water. A typical efficiency of GSHP is around 3-4 units of heat produced for every unit of electricity used to pump the heat.

- Based on evidence gathered in Camco's previous work, it can be assumed that 45% of houses, bungalows and flats have suitable access to enable a GSHP installation[12], with on average a 5 kW_{th} system appropriate per dwelling.
- In the commercial/industrial sector, a 5 kW_{th} system would be appropriate per 150 m^2 of floor area, again taking 45% of buildings as being suitable
- As identified in Table 6, GSHPs are prescribed as a viable solution for some new build residential developments. To meet the zero carbon needs of these future developments, GSHPs would be installed in 3,200 dwellings.

The technical potential for ground source heat pumps is for 460 MWth to be installed in all suitable dwellings and businesses, contributing 23% of the baseline heat demand in the three districts, but increasing the electrical demand by 14%.

5.7 Hydropower

There is theoretical potential for energy generation wherever there is water movement or difference in height between two bodies of water. The resource available depends upon the available head, i.e. the height through which the water falls (in metres) and flow rates, i.e. the volume of water passing per second (in m3/sec).

The geography of Norfolk does not lend itself to large falls of water, and hence the technical potential for hydro is the smallest of all the technologies considered. Although there are many mills, it is assumed that many fall under heritage or environmental designations, and even more will not be suitable for a micro-hydro installation. Only 17 locations have been identified following discussions with landscape officers at each of the districts. These are sites that either have falls of water greater than two metres, or sites that have had previous interest in developing a hydro plant. Typically, micro-hydro installations for such small sites are in the region of 20 to 50 kW.

The technical potential for hydropower is for 17 installations totalling 285 kW, contributing negligibly to the baseline electricity demand in the three districts.

5.8 Introduction to 'practical' renewable energy resource

The technical renewable energy resource assessment outlined above provides an indication of the total potential renewable energy resource within the area, but it does not provide a practical or realistic target for renewable energy within the area. In order to set realistic yet ambitious renewable energy targets, market conditions and other constraints (largely

[12] The Closing the Loop project undertaken for the Energy Saving Trust in 2007found that just under half of a sample of social housing was potentially suitable for GSHP installations

landscape and visual considerations) need to be accounted for. Market conditions can be inferred from recent historical experience but the future will be influenced by a wide range of issues such as government policy, political delivery, underlying national and local economics, technological advancement and consumer behaviour; hence it is difficult to predict market uptake over time. Likewise, landscape and visual considerations are highly subjective and the views of stakeholders are variable (both spatially and over time). Nonetheless, it would be very difficult to exploit all the renewable energy identified within this technical assessment.

6 Recommendations for Joint Core Strategy and LDF Documents

6.1 Outcomes of the Indicative Energy Strategies and Renewables Assessment

The indicative energy strategies for the planned developments illustrate that it is possible to build to zero carbon standards, but that it does place additional costs on the development. The comparison between the communal system approach and the microgeneration approach illustrates that the microgeneration solution struggles to achieve zero carbon standards and has a much higher cost at 2.5 times higher. If the Government's proposed new definition of zero carbon housing is followed, then the developments can achieve zero carbon standard status at an even lower cost.

The analysis also demonstrates that 70% of the new development will be large scale,, suitable for communal energy supply systems which are more capable of achieving low to zero carbon standards through on, or near-site, energy supply.

6.2 Potential Low Carbon Policy for the Joint Core Strategy

6.2.1 Setting carbon standards for new development

The tightening carbon requirements in the Building Regulations over the next seven years until zero carbon requirement by 2016 will allow developers flexibility in terms of their choice of technology and approach to meeting carbon targets. The GNDP needs to determine how to embed these carbon requirements within the JCS and subsequent LDFs, and to shape the interpretation of the Building Regulation requirements within the area. This situation is made even more complex by the Government's changing definition of what constitutes a zero carbon home.

The two key variables in terms of crafting planning policies for new developments are the level of carbon reductions required and the flexibility allowed in meeting these requirements. Although it represents an example of regional planning policy, the London Plan is a very good example of highly prescriptive planning policies that even prescribe the balance of technologies required depending on the nature of the development. If planning policy is only prescriptive over carbon targets and is not able to exercise some degree of control over the choice of technology, then developments may opt for technologies that may be inappropriate for the particular location or 'sterilise' the ability of the development to achieve very low to zero carbon status in the long term. As outlined in chapter 4, the type of development and the scale of the development all determine the most appropriate technical approach to energy supply and the level of carbon reductions that are achievable. In general, larger developments are able to achieve significant carbon reductions more cost effectively than small developments.

When considering carbon requirements within the JCS, the key question is whether the proposed Building Regulation improvements are adequate or whether the GNDP and the partner authorities would like to set stricter requirements. Tighter requirements could be set for all new development in the district or site specific policy could be set for specific developments.

The Government has set out its intentions for improving the carbon performance of new developments into the future with its announcement of the tightening of Building Regulations for new homes along the following lines:

- 2010 – a 25% carbon reduction beyond current requirements;
- 2013 – a 44% carbon reduction beyond current requirements; and,
- 2016 – 100% carbon reduction beyond current requirements.

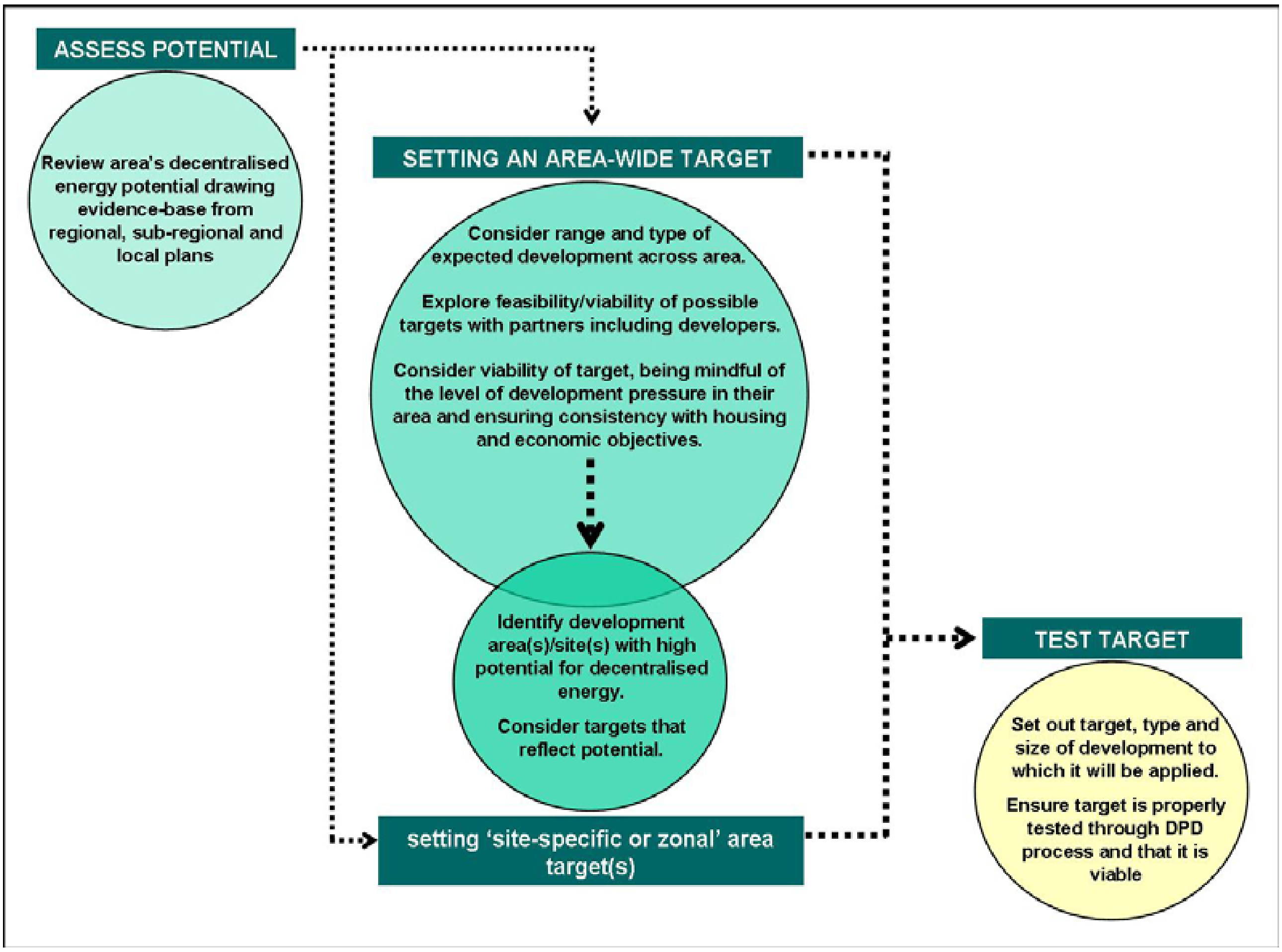
What percentage of the 23,000 new homes are likely to be built before 2016 and how many will be built after this date? If the majority of the homes are likely to be constructed after 2016 then the impact of locally specific carbon standards for new development within the GNDP area might well be small, because national legislation will require all new housing has to be zero carbon from 2016 onwards regardless of local policy. Under the current economic conditions, the pace of housing development within the UK has slowed right down, and therefore it is very likely that the housing projection figures will fall back a few years. In which case, the proportion of housing units which will be built after 2016 will be larger and the effect of tighter carbon requirements, and carbon standards that are in advance of national policy, will have a smaller corresponding impact on carbon emissions.

Nonetheless, if the first phases of the larger scale developments come forward before 2016, and these first phases install energy solutions that only achieve relatively small carbon savings, then they might miss the opportunity for putting in place zero carbon infrastructure across the whole of the large scale development.

The figure below outlines the approach of using the evidence base of the low carbon and renewable energy potential resource within the district to set carbon standards for new developments. The carbon targets for specific developments would not only be based on the potential renewable resource around the district, but also, perhaps more importantly, the specific characteristics of the developments themselves and the specific characteristics of the development sites.

Figure 11: Approach to setting low carbon targets for new developments[13]

[13] From Working Draft of Practice Guidance to support the Planning Policy Statement: Planning and Climate Change, CLG (ERM & Faber Maunsell) March 2008



6.2.2 Suitability criteria for communal energy systems and CHP

District heating networks account for the majority of the capital costs of delivering biomass heating and CHP systems. However the costs vary according to the density and layout of the development, and the specific conditions of a development determine the economics of the communal energy and CHP system. The density of the development is the key determining factor in terms of the economics of a communal system. The Community Energy: Urban Planning for a Low Carbon Future report provides indicative costs of district heating systems calculated per dwelling, and illustrates that the cost of communal systems increase substantially in lower density development. However, these unit costs for communal systems in low density development may still be a lower cost approach to delivering zero or very low carbon housing than through individual building integrated renewable energy systems. The number of dwellings is also important to the economic viability of CHP and although it is possible to install small CHP systems, they tend to be expensive and larger developments are needed in order to install commercial CHP systems. In general, 500 dwellings is a minimum number for a CHP system (although it can be smaller for ideal applications such as sheltered housing or mixed loads). Above 1,000 dwellings (and at the appropriate density), CHP and communal heating schemes tend to have excellent commercial prospects as an investment in their own right for ESCos, and may not even require additional investment contributions from a housing developer.

Table 9: Indicative costs of district heating systems[14]

	MEDIUM RISE APARTMENT BLOCK	PERIMETRE BLOCK OF FLATS & TOWNHOUSES	TERRACED HOUSING	DETACHED/ SEMI-DETACHED HOUSING
FORM	Corridor access, 5-6 storeys	Stairwell or street level access, 3-4 storeys	Street level access, 2-3 storeys	Street level access, compact layout
NET DENSITY	120 units/ha	80 units/ha	80 units/ha	40 units/ha
PIPE LENGTH	8m	11m	13m	19-24m
COST PER DWELLING	£2,800	£4,100	£5,300	£7,700 - £9,550

6.3 Assessment of the Viability of Higher Carbon Standards for New Development

It is up to the GNDP and the individual councils what carbon standard they adopt for new development. If the GNDP is keen to encourage zero carbon developments before 2016, then PPS 1 requires an evidence base demonstrating that local circumstances enable zero carbon status can be achieved. The indicative energy strategies demonstrate that zero carbon developments[15] are possible within the GNDP area for the larger developments, but that zero carbon compliance will put a significant extra cost on the development.

It is very difficult with current technology for the average small scale urban or rural infill to achieve very substantial carbon reductions unless the development can share energy systems with existing neighbours. This is mainly due to the fact that PV will be relied on to generate electricity and with limited space to integrate PV in dense urban infill it may not be technically feasible. However, for larger urban extension developments of over 1000 dwellings, the chances of achieving zero carbon status are greater if biomass or gas CHP can be used to generate renewable electricity. The large developments, such as urban extensions, are more easily able to achieve zero carbon status using a range of renewable technologies and communal heat networks, with the majority of electricity provided by wind energy, biomass/gas CHP and PV.

The key issue regarding whether the larger developments in the GNDP area can achieve zero carbon energy supply, is whether they can be built in conjunction with large wind turbines that can provide large amounts of zero carbon electricity? The available wind resource for the area has been shown to reside some distance away from the key development sites - nonetheless, this does not mean that the local wind resource is incompatible with the energy demands of the new development, and in fact the new developments can still establish a contractual relationship with wind turbine installations located away from the site. The GNDP and the partner councils could play a role in stimulating and sanctioning such relationships between housing developers and commercial wind developers, or between developers and a local community owned wind farm. The

[14] From Community Energy: Urban Planning for a Low Carbon Future, TCPA & CHPA 2008
[15] Following the Government's current definition of zero carbon housing

councils could play a key role facilitating community owned wind farms, thus reducing opposition to renewable energy development among residents. Keeping the facility under community ownership could also keep the revenues from energy production in the local economy. If the public sector were to establish an ESCo to supply energy to the new developments then it could collate the energy demands and risks of the smaller scale developments so as to set-up a contract with a wind turbine developer, or even install turbines itself.

6.4 Consideration of Undue Burden for Developers

6.4.1 Impact on development costs

Consideration of undue burden is a key element of assessing what carbon requirements are acceptable for the GNDP, or for specific developments within the area. Section 4.3.4 above outlines indicative costs for achieving zero carbon standards within the proposed new settlements. It demonstrates that the costs of compliance with the current definition can be reduced if communal energy systems are adopted, and that the proposed new definition should reduce compliance costs for the developer. The Department of Communities and Local Government published a cost analysis of the Code for Sustainable Homes in July 2008 which estimates the cost of achieving the carbon requirements within the different levels of the Code. Due to the different costs associated with different development types, the cost analysis has been undertaken for different sizes and types of development, and different housing types. It also highlights the lower costs of achieving the carbon reductions when wind energy can be utilised. This analysis illustrates that if contracts are established with large wind turbines to supply the development, then the unit cost of achieving CSH Levels 5 & 6 could be relatively low. These unit costs will of course change if the proposed new definition of zero carbon housing is adopted, and the cost of achieving CSH Level 5 & 6 could come down significantly.

Table 10: Housing unit costs of achieving the carbon requirements of CSH Levels 4, 5 & 6 WITHOUT wind[16]

	Code Level	Detached	End Terrace	Mid Terrace	Flat
Small development	4	£10,914	£5,880	£5,133	N/A
	5	£22,367	£13,292	£11,933	N/A
	6	£40,228	£29,393	£29,172	N/A
Market Town	4	£9,868	£7,115	£6,187	£5,054
	5	£17,132	£12,353	£10,742	£9,962
	6	£32,752	£24,822	£24,696	£18,996
Urban regeneration	4	£8,223	£5,930	£5,156	£4,782

[16] *Cost Analysis of The Code for Sustainable Homes, DCLG July 2008*

	5	£14,254	£10,278	£8,938	£8,289
	6	£31,125	£23,631	£23,569	£16,775

Table 11: Housing unit costs of achieving the carbon requirements of CSH Levels 4, 5 & 6 WITH wind[17]

	Code Level	Detached	End Terrace	Mid Terrace	Flat
Small development	4	£7,458	£5,586	£5,500	N/A
	5	£18,722	£10,687	£8,539	N/A
	6	£36,583	£24,721	£24,756	N/A
Market Town	4	£2,600	£2,000	£1,782	£1,593
	5	£3,053	£2,600	£2,600	£2,600
	6	£13,065	£8,771	£8,950	£8,685

The additional cost on developments consists of the capital costs of enhanced energy efficiency measures, building integrated technologies (PV, STHW, GSHP) and communal infrastructure (heat networks, additional cabling). These costs illustrate that the marginal cost of delivering further carbon reductions in new developments gets higher as you progress towards CSH 6 and achieving a zero carbon development. Developers can work in partnership with an Energy Services Company (ESCo) to finance, maintain and operate the energy system for a new development and therefore reduce the costs and the level of burden that they face.

The onus should be on the developer to prove if and why they cannot meet any given carbon targets. In evaluating the impact of the carbon costs on the viability of the development, the developer would need to consider the current state of play of all other development costs as well the market sales prices and land value at that time. Interpretation of the results also requires a judgement being made as to whether the additional costs will be born by the end consumer (the buyers of the homes and buildings), the landowner (who could take a drop in sales price) or the developer or a combination of these. This requires analysis on a case by case basis depending on what the market will bear at the time of selling and if the developer either already owns the land or has it under option.

The impact on developers is not only that of cost, and there is also the challenge for developers of installing energy infrastructure, understanding the energy supply business and working with ESCos. Many developers have considered the recent focus on low carbon developments to be a huge burden due to their lack of understanding of the issues.

[17] *Cost Analysis of The Code for Sustainable Homes, DCLG July 2008*

Nonetheless, the knowledge of the development industry is advancing all the time and as a result the knowledge barrier is decreasing all the time. Even though the carbon standards in the Building Regulations will continue to get tighter, the skills and knowledge burden on developers is unlikely to increase because their understanding is constantly increasing.

6.4.2 Diverting finance to more cost effective local carbon reduction measures

The proposed new definition of zero carbon housing considers whether it is more appropriate to divert finance to more cost effective offsite carbon reduction measures rather than eek out continually more expensive carbon reductions to achieve a zero carbon development. In the same way, the GNDP may consider that developer payments to local carbon offset schemes might be a more practical solution for carbon neutral developments. The Joint Core Strategy could require developers to pay to offset all the residual emissions from their developments following the approach taken by Milton Keynes Council. For example, if the Council sets a policy requiring developers to achieve CSH Level 4, rather than 5 or 6, then it could also require all developers to pay money into the offset fund to offset the residual emissions – note that the difference in cost between CSH 4 and 6 in the cost analysis of the CSH can be up to £30,000, whereas similar reductions in carbon emissions within existing houses can be delivered at a far smaller cost. The Council would need to establish a 'carbon offset fund' into which these payments are deposited, and then distributed to energy saving schemes within the district, such as insulation, renewable energy projects or district heating infrastructure. Milton Keynes Council has set a cost per tonne of carbon that it requires developers to pay which is based on the cost of delivering carbon savings through loft and cavity wall insulation in existing homes. If this money is invested in loft and cavity wall insulation then it will exactly offset the carbon emissions from the new build, which could then be viewed as a 'carbon neutral' development. However, in order to claim that the new developments are carbon neutral, it is essential that these carbon reductions in existing housing are 'additional' savings – ie that they wouldn't have happened unless they were financed by the carbon offset fund.

The carbon offset fund could nonetheless be a very effective mechanism in the years up to 2016 if a planning authority feels that it is too expensive a demand to expect developers to deliver zero carbon developments. They could require the developers to provide carbon neutral developments by covering the costs of their residual carbon emissions based on an agreed market price per tonne of carbon. The definition of a 'zero carbon development' adopted here is that of all heating and power needs being supplied from local renewable energy, whereas a 'carbon neutral development' is one which offsets its (remaining) carbon emissions through investment in external carbon saving measures.

6.5 Planning policy to support developers in achieving low carbon standards

6.5.1 Need to support low carbon infrastructure

Even if the GNDP and partner councils decide that the carbon requirements within the phased Building Regulation improvements are strict enough, there are still a number of measures and policies that need to be implemented within the JCS and LDFs to help ensure that developers meet these standards. A key issue is ensuring that developers install the correct energy supply systems so as to enable continued carbon reductions into the longer term. It is important that developers do not opt for cheaper strategies in the earlier phases which jeopardise the ability of the development to achieve significant carbon savings in the longer term (post 2013/ 16). In particular, developers need to plan for a communal system from the outset so as to ensure that greater carbon reductions are achievable. If developers concentrate on individual building systems for the earlier phases in the period pre-2016, then it will be difficult to introduce successful communal systems in the later periods.

The indicative energy strategies for the proposed new settlements outlined in chapter 4 provide a useful guide to the energy strategies that developers will need to install in order to achieve very high carbon standards. A detailed understanding of the technical requirements for different development types will also enable the planning authority to outline in detail what they expect from developers - which will aid planning negotiations. It will also help ensure that energy strategies for phased developments are future-proofed so that they do not opt for individual building solutions in the early phases which jeopardise the viability of a development-wide CHP and district heating scheme.

The inclusion of a large wind turbine can be an important element of a low carbon strategy, but in order to progress this option the developer will need to arrange a contract with a wind turbine developer and a land-owner. This presents additional challenges for the developer and the Council may need to assist the developer in forming relationships with adjacent land-owners and in encouraging land-owners to opt for installing turbines on their land. It is unlikely that a large wind turbine can be located on the actual development site as it would be too close to housing, and it will therefore need to be located on land close to the site. This will require the LDF to specifically allow for ‘offsite’ renewable energy in supplying energy to new developments, so that developers can use a wind turbine located on land nearby to provide power for the development. There are additionality issues that will need careful consideration for each development. The GNDP should therefore consider allocating sites for wind turbine development that can supply the major new developments.

6.5.2 Characteristics of communal infrastructure

As outlined in chapter 4, shared low carbon infrastructure has an essential role to play in enabling carbon reductions in the built environment and in facilitating the exploitation of renewable energy. District heating networks are particularly important in terms of enabling the efficient use of biomass fuel through combined heat and power (CHP) systems or enabling advanced technology energy-from-waste CHP plants to provide heat and power to communities. Planning policy needs to be proactive in encouraging these networks, and in encouraging buildings to connect to these networks – and the approach can vary from prescriptive requirements to more general policies of encouragement.

Combined heat and power and biomass heating are vitally important low carbon technologies, and yet their use is generally dependent upon district heating networks in order to distribute the heating to housing and other buildings. CHP and district heating suffer a general lack of support policy and are not favoured by the UK’s energy market place. The challenge of realising the carbon savings from CHP and biomass heating within the existing built environment is generally wrapped up within the challenge of developing district heating networks which require high capital investment and long payback periods. CHP and district heating require support from both planning policy and financing mechanisms. The public sector can further assist heat network development by using their buildings as ‘anchor heat loads’ to form the basis of heat network development. Large buildings with fairly constant heat demand such as leisure centres, hospitals, prisons and hotels are all effective anchor loads.

6.5.3 Heat mapping

It is possible to quantify the potential for district heating, and the associated carbon savings of connecting existing buildings to a heat network, through producing a ‘heat map’ for the

GNDP area. The heat map would quantify the areas of greatest heat demand within the district and thereby highlight where CHP and district heating networks would be most effective. The data collected includes what building types and floor areas are present and what their, heating, cooling and power demands are. This helps to build up an existing heat, cooling and power density map which identifies where CHP can provide an excellent carbon reduction solution within the area.

6.5.4 Linking existing communities to emerging heat networks

CHP and district heating has the greatest scope for delivering carbon reductions in existing buildings which are more energy inefficient than new developments and are therefore responsible for greater carbon emissions. In addition, the more energy efficient a building is, then the lower its heating demand, and therefore the less significant the carbon savings from a CHP plant. The establishment of CHP and heat networks within existing communities is very difficult however, due to the competition provided by the incumbent heating system. New policy mechanisms will be required in order to capitalize on the low carbon infrastructure for new communities, and develop this into existing communities. Measures will be needed to encourage and enable the roll out of district heating, through planning policy and enforcement, through connecting public sector buildings and through establishing a financing mechanism to help reduce the level of risk and help integrated networks get started.

6.5.5 Overcoming project risk and enabling commercial delivery

The installation of low carbon infrastructure, such as heat networks for large developments, requires considerable financial investment, and yet due to the long term phased construction of the development the returns on this investment will not be received until many years into the future. For this reason a support mechanism may be required to provide infrastructure funding for combined heat and power and district heating systems under current market conditions.

The government has established the Community Infrastructure Levy (CIL) to provide funding for long term infrastructure. However, the CIL is currently focussing on other types of infrastructure, such as transport and social infrastructure, and is unlikely to provide any finance for energy infrastructure. Nonetheless, the structure and management of the levy is a useful example of how local or sub regional funds could be established to support the development of low carbon infrastructure.

Infrastructure funding could be partly achieved through capturing the increase in land value that occurs when development is permitted, which means that developer contributions can be harnessed without stifling development incentives. However, general funds raised in this way will have many demands placed on them and therefore a separate fund for energy infrastructure is likely to be needed with the public sector providing the initial lump sum which is then repaid through developer's energy contributions (see Non-Planning Policy section below).

This public sector operated ring fenced 'carbon investment fund' could provide the upfront capital needed for financing large scale low carbon infrastructure such as CHP and district heating networks that can supply phased developments. The carbon investment fund would bring forward the value of staged developer contributions to early stage investment and would be reimbursed through payments from private sector developers as their developments are rolled out.

6.6 Monitoring and Enforcement

To develop effective monitoring and compliance processes we make the following recommendations:

- Ensure that the new developments include provisions for energy monitoring in their Sustainable Energy Strategies that accompany planning applications. The monitoring programmes should be able to provide annual figures on CO_2 emissions for dwellings and non-residential buildings, and preferably non-residential buildings should split into office, retail and industrial. It would also be useful to obtain figures for the amount of energy generated by different renewable energy technologies to compare with the original Sustainable Energy Strategies in order that lessons can be learnt if any of the systems are under performing.
- GNDP could prepare CO_2 emissions trajectories of what they expect in the JCS based on the phasing of the new housing between now and 2026. This would be zero emissions if the JCS adopted zero carbon requirements with immediate effect. This modelled emissions trajectory could be compared with the monitored actual data as it comes in, and in this way the LDF carbon targets can be checked.
- All low carbon energy installations need to be captured in the Annual Monitoring Report (AMR) for each council. In order to have data available for the AMR, each council needs to establish a database which is continuously populated with data about new installations. Processes can be created to ensure that data can be provided for new developments when they are completed but it is likely to be more difficult to capture data about small scale renewables that are installed on existing buildings, as many forms of microgeneration no longer require planning permission.
- Monitoring is also important for the existing building stock in terms of CO_2 emissions for the area as a whole; which should be captured as part of the National Indicator 186 reporting mechanism. It would also be useful to monitor the number and type of renewable energy installations progressed throughout the area to compare with overall CO_2 emissions.

7 Non-Planning Delivery Mechanisms for Enabling Low Carbon Development

7.1 Coordinating the Development of Low Carbon infrastructure

7.1.1 Coordinating the development of low carbon infrastructure

Planning policy alone will not be able to deliver low carbon and renewable energy within the district, and a range of policy measures covering economic development to council initiated energy projects will also be required. Managing and financing energy infrastructure for long term, phased development projects is extremely challenging. Large combined heat and power systems are a very cost effective low carbon strategy but they are difficult to establish in phased development. The GNDP Councils need to encourage developers to engage with expert entities in order to most effectively progress energy infrastructure within their developments. Key steps include:

- Planning & delivery of low carbon infrastructure should be carried out by an entity with long term interest in assets, such as an Energy Services Company (ESCo);
- Developers should be encouraged to engage early with ESCos to facilitate a more effective approach to rolling out low carbon infrastructure;
- A Special Purpose Vehicle could be established to lead early client negotiation and mitigate risk before bringing proposals to market.

7.1.2 Local ESCOs to develop low carbon energy project?

The GNDP and council partners could also seek to establish an ESCO for the area which works to install sustainable energy systems within both the new development and existing buildings. A special purpose vehicle for the Norwich area could particularly help in rolling out CHP and district heating to existing communities, and thereby help realize the substantial carbon reductions that CHP can deliver to existing buildings. This ESCo could either be established at the district level or at the GNDP level. The term ‘Energy Services Company’ or ESCO is applied to many different types of initiatives and delivery vehicles that seek to implement energy efficiency measures or local energy generation projects. ESCOs are established in order to take forward projects that the general energy market place is failing to deliver – and in this way ESCOs are designed to overcome the market and policy failures that affect local sustainable energy projects. There are a number of commercial ESCos in existence which can support developers in designing, installing and operating a communal energy system for a new development. These ESCos may either operate the energy system entirely themselves or enter into an arrangement with the developer and other entities in order to establish a new ESCo specifically designed to operate the energy infrastructure of the new development. These development specific ESCos tend to be arranged so that they are part, or wholly, owned by the residents of the development, and are therefore often referred to as ‘community ESCos’.

An ESCO can take many forms and be designed to progress small energy projects or large projects. Different ESCO applications include:

- Low carbon energy supply for a new development

- District heating or CHP scheme for social housing and / or other community and private sector customers
- Community renewables projects
- Retrofitting energy efficiency measures into buildings or energy management in buildings
- Pre-commercial energy development/ projects and small bespoke projects.

There is no standard definition of an ESCO in the UK, but existing ESCOs can be categorised in a number of ways. Perhaps one of the most informative approaches to categorisation is to consider the balance of private and public sector involvement and ownership. An ESCO can be entirely owned by the public sector or be an entirely private entity.

There are essentially three different types of ESCO:

- Public sector driven
- Private sector driven
- Community driven.

For an ESCO to progress an energy system within a new development, it will generally be given a long lease for the energy centre building and plant and the distribution systems with the responsibility to operate, maintain, and replace as necessary. Implementing a full ESCO project is a long and complex process which relies upon expert business, procurement, legal and technical advice. Contracts bring together the procurement, finance and management arrangements for an ESCO. The particular procurement strategy that is followed for any given ESCO will differ from case to case, but will follow the basic contract structure of a relationship between a technical energy expert company and the entity that requires their services. Contract Management will be an important element of the long term monitoring of the successful delivery of the output specification and the successful relationship with the expert energy services partner. Good partnership working is essential to the viable and successful operation of a CHP and decentralised generation scheme.

7.1.3 Public sector led ESCOs

Public authorities can lead the establishment of ESCOs generally with the desire to bring forward the market for energy services, particularly with respect to low carbon, decentralised energy supply, where they identify gaps in the commercial market. Local authorities are the principal candidates for this but other public agencies including regeneration organisations, NHS Trusts, Regional Development Agencies and the sub-regional partnerships can drive them forward. Local authority led ESCOs are typically established to progress energy efficiency refurbishment and CHP in social housing or council buildings, or to deliver renewable energy projects for council buildings or the local community. There are a number of local authority ESCO facilitated projects which have overseen the roll-out of CHP services to include private sector customers, such as in Woking and Sheffield town centres. More recently local authorities have begun to set-up ESCOs to install sustainable energy infrastructure as a component of large regeneration projects.

Typical features include:

- Led by Local authority, RDA or other public organisations such as NHS Trusts and sub-regional partnerships

- Private sector partners often also involved
- Umbrella approach – where a series of projects being brought forward over time
- Focus on initial delivery to own stock / estate
- Roll out of services to town or new growth areas
- Long term view of payback
- Public sector discount rates

A local authority is able to set-up an ESCO by using the following powers and duties:

- Well being power permitting local authorities to do anything which they reasonably consider will improve the well-being of their area;
- The duty of a local authority to secure best value in the performance of its functions.

Local authority ESCO activity is controlled by the rules governing local authority borrowing, trading and charging for services and public procurement legislation. Key relevant legislation concerns the supply of utilities, and particularly electricity which is heavily regulated with complex licensing arrangements. Although a local authority led ESCO might be entirely public sector owned and operate as a public body or quasi-public body, it may deliver its services through contracting private sector companies.

An ESCO or special purpose vehicle led by a public sector organisation may be needed if a low carbon project is not being taken forward by the market place due to financial or technological risks. An ESCO can be designed so as to manage these risks and enable a project to proceed. Nonetheless, a local authority or community group will only want to go down the path of establishing an ESCO if the energy project they wish to pursue is of no interest to an existing ESCO or if certain market risks cannot be reduced through other actions by the public sector, such as guaranteeing revenue streams for the heat or electricity generated by a renewable energy installation. Establishing an ESCO is not a simple short term task and the there are risks involved so it is important the need for an ESCO is fully established at the outset.

When developing the plans for a low carbon project, it is sensible to test the business case with energy experts and existing commercial ESCOs that have implemented similar projects. Nonetheless, the local community or local authority might want to maintain a significant degree of control over the project to ensure that it delivers certain social and environmental objectives, and therefore might wish to establish its own ESCO in partnership with an existing private sector ESCO which could undertake the technical implementation.

7.2 Financing low carbon infrastructure

7.2.1 Addressing investment challenge for communal infrastructure such as district heating

A ‘carbon investment fund’ could help overcome the high upfront costs of energy infrastructure with the public sector providing the initial lump sum which is then repaid through developer’s energy contributions. This public sector operated ring fenced carbon investment fund could provide the upfront capital needed for financing large scale low carbon infrastructure such as CHP and district heating networks that can supply phased developments. The carbon investment fund would bring forward the value of staged developer contributions to early stage investment and would be reimbursed through payments from private sector developers as their developments are rolled out.

Key actions to overcome potential investment shortages include:

- A ring fenced carbon investment fund may be needed to bring forward value of staged developer contribution to early stage investment (initially financed by the public sector, but reimbursed through payments from private sector developers);
- Contractual complexities & residual uncertainties need to be managed through secured rights to sell energy & carbon benefits to customers into the future (ESCos need to know the size of market for heat & power, timing of development, & price of future energy);
- Housing developer investment needs to be channelled towards shared offsite renewable developments and carbon investment fund could manage this role.
- Additional measures needed to mitigate early stage infrastructure development risk;
- Increased support for renewable energy development with mechanisms to contractually link offsite renewable energy infrastructure to new developments.

7.2.2 Managing contractual complexities & project uncertainties

Key actions to mitigate risk include:

- Public sector to work with developers and ESCos to help secure rights to sell energy & carbon benefits to customers into the future.
- Public sector to ensure that developers commit their buildings to the energy network with long term energy power & heat purchase contracts.
- Public sector to commit to long term power and heat purchase contracts with ESCos for their own buildings so as to help establish low carbon networks.

7.2.3 Public sector leading by example

The GNDP councils have a real opportunity to directly progress renewable energy installations and decentralized energy generation by taking forward projects on their own buildings and land. As outlined above, the public sector could establish a local ESCO to help implement these low carbon energy projects.

The public sector has opportunities in terms of using public buildings as an anchor heat load around which to establish CHP and district heating networks, establishing renewable energy installations on buildings, such as PV and solar water heating, and even a power supply agreement with a wind turbine located within the districts. Key actions include:

- Public sector buildings to provide 'anchor loads' for district heating and low carbon infrastructure networks so as to lead the way in installing CHP and developing heat networks;
- Renewable energy installations on council buildings, including PV, solar water heating and small to medium wind turbines;
- Identify a number of public sector demonstration projects across the council areas;
- Develop an action plan for implementing these demonstration projects.



Creating a sustainable low carbon society

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