AECOM

Design + Planning
Building Engineering

Renewable and Low Carbon Energy Study for Central Lincolnshire

November 2011

Executive Summary

STUDY OBJECTIVES

The Central Lincolnshire Joint Strategic Planning Committee appointed AECOM to undertake a renewable and low carbon energy study to inform the evidence base in the development of policies for the Central Lincolnshire Core Strategy. The objectives of this study are:

- Understand current and future energy and carbon profile for Central Lincolnshire.
- Review/update regional renewable energy resource assessment to better reflect local circumstances in Central Lincolnshire.
- Provide advice on the factors which will affect the realisation of higher levels of deployment. Consider scenarios for this deployment.
- Help set appropriate policy and targets for the Core Strategy.
- Analyse a set of strategic sites or typologies to determine how development can deliver renewable and low carbon energy and what the most appropriate and viable options may be.
- Outline an action plan for delivery identifying key actions and partners.

The main purpose of this study is to provide information on the subject of renewable and low carbon technology for the Central Lincolnshire Joint Planning Unit informing for the development of the Core Strategy. This follows the Planning Policy Statement 1 (PPS1) supplement on climate change, which states:

"Planning authorities should have an evidence-based understanding of the local feasibility and potential for renewable and low carbon technologies, including micro-generation, to supply new development in their area."

The Government's latest planning policy, the draft National Planning Policy Framework (2011), reinforces the PPS1 supplement as it states that local authorities should:

"Identify and map opportunities for renewable and low carbon energy... have a positive strategy to promote energy from renewable sources and design their policies to maximise renewable and low-carbon energy development..."

CURRENT STATUS OF ENERGY AND CO2 EMISSIONS

Central Lincolnshire's carbon profile represents the urban setting of Lincoln, and more rural character of North Kesteven and West Lindsey. As can be seen from Table 1 below, road transportation does not contribute significantly to Lincoln's carbon profile, while it makes up a large proportion of West Lindsey and North Kesteven's emissions. Overall, the average emissions per capita are lower than the UK average, but one needs to consider the context of the area. Goods and services from industry outside of Central Lincolnshire which count towards other areas CO_2 emissions will be consumed by the population of Central Lincolnshire effectively increasing the carbon footprint of the average resident.

Table 1: Comparison of Carbon Emissions (in Kilotonnes, Kt) for Central Lincolnshire Districts and the UK ($KtCO_2$ – kilo (1000) tonnes of CO_2)

	Lincoln		North Kesteven		West Lindsey		Central Lincolnshire		UK Average	
	$KtCO_2$	%	$KtCO_2$	%	$KtCO_2$	%	$KtCO_2$	%	$KtCO_2$	%
Industry & Commercial	266	51%	263	36%	228	45%	199	31%	730	38%
Domestic	194	37%	238	32%	149	29%	225	35%	657	34%
Road Transport	65	12%	235	32%	131	26%	221	34%	522	27%
Total Emissions	**525**		**737**		**508**		**645**		**1,907**	
Total Per Capita	**6.0**		**7.4**		**7.9**		**6.8**		**8.2**	

ENERGY PROFILE OF BUILT ENVIRONMENT

This study provides an assessment of current energy consumption in Central Lincolnshire, and projects how this may change into the future taking into account additional demands through new development and employment, and also reductions through efficiency improvements. Figure 1 illustrates that by 2026, the additional energy consumption from new buildings is relatively small compared with the existing stock. This is due to both higher building standards, and the relatively small amount of stock in the new build sector. This stresses the importance of focusing on energy improvements to existing buildings if large reductions in energy demand and CO_2 emissions are to be achieved.

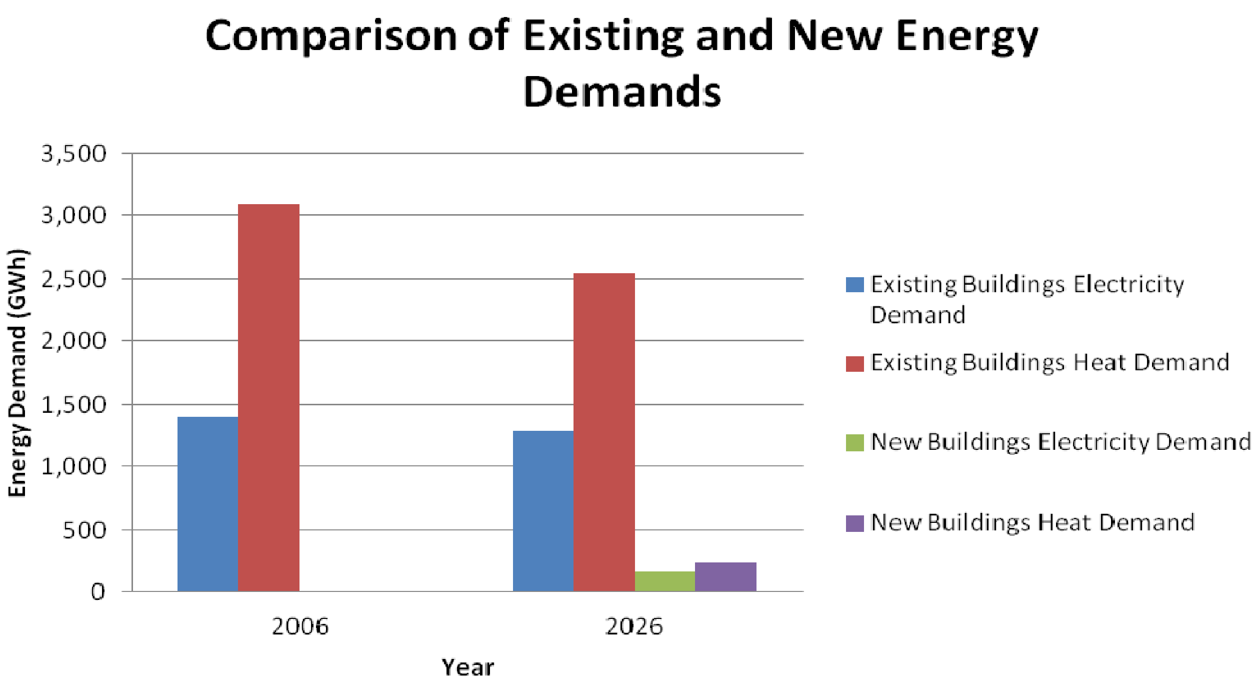

Figure 1: Comparison of energy demand from existing and new buildings for 2006 (benchmark data year) and 2026.

RENEWABLE ENERGY INSTALLED CAPACITY IN CENTRAL LINCOLNSHIRE

Renewable and low carbon energy schemes will be essential in delivering CO_2 reductions across Central Lincolnshire. Whilst energy efficiency improvements can help limit the overall demand, a large residual energy demand will remain. Central Lincolnshire currently produces around 40 Gigawatt-hours (GWh) of renewably sourced electricity per year which is equivalent to only 0.2% of the total annual energy demand. Figure 2 shows that, when compared with surrounding authorities, Central Lincolnshire authorities are generating below average. However, the potential for Central Lincolnshire planning authorities to increase their renewable and low carbon energy supply is significant with 565GWh of renewable energy currently in the planning process.

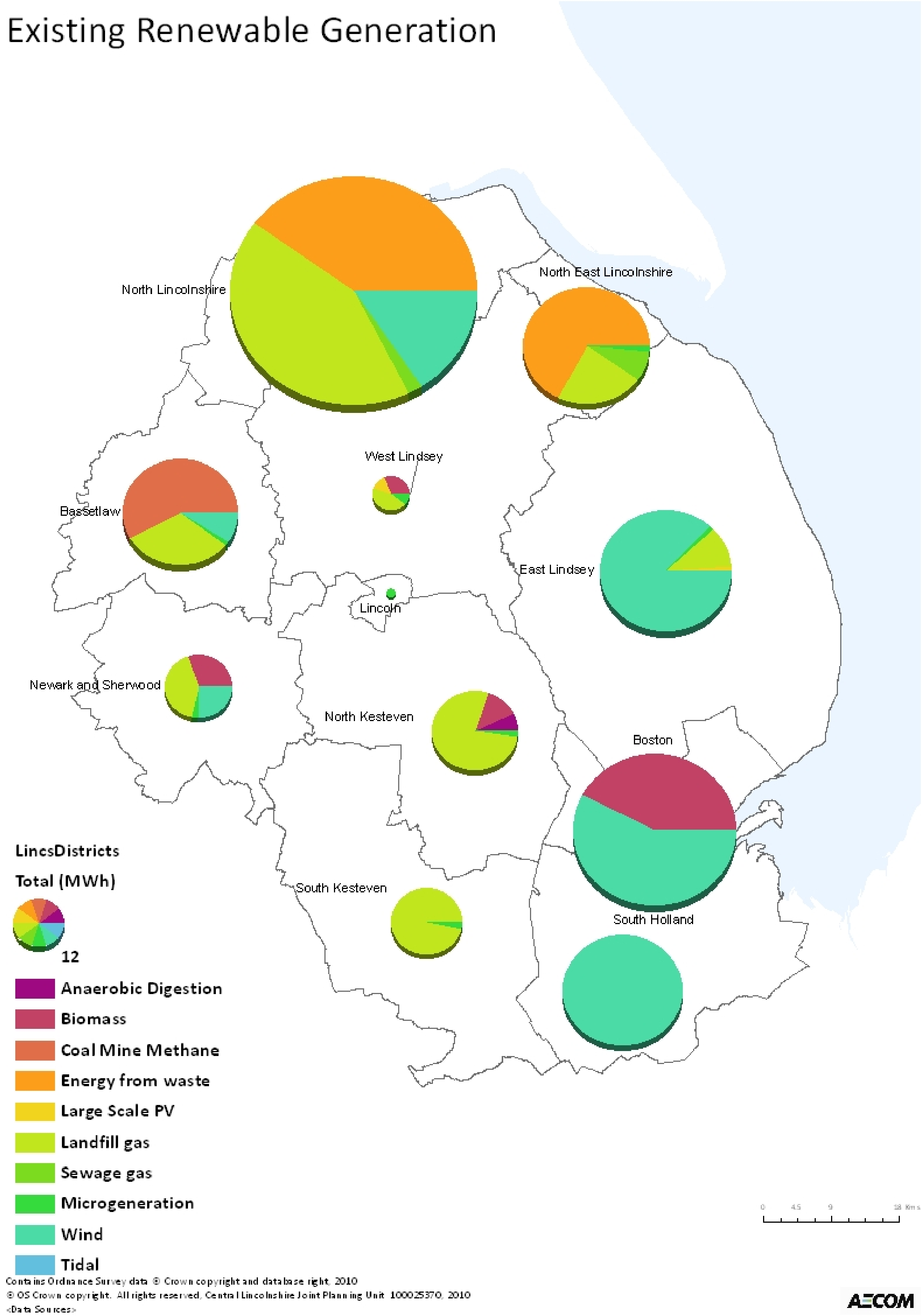

Figure 2: Breakdown of Renewable Energy in Central Lincolnshire and Surrounding Area

TECHNICAL POTENTIAL OF RENEWABLE ENERGY IN CENTRAL LINCOLNSHIRE

The large number of renewable energy projects currently at planning application stage reflects the significant potential for renewable and low carbon energy generation in Central Lincolnshire. Within Central Lincolnshire, the Districts of West Lindsey and North Kesteven are favourable for wind energy. Research of technical potential across the East Midlands shows that over 50% of the technical potential for renewable electricity is from large scale wind, with North Kesteven and West Lindsey having some of the highest potential in the region. Biomass is another potently resource for the rural areas of Central Lincolnshire, and establishing a biomass supply chain, including the development of energy crops, will help this resource to be developed. The areas with higher population densities – Lincoln, Gainsborough, Sleaford, North Hykeham – and a collection of villages on the outskirts of Lincoln all present good opportunities to generate and support renewable heat in the form of district heat networks. Figure 3 shows the spatial energy opportunities that exist for Central Lincolnshire in the form of an energy opportunities map.

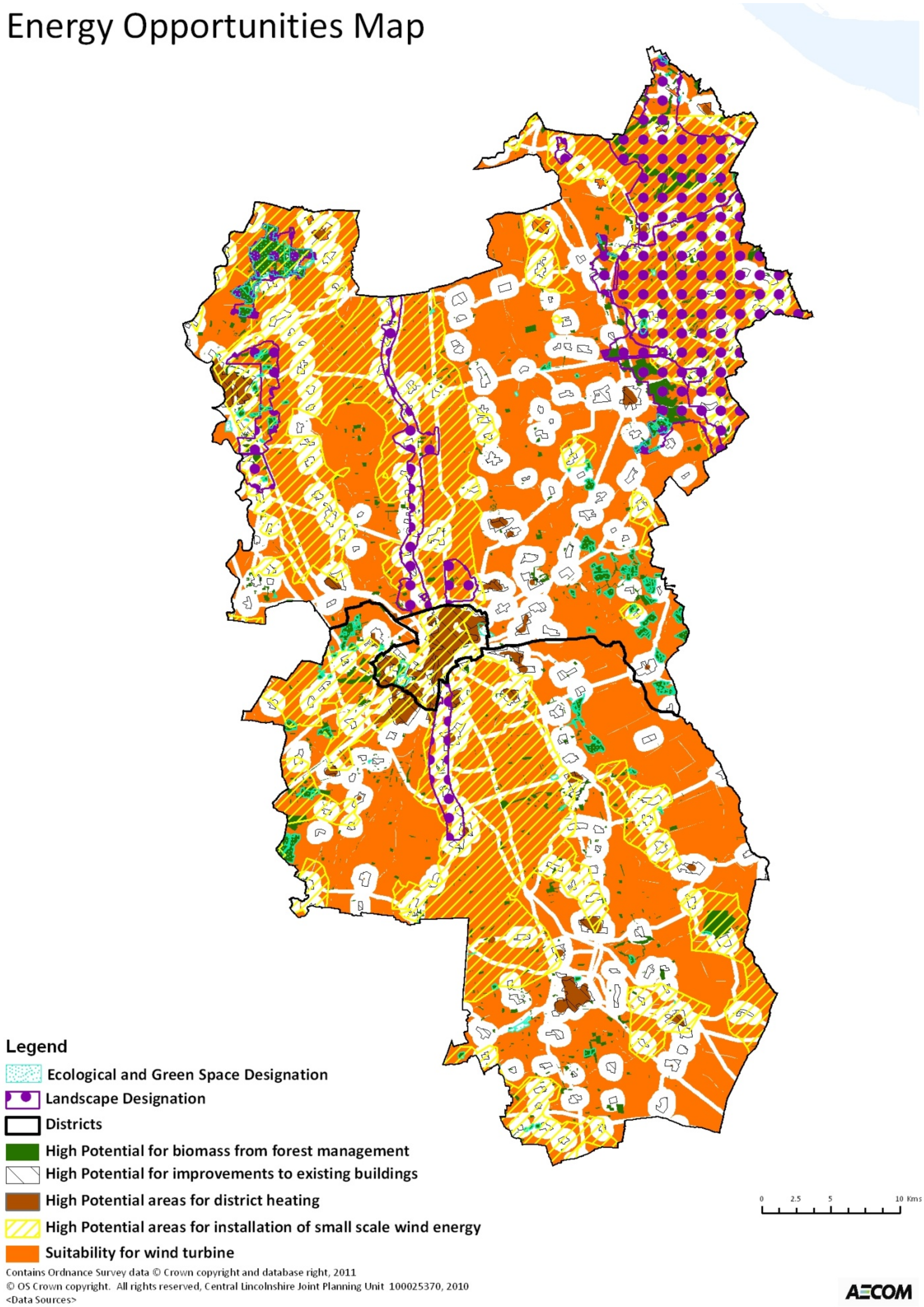

Figure 3: Energy Opportunities Map for Central Lincolnshire highlighting the potential locations for renewable and low carbon energy sources.

DELIVERY OF RENEWABLE ENERGY IN CENTRAL LINCOLNSHIRE

The technical potential provides insight into Central Lincolnshire's renewable energy theoretical maximum, only considering factors relating to geography and natural environment. However understanding what can realistically be delivered requires an analysis of delivery partners, their drivers, and their capacity to deliver projects. While the technical potential is high, there are a number of barriers which need to be overcome, through coordination, leadership, and expertise. A stakeholder workshop confirmed that the local ambition to overcome these barriers is high and delivery options routes can exist with support and guidance. Two scenarios 'baseline' (business as usual) and 'all actions adopted' (optimised) – were modelled to examine how much renewable and low carbon energy could be delivered by four different partners: energy developers, private sector, public sector, and community groups. While energy developers were determined to be the most important delivery partner through the construction of wind farms and biomass power schemes, the other delivery partners were determined to play a key supporting role to enable and mitigate risks for energy developers. Figure 4 shows the results of the scenario testing based on how much each delivery partner can contribute.

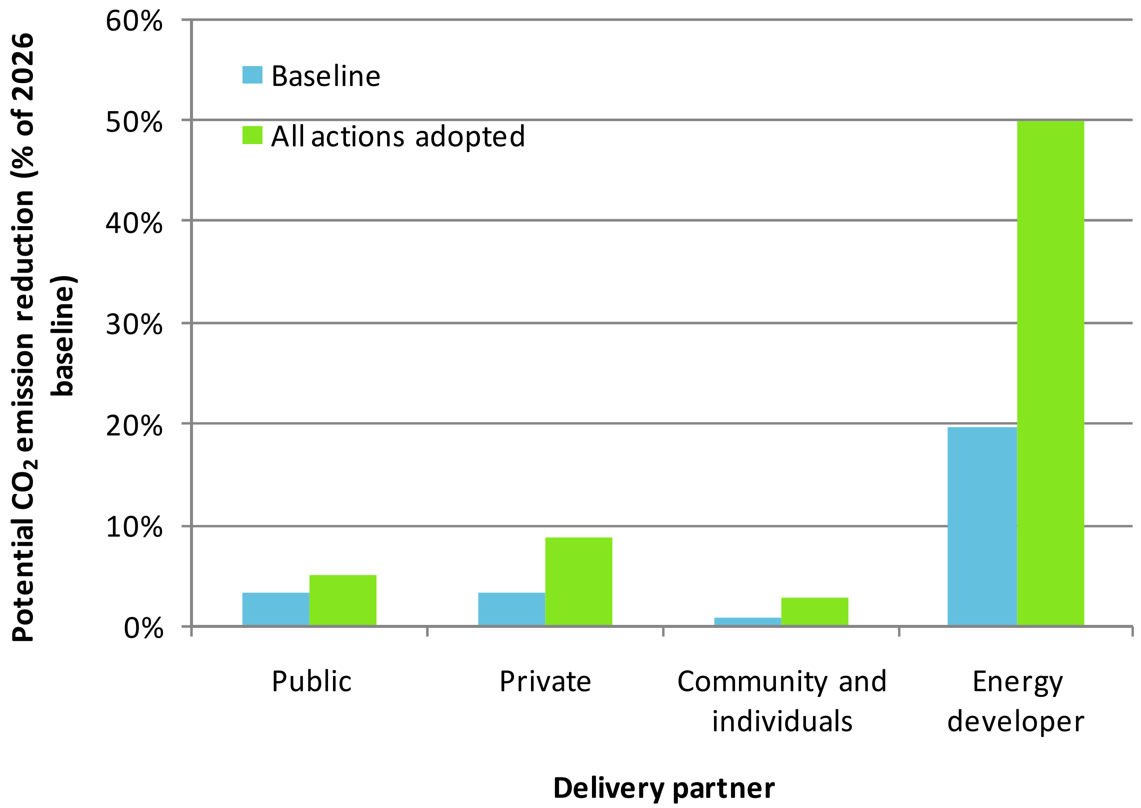

Figure 4: Potential CO_2 savings as a percentage of the 2026 baseline emissions from each delivery partner.

Figure 5 shows the scenario testing results based on how much renewable energy the delivery partners could realistically deliver, grouped by technology type. These results combined with the baseline energy consumption information, demonstrate that Central Lincolnshire could exceed the UK Government national targets for renewable energy of 30% renewable electricity and 12% renewable heat by 2020. To achieve these national targets resources will need to be exploited where available to support less resource rich areas. The significant potential of wind in particular in Central Lincolnshire supports the application of 60% renewable electricity targets by 2026. The potential for heat is limited largely by available heat loads, and therefore local trajectories in line with national targets are more likely.

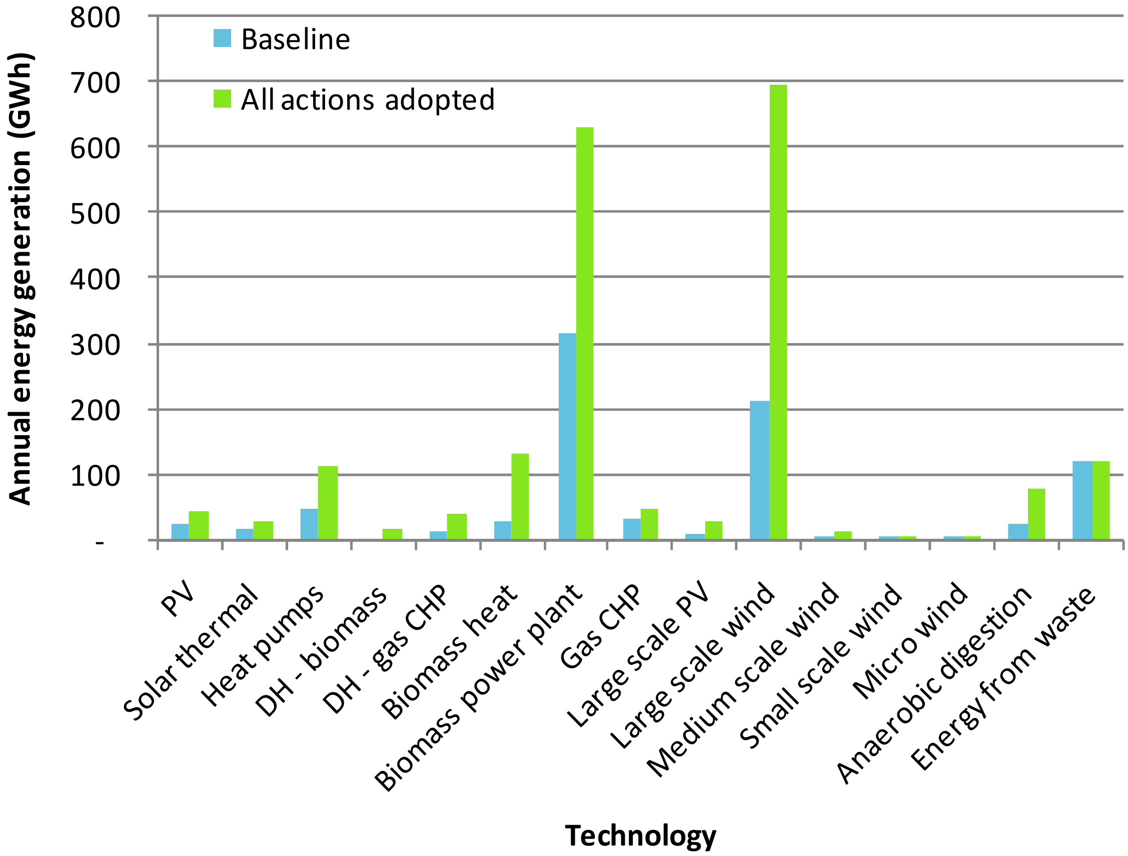

Figure 5: Scenarios for energy generation by technology

EXTERNAL SUSTAINABILITY DRIVERS

External drivers will also influence the delivery of renewable energy in Central Lincolnshire. Expected changes to Building Regulations Part L will drive the delivery of zero carbon developments. Part of these changes is the likely creation of "Allowable Solutions," which enable developers to contribute to an offset fund, which funds off-site low carbon and renewable energy projects once viable on-site carbon reduction measures have been met. If Central Lincolnshire planning authorities are interested in Allowable Solutions being used for local projects, they will need to play a role in its coordination, identifying local eligible projects and developing mechanisms for the collection of allowable solutions.

A wider approach to sustainable design and construction than just carbon and energy might also be desirable. The Code for Sustainable Homes for domestic buildings, and non-domestic ratings systems, could be implemented on an area-wide, or site specific basis. BREEAM (Building Research Establishment Environmental Assessment Method) is an example of a ratings scheme for non domestic buildings although flexibility should be allowed for alternative assessment schemes. As shown in Figure 6, the more ambitious Code levels (5 and 6) carry with them significant cost implications which may not be viable for certain developments. The viability will heavily depend on site specific conditions and therefore standards need to be set which are both challenging, but not punitive. For non-residential buildings, the cost increase to achieve different BREEAM targets also increases for higher targets and there can be significant cost implications in achieving BREEAM 'Outstanding'.

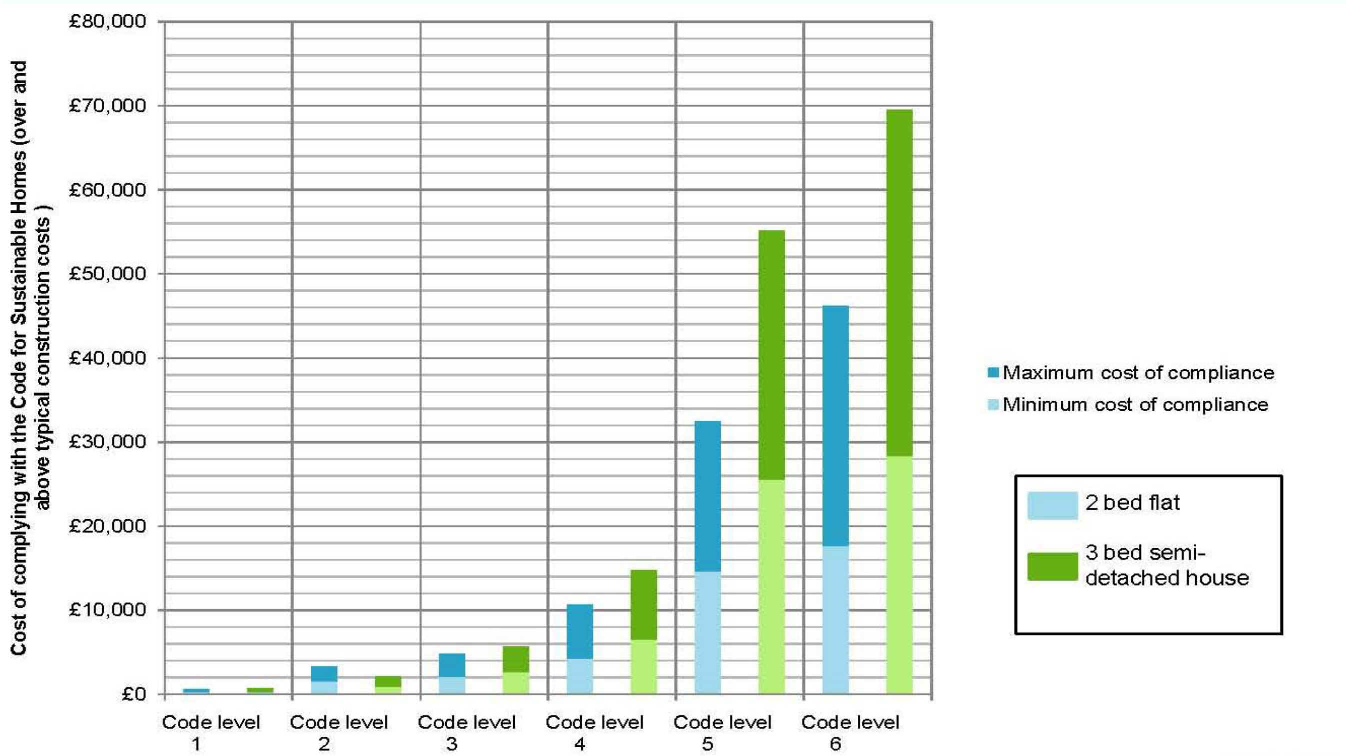

Figure 6: Costs associated with complying with the Code for Sustainable Homes

DEVELOPMENT TYPOLOGIES AND TESTING

To gain a better understanding of how low carbon and renewable energy might comply with expected changes in Building Regulations in a manner specific to Central Lincolnshire, four development typologies have been assessed. For each development type, the available technical solutions for each building type have been modelled, with the resultant CO_2 savings relative to a baseline, and the additional costs calculated. The results show that in general the cost increases in line with CO_2 reduction, and that the relative cost of achieving CO_2 reductions changes for each building type. Alongside this, the maximum viable CO_2 reduction which can be achieved for each building type also varies. This demonstrates the importance of flexibility in local target setting, taking into account the type and nature of development and the resources and technical options available to the development. Table 2 shows the development typologies modelled alongside site opportunities and constraints.

Table 2: Site analysis typologies

Typologies	Housing	Commercial	Other	Assumed Housing Density	Detached %	Semi %	Terrace %	Flats %	Site Constraints	Site opportunities
• Large urban extension / eco-town	2000 homes	30,000 m2 of B1 10,000m2 of B8	1 primary school, 1 local centre (retail, community, leisure, health care, library, crèche, church)	55 dwellings/ ha	25	30	30	15	• Phasing • Landscape character • Multiple developers	• Retrofit heat systems to adjoining development • Allowable solutions • Site-wide systems • Nearby industrial areas • Masterplanning
• Small rural development in village	10 homes	none	none	20 dwellings/ ha	60	40	0	0	• Landscape character • Residential amenity	• Wind opportunity area • Solar PV
• Medium urban infill development	100 homes	none	All residential	50 dwellings/ ha	15	40	35	10	• Tight urban environment	• Retrofit heat systems to adjoining development • Allowable solutions • Nearby town centre
• Business Park development	none	43,000 m2 B1, 35,000 m2 B2, 17,000 m2 B8, 4,645 m2 C1, 7,154 m2 D2	Includes hotel, public house	-	-	-	-	-	• Variable/unpredictable uses	• Symbiotic industries • Waste heat • Masterplanning • Large roof areas

POLICY RECOMMENDATIONS

If delivery rates of low carbon and renewable energy are to be maximised, policy will play an important role. Planning policy has the ability to influence existing development through retrofitting, and new development through design and build requirements. Policy also has the impact of reducing risks through providing long term assurances, and signals commitment to increasing renewable energy capacity to commercial energy developers. Table 3 summarises the policy and planning recommendations made.

Table 3: Recommendations for policy options and wider planning recommendations

Energy Opportunity Type	Policy Option	Planning Recommendation
Existing Development		Guidance and encouragement for consequential improvements
New Development	Efficient design of new development Sustainable Design and Construction Targets Design for climate change adaptation Strategic sites targets	Prioritisation of carbon-efficient growth locations through spatial planning
Strategic Interventions	Renewable energy vision Delivery of the energy opportunities map District heating priority areas Wind energy development Allowable Solutions Strategic adaptation interventions	Guidance on considerations for wind energy applications Working with the Lincolnshire Wolds Local Adaptation Strategy

IMPLEMENTATION

Driving delivery forward will require an effective implementation plan, which sets priorities according to which actions are likely to have the greatest effect on delivery. Table 4 sets these priorities, and includes the main actors, expected timeframes for delivery, what support could increase the likelihood of success, and priority level.

Table 4: Increasing Renewable Energy Uptake – Setting Implementation Priorities

Action Description	Main actor(s)	Timeframe	Support required from	Priority
Partnership Working				
Participate in partnerships with public sector organisations to deliver large scale projects	Energy Developers	Long-term	Renewables champion on local authority council	High
Engage energy developers in discussions about potential to improve communities	Community group/ individual leader	Medium -term	Supportive energy developer Local council	High
Support community groups	Local councils	Short-term		High
Engage early with local communities and councils about large scale energy schemes	Energy Developers/ESCO	Medium -term	Community members Local council	High
Partner within industry and establish business forums	Private sector	Medium -term		Medium
Act as a leader and facilitator, coordinating separate bodies in the delivery of renewables	Local councils	Short-term		Medium
Establish county or region-wide local authority expertise network	Local councils	Long-term		Medium
Engage with private industry to support community initiatives	Community groups, local councils	Short-term	Local champions with private industries	Low
Partner with similar organisations	Leaders of various community groups	Short-term	Local council Other experienced communities	Low

Education and Empowerment				
Energy education and promotion	Community groups Schools and colleges Local councils	Short-term	Community buildings Advertising support	High
Use public sector powers to support residents	Local councils RSLs	Medium-term		High
Support community champions	Local councils Local businesses	Short-term		Medium
Train and employ residents for low carbon economy jobs	Lincoln College University of Lincoln	Long-term	Energy Developers	Low
Investment and Resources				
Scope and conduct feasibility studies to deliver strategic projects such as district heating	Local councils Hospitals University of Lincoln	Short-term	Private Sector Energy Companies Carbon Trust	High
Feasibility studies for renewables for businesses and landowners	Business and Industry Groups Farming Groups	Medium-term	Local Councils	High
Improve infrastructure and supply chains	Local councils	Long-term	Energy companies and developers	High
Establish an Energy Company (ESCo)	Community groups Local councils	Long-term	Energy developers	High

Public sector adoption of energy efficiency and renewable energy on all properties	Local councils Schools/colleges Hospitals RSLs	Long-term		High
Fund feasibility studies for community schemes	Local councils	Medium-term	Funding organisations	High
Co-ordinate and promote private funding	Private sector	Medium-term		High
Public sector to coordinate a fund for energy projects	Local councils Schools	Medium-term	West Lindsey Council, and others who have successfully obtained funding	High
Audit resource use	Industry sector Agriculture and farming sector	Short-term	Industry groups Farming groups	Medium
Public sector undertake property energy audit of council buildings and assets	Local councils	Long-term		Medium
Innovation				
Allowable solutions identification and delivery	Local councils	Medium-term	Other councils who have been through the process e.g. Woking BC on delivery and Huntingdonshire on allowable solutions	High
Establish new business models that consider how communities can benefit from energy schemes	Energy Developers	Medium-term	Leadership within community	Medium
Perform an energy life cost analysis	Large energy users	Short-term	Industry groups	Medium
Create local innovation hubs	Local councils Energy-focused businesses	Long-term	Higher education – universities and colleges	Medium

Develop private sector champions	Local business leader	Medium -term		Medium
Investigate best practices within industry	Industry and business groups Farming groups	Medium -term		Low
Planning and Strategy				
Public sector implement clear and support policy	Local councils			High
Work across local authority boundaries and at a County level to establish consistent guidance	County-wide working group	Short-term		Medium
Establish potential to deliver community energy schemes	Private sector	Medium -term		Medium
Express views to local council	Community groups/individuals	Short-term	Local council	Medium

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1. Introduction

1.1 CENTRAL LINCOLNSHIRE – SETTING THE CONTEXT

AECOM were appointed by Central Lincolnshire Joint Planning Unit (JPU) to develop an evidence base to inform the development of low carbon and renewable energy policies for inclusion in their Core Strategy and supporting documents.

Figure 7 shows the area covered by Central Lincolnshire. The City of Lincoln is the largest settlement in Central Lincolnshire with the towns of Gainsborough and Sleaford playing a significant role in the provision of services. A variety of smaller villages and settlements complement these towns. With the exception of Lincoln Cliff, which runs north-south through the centre of the area, the landscape is largely flat and rural in nature with a large amount of farmland.

1.2 SCOPE OF THE STUDY

This study seeks to ensure that the objectives set out in the Core Strategy can be delivered in a more sustainable, carbon efficient way. The primary focus of the study is the delivery of carbon reduction through energy efficiency and renewable and low carbon energy generation. Where previous studies have discussed the technical potential for renewable energy, this study will instead concentrate on delivery strategies that can translate technical potential into tangible results. This shift from focusing on technical potential to focusing on what can be practically delivered taking into account the delivery partners represents a new approach for energy studies. The study also includes an assessment of possible delivery scenarios and a discussion on policy drivers that would help improve the delivery of renewables.

The development of this evidence base responds directly to requirements set out in national planning policy. The role of planning in helping combat climate change and promote renewable and low carbon energy has been increasingly emphasised over recent years. The longstanding supplement to Planning Policy Statement 1: Planning and Climate Change requires local authorities to understand the potential for incorporating renewable and low carbon technologies in their authority area:

"Planning authorities should have an evidence-based understanding of the local feasibility and potential for renewable and low-carbon technologies, including micro-generation, to supply new development in their area." – PPS1 Supplement on Climate Change (page 16).

Under the current PPS1 Supplement on Climate Change states Local Authorities should:

1. Along with criteria based policies, identify suitable sites for decentralised and renewable or low carbon energy;

2. Expect a proportion of energy supply for new development to be secured from decentralised and renewable or low carbon energy, by:
    - Setting targets where necessary;
    - Where opportunities allow, bringing forward development area or site-specific targets;
    - Setting thresholds and development types to which the target will be applied; and
    - Ensuring a clear rationale for the target and it is properly tested.

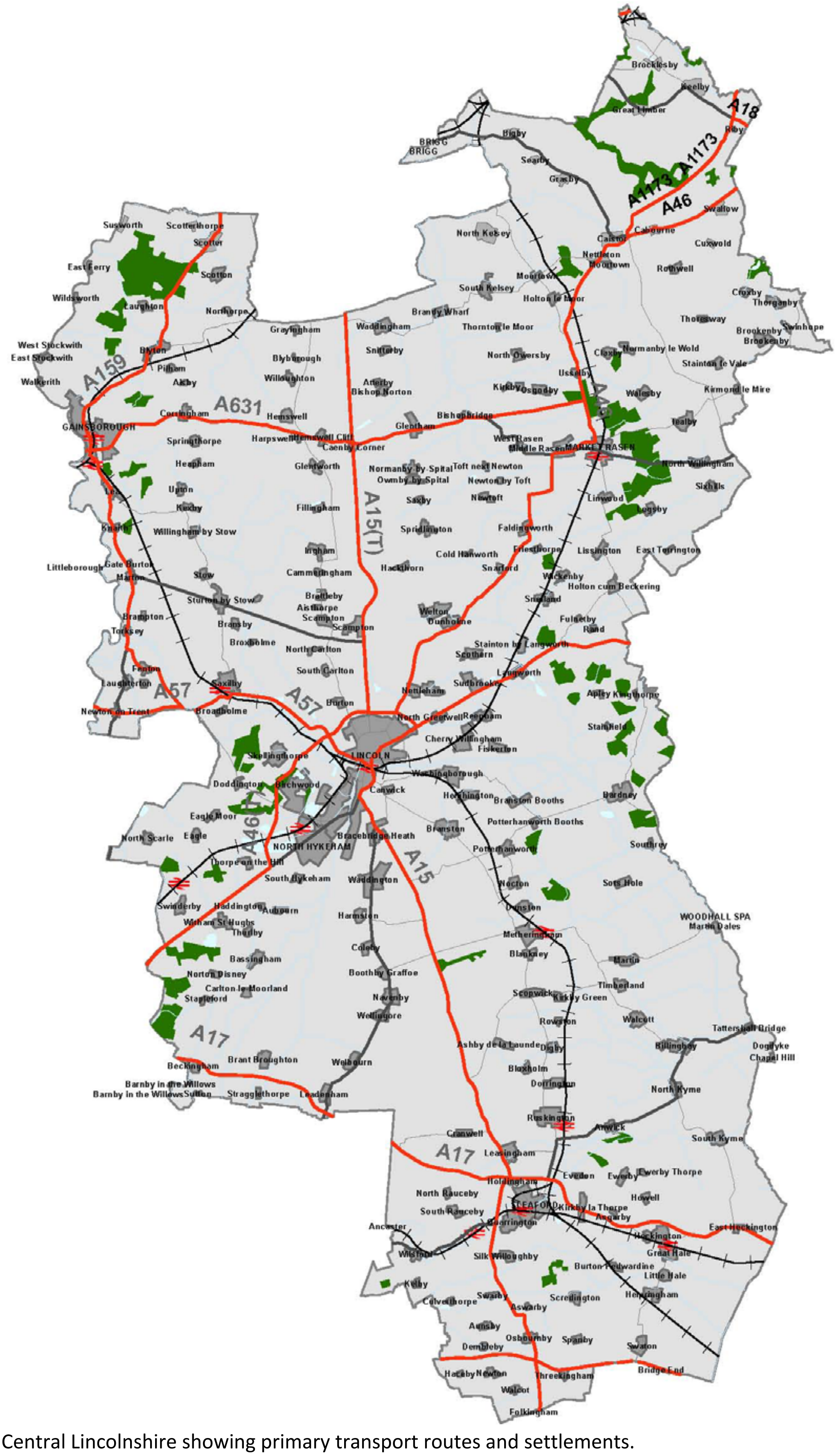

Figure 7: Map of Central Lincolnshire showing primary transport routes and settlements.

Since the release of the PPS1 Supplement on Climate Change, however, a new draft PPS was released for Consultation entitled 'Planning for a Low Carbon Future in a Changing Climate' (2010). The draft PPS combines and updates the PPS1 Supplement on Climate Change and PPS22 on Renewable Energy. The draft PPS states:

Local Authorities should assess their area for opportunities for decentralised energy. The assessment should focus on opportunities at a scale which could supply more than an individual building and include up-to-date mapping of heat demand and possible sources of supply. Local planning authorities should in particular look for opportunities to secure:

i. *Decentralised energy to meet the needs of new development;*

ii. *Greater integration of waste management with the provision of decentralised energy;*

iii. *Co-location of potential heat suppliers and users; and*

iv. *District heating networks based on renewable energy from waste, surplus heat and biomass, or which could be economically converted to such sources in the future.*

The draft PPS also encourages local authorities to work with neighbouring authorities to identify and understand the potential for all types of renewable and low carbon energy infrastructure over a larger area, then put in place policies to support the delivery of such infrastructure.

The coalition Government has recently published the draft National Planning Policy Framework (draft NPPF) for consultation. The NPPF will replace the current suite of national Planning Policy Statements, Planning Policy Guidance notes and some Circulars with a single, streamlined document. While the NPPF is to be read as a whole, in the context of renewable energy, the draft NPPF states that one of the Core Planning Principles is that planning policies and decisions should enable the reuse of existing resources, such as through the conversion of existing buildings, and encourage, rather than restrict, the use of renewable resources. Further, it supports a move to a low-carbon economy, stating that planning authorities should:

- Plan for new development in locations and ways which reduce greenhouse gas emissions; and
- When setting any local requirement for a building's sustainability, do so in a way consistent with the Government's zero carbon buildings policy and adopt nationally described standards.

This study aims to provide a robust evidence base following the current PPS1 Supplement on Climate Change, the draft PPS 'Planning for a Low Carbon Future in a Changing Climate', and emerging direction of the draft NPPF. Through an understanding of the current situation in Central Lincolnshire, review of policy direction and analysis of the area's potential, this report sets out the premise and justification for policies to be included in the emerging Core Strategy. The study considers proposed new development and changes to the Local Planning Authority (LPA) area over the next 15 years which the Core Strategy is required to cover as a minimum.

1.3 PREVIOUS REPORTS

This study builds on and reviews the *Low Carbon Energy Opportunities and Heat Mapping for Local Planning Areas Across the East Midlands: Final Report* (hereafter referred to as the **EM Low Carbon Energy Study**), prepared for the East Midlands Councils in 2011 by Land Use Consultants, the Centre for Sustainable Energy and SQW. The study identifies the technical potential for renewable and low carbon energy schemes within the East Midlands region. With respect to Central Lincolnshire, the report concludes that the best potential for the two rural districts – North Kesteven and West Lindsey – is large scale wind energy which has the potential to deliver 57% of all the renewable energy potential for Central Lincolnshire When considering all scales of wind, the report suggests this number increases to 91%. In urban areas, in particular Lincoln, the potential for wind generation is negligible, but the relatively high heat densities present can provide opportunities for renewable and low carbon heating schemes such as the development of district heating networks.

The EM Low Carbon Energy Study is used as a starting point for calculating the potential to deliver renewable and low carbon energy in this report. However, the assumptions used to calculate the technical potential in the EM Low Carbon Energy Study have been tested and, where appropriate, have been refined to reflect a more accurate picture of what is technically feasible. This is done in chapter 5 in the section titled, *Review and Testing of Technical Potential at a Local Scale*.

1.4 THE NEED FOR LOW AND ZERO CARBON FORMS OF ENERGY

The challenge of reducing CO_2 emissions and mitigating the effects of climate change is global in nature. Although national policy sets out an overall approach to achieving the target of an 80% reduction in CO_2 from 1990 levels by 2050, the PPS1 Supplement highlights that it is the responsibility of local authorities and local planning to seek to understand and capitalise on local opportunities to deliver CO_2 reductions associated with the built environment. To develop policy and targets on a local level, it is important to understand three areas of context; policy context, physical context and delivery context. While the policy context is consistent on a national level, the local response needs to be tailored according to regional and local policy context, the physical constraints and opportunities of a local area and the market and delivery opportunities available. A tailored local evidence base enables a direct and meaningful application of national aspirations for CO_2 reduction.

Figure 8 below demonstrates the policy development process. This process has been used to structure this evidence base report.

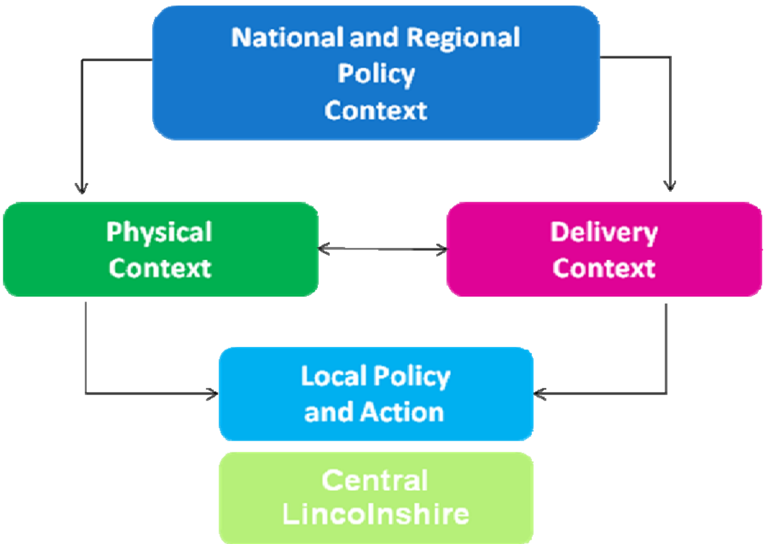

Figure 8: Policy Development Process.

It should be noted that where possible information and statistics have been collected at a district level and cited in the report. However, this has not always been possible and, therefore, the next most localised geographical area with available information and statistics has been used. This has generally been at a county or regional level.

1.5 STRUCTURE OF THIS REPORT

The rest of this report is set out as follows:

- **Chapter 2: Drivers and Policy** - Provides an overview of the national and local drivers for increasing the local potential for generating low and zero carbon forms of Energy
- **Chapter 3: Energy and Carbon Profile** – Examines the current level of CO_2 emissions, and energy efficiency in Central Lincolnshire. This information allows a baseline to be established which can be used to inform future strategy.
- **Chapter 4: Existing Renewable Energy Audit** – Examines the current levels of low and zero carbon generation in Central Lincolnshire as well as relevant activities that have, or are taking place.
- **Chapter 5: Review of Technical Potential for Renewable Energy** - Examines the potential for low and zero carbon energy sources in Central Lincolnshire. The EM Low Carbon Energy Study conducted for DECC in 2011 is used for technical potential and supplemented with local information to provide an accurate picture of how much of each resource can feasibly be delivered.
- **Chapter 6: Testing Delivery Potential for Renewable Energy** – Discusses stakeholders' perspectives on how best to drive delivery and uses case studies to illustrate how actions can drive delivery.
- **Chapter 7: Testing Delivery through Growth** - Assesses the viability of incorporating low and zero carbon forms of energy on new development in Central Lincolnshire, taking into account the local opportunities and constraints in combination with technical viability. This information can be used to help inform local planning policy development and decision making on planning applications.
- **Chapter 8: Policy and Planning Recommendations** – Outlines how sound planning policy and long-term strategic vision can be developed in a viable manner to promote low carbon development in Central Lincolnshire
- **Chapter 9: Action Plan** – Discusses an implementation plan, based partially on stakeholder consultations, to increase likely uptake of renewable energy in Central Lincolnshire

2 Drivers and Policy

This chapter provides an overview of the national and local drivers for increasing the local potential for generating low and zero carbon forms of Energy

2.1 NATIONAL AND INTERNATIONAL POLICY

The challenge of climate change, and the need to reduce greenhouse gases and stabilise carbon dioxide (CO_2) in the atmosphere to 450ppm (parts per million) has intensified in recent years. At the international level, the Kyoto Agreement is currently being updated (using the "Bali Roadmap") and was to be agreed in Copenhagen in December 2009. However, following failure to agree a framework for carbon reduction at Copenhagen, only minor progress was made at the conference in Cancun, Mexico in 2010. The next UN Climate Change Conference is scheduled to meet in South Africa in November 2011. An agreement will commit the UK to an updated CO_2reduction path, as well as technology development and transfer and financial investment, which will need to be reflected in planning policy. In addition, the UK Government is committed to reducing greenhouse gas emissions by 80% from 1990 levels by 2050, and at least 34% by 2020, through the *Climate Change Act (2008)*. The Act is supported by the *UK Low Carbon Transition Plan*, a national strategy for climate and energy, which sets out the Government's approach to meeting their CO_2 reduction commitments. To achieve this long term target, the UK Government in May 2011 announced intermediate carbon reduction target of 50% by 2025. As building related CO_2 emissions currently account for approximately 25% of all CO_2 emissions, improving efficiency and supplying buildings with renewable and low carbon energy is a priority. Furthermore, it is predicted that around two thirds of the current housing stock will remain in 2050, highlighting the importance of improving the existing housing stock as well as ensuring new buildings are highly efficient. The Transition Plan includes commitments to reducing greenhouse gas emissions from existing housing stock by 29% and by 13% for places of work on 2008 levels by 2020.

A crucial part of the Government's strategy to reduce CO_2 emissions is a step-change in the resources used to generate electricity and heat, through a switch away from fossil fuels (such as coal, oil and gas), to a much higher reliance on renewable and low carbon energy. Installations of renewable and low carbon energy infrastructure will need to be both significant and widespread, with every local authority area looking to utilise opportunities. The UK is currently committed to meeting carbon reduction targets set out by the European Commission in the *EU Renewable Energy Target* which requires a 20% reduction in CO_2 associated with electricity, heating and transport through conversion to renewable energy sources. To meet their proportion of this target, the UK is expected to supply 15% of its energy from renewable sources. The translation of this target across to the various types of energy generation is not equal in portion, and is instead related to the opportunities and delivery constraints associated with each. Accordingly, the following proportions of renewable energy supply are expected for the three sectors:

- 30% of electricity
- 12% of heat
- 10% of transport.

This study is primarily concerned with the use of electricity and heat in the built environment. The calculations do not include an assessment of the potential for renewable and low carbon energy in transportation although some references are made to the use of biogas in transportation.

Traditionally, drivers and targets for renewable energy have focussed on electricity supply. We are now seeing an expansion in focus to consider heat supply as well. *The Draft Heat and Energy Saving Strategy* (2009) aims to ensure that emissions from all existing buildings are approaching zero by 2050. Proposed mechanisms for achieving this include a new focus on district heating in suitable communities, and removing barriers to the development of heat networks, encouragement of Combined Heat and Power (CHP) and better use of surplus heat through carbon pricing mechanisms. Alongside the drivers for CO_2 reduction and the inclusion of renewables, there are also targets and strategies in place to encourage the inclusion of CHP schemes in new and existing neighbourhoods. In 2000 the Government set a new target to achieve at least 10,000 Megawatts-electrical (MWe) of installed 'Good Quality' CHP capacity by 2010[1,2]. In support of this target, the Government set a target to source at least 15% of electricity for use on the Government Estate from Good Quality CHP by 2010. The Government fell well short of this target, only sourcing 6%, which meets the Good Quality standard. However, the shortfall, combined with the introduction of the Renewable Heat Incentive (RHI)[3], suggests the Government will be placing significant emphasis on uptake of CHP going forward. Local authorities will play a key supporting role in the implementation of CHP.

Planning Policy Statement 1*: Delivering Sustainable Development* (PPS1) (2005) places an emphasis on promoting more sustainable development, with a *supplement to PPS1 on climate change* released in December 2007. The PPS1 supplement advised planning authorities to provide a framework to encourage low carbon and renewable energy generation in their local development documents and confirmed that there are situations where it is appropriate for the LPA to expect higher standards than Building Regulations. Paragraphs 31-33 explain that the local circumstances that warrant higher standards must be clearly demonstrated, such that there are clear opportunities for low carbon developments or that without requirements, development would be unacceptable for the proposed location. Paragraph 32 suggests that local requirements should focus on the development area or site-specific opportunities and that the requirement should be in terms of achievement of nationally described standards such as the Code for Sustainable Homes. Paragraph 33 requires that decentralised energy or other sustainable requirements should be set out in a DPD. Care must also be taken to demonstrate that the requirements are viable, will not impact on the supply and pace of housing development and will not inhibit the provision of affordable housing. The consideration of targets both on a LPA-wide scale and for strategic sites is a focus of this study.

Planning Policy Statement 22: Renewable Energy (PPS22) (2004) is becoming outdated and superseded by more current guidance, in particular the proposed National Planning Policy Framework (see below). However it is still important to refer to this guidance and targets on renewable energy. It sets out policies that cover technologies such as onshore wind generation, hydro, photovoltaics (PV), passive solar, biomass and energy crops, energy from waste (but not energy from mass incineration of domestic waste), and landfill and sewage gas. PPS22 sets out the Government's energy policy, including its policy on renewable energy, which is set out in the Energy White Paper. The *Energy White Paper* (2007) aims to put the UK on a path to cut its CO_2emissions by some 60% by 2050, with real progress by 2020, and to maintain reliable and competitive energy supplies (this 2050 target was superseded by the 2008 Climate Change Act target of 80%). The development of renewable energy, alongside improvements in energy efficiency and the development of CHP will make a vital contribution to these aims. The Government set a target to generate 10% of UK electricity from renewable energy sources by 2010, but failed to meet this

[1] Megawatt electrical refers to electricity generation as opposed to thermal, or heat generation
[2] Good Quality refers to CHP schemes that are energy efficient. The CHP Quality Assurance programme (CHPQA) rates the quality through assessing the thermal and electrical outputs of CHP schemes.
[3] The Renewable Heat Incentive (RHI) is a financial incentive scheme designed to increase uptake of low carbon heating schemes.

target. The White Paper also set out the Government's aspiration to double that figure to 20% by 2020, and suggests that still more renewable energy will be needed beyond that date.

Paragraph 6 of PPS22 states that local planning authorities should only allocate specific sites for renewable energy in plans where a developer has already indicated an interest in the site, has confirmed that the site is viable, and that it will be brought forward during the plan period. Planning applications for renewable energy projects should be assessed against specific criteria set out in regional spatial strategies and local development documents. Local planning authorities should, therefore, ensure that such criteria-based policies are consistent with, or reinforced by, policies in plans on other issues against which renewable energy applications could be assessed.

Paragraph 8 of PPS22 states that 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. These policies are required to ensure that requirement to generate on-site renewable energy is only applied to developments where the installation of renewable energy generation equipment is viable, should not put an unnecessary burden on developers by, for example, specifying that all energy to be used in a development should come from on-site renewable generation. Guidance on the formulation of these policies and best practice can be found in the companion guide to PPS22. These targets and LPA requirements within policy are still pertinent and important for this study, although the setting of specific targets for renewable energy, and not targets for CO_2 reduction from renewable and low carbon energy, is bad practice.

In recognition of the overlap and synergies between the PPS1 supplement and PPS22, a *draft PPS* on 'Planning for a Low Carbon Future in a Changing Climate' was released for consultation in March 2010. The draft PPS aims to combine and update the PPS1 supplement and PPS22, calling for regional authorities to set ambitious targets for renewable energy and a clear strategy to support their delivery. Regional authorities were asked to conduct studies using a consistent methodology to highlight comparative contributions that LPA areas can offer in terms of renewable resources. Although the coalition Government has since abolished the regional authorities, funding and support remained from the Government for conducting the energy studies, and the East Midlands Councils developed this evidence through the Low Carbon Energy Opportunities and Heat Mapping study. This regional study remains a valuable resource and has been used to inform low carbon energy capacity within this report following the initial intention of the draft PPS for Local Development Frameworks (LDF) to support the regional strategy by not unreasonably restricting renewable and low carbon energy developments and incorporating supportive local context through criteria-based policies.

The draft PPS states that LPAs should also set out opportunities for decentralised energy and district heating and support opportunities for community-led renewable and low carbon developments, including the production and management of bio-energy fuels. It clarifies that authority-wide targets for carbon reduction associated with new development are likely to be unnecessary following planned changes to Building Regulations in 2013 (see below), though recognises targets could be set for the period prior to that change. It encourages LPAs to select development sites by considering their potential to exploit low carbon energy sources and to identify and set policy for strategic sites where there are significant opportunities for carbon reductions. It also urges LPAs to set out how their area will be planned to adapt to climate change, considering local vulnerabilities and possible adaptation methods. It is unlikely that the draft PPS will be adopted given the streamlining of planning policy by the Coalition Government and the recent publication of the draft National Planning Policy Framework (see below).

In July 2011 the Government published the *draft National Planning Policy Framework* (NPPF) for consultation. The NPPF will replace the current suite of national Planning Policy Statements, Planning Policy Guidance notes and some Circulars with a single, streamlined document. The NPPF will set out the Government's economic, environmental and social planning policies for England. Taken together, these policies articulate the Government's vision of sustainable development, which should be interpreted and applied locally to meet local aspirations. The draft NPPF continues to recognise that planning system is plan-led and that therefore Local Plans, incorporating neighbourhood plans where relevant, are the starting point for the determination of any planning application. In assessing and determining development proposals, local planning authorities should apply the presumption in favour of sustainable development and seek to find solutions to overcome any substantial planning objections where practical and consistent with the NPPF.

In relation to renewable energy, the draft NPPF notes that local planning authorities should recognise their responsibility to contribute to renewable energy generation. Specifically, the document states they should:

- *Have a positive strategy to promote energy from renewable and low-carbon sources, including deep geothermal energy*
- *Design their policies to maximise renewable and low-carbon energy development while ensuring that adverse impacts are addressed satisfactorily*
- *Consider identifying suitable areas for renewable and low-carbon energy sources, and supporting infrastructure, where this would help secure the development of such sources*
- *Support community-led initiatives for renewable and low carbon energy, including developments outside such areas being taken forward through neighbourhood planning; and*
- *Identify opportunities where development can draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers.*

Further, when determining planning applications, local planning authorities should view sustainable developments favourably. This includes not requiring applicants for energy development to demonstrate the need for renewable and low carbon energy, and approving applications if its impacts are, or can be made, acceptable.

The Government has also announced its intention for *Building Regulations* to require that emissions are incrementally decreased towards 'zero carbon' in residential development by 2016, with non-residential development expected to meet the zero carbon target by 2019. The enforcement of CO_2 reductions through Building Regulations, removes the emphasis somewhat from planning. Previously stand-alone policies for CO_2 reduction, such as 'Merton-style rules' for inclusion of certain percentages of renewable energy supply, have been used for new development, but such policies are likely to be superseded by proposals for changes to Building Regulations. However, LPAs can still require sites to go beyond Building Regulations where viable as outlined in the PPS1 Supplement on Climate Change although all requirements should be compatible with the Building Regulations.

The proposed residential Building Regulations correspond to the Dwelling Emission Rate (DER)[4] targets set out in the energy section of the Code for Sustainable Homes for levels 3 (25% reduction) and level 4 (44% reduction), however the definition of zero carbon is likely to differ from the level 6 of the Code (the Code is discussed in greater detail in section 7). It is a common misconception that full Code levels will be required under the government proposals, but in fact it is just the mandatory CO_2 targets of the Code that will be applied through Building Regulations (the energy category is one of nine different categories in the Code). Expected changes to Building Regulations are discussed in more detail in section 2.5 below.

[4] The dwelling emission rate (DER) is the calculated maximum amount of carbon dioxide a dwelling is predicted to emit per square metre of floor area per year

Circular 05/2005 (Planning Obligations) states that the objective of the planning system is to deliver sustainable development and those obligations are intended, among other things, to secure a contribution from a developer to compensate for loss or damage created by a development or to mitigate a development's impact.

The *Energy Act* (2008) gives power to the Secretary of State to establish or make arrangements for the administration of a scheme of financial incentives to encourage small scale low-carbon electricity generation. The holders of distribution licences may also be required under this act to make arrangements for the distribution of electricity generated by small-scale low-carbon generation and to make a payment to small-scale low-carbon generators (or to the Gas & Electricity Markets Authority). This act also allows the Secretary of State to make regulations to establish a new scheme to facilitate and encourage renewable heat generation and to establish methods to administer and finance the scheme.

The *Planning Act (2008)* paved the way for a new planning system for approving nationally significant infrastructure projects, and introduces the concept of National Planning Statement (NPS). Twelve NPSs detailing Government policy on infrastructure have been published. One of these is dedicated to renewable energy sets out the criteria for assessing large scale renewable energy projects. The act also adds a duty on councils to take action on climate change within their development plans.

In addition, the *Planning and Energy Act (2008)* enables local planning authorities to set requirements for energy use and energy efficiency in local plans, including:

- a proportion of energy used in development in their area to be energy from renewable sources in the locality of the development;
- a proportion of energy used in development in their area to be low carbon energy from sources in the locality of the development; and
- Development in their area to comply with energy efficiency standards that exceeds the energy requirements of building regulations.

The Coalition Government's Change in Direction

With the recent change in government, it is important to understand how their thinking might change with respect to climate change. Thus far, their policies have been mixed in relation to their support for environmental sustainability and renewable energy. Some specific changes include:

Carbon Targets

In May 2011, the coalition government introduced some of the most stringent carbon emissions reduction targets of 50% below 1990 levels by 2025. They have also signalled that they will seek to increase the Renewable Energy Targets. On the other hand, national targets and climate change adaptation indicators, such as NI185, NI186 and NI188, have been abolished.

Driving Action

The new government has indicated that they support local carbon reduction measures and intend to encourage energy efficiency, and create green financial products that will help the UK work towards a greener future. However, they have also reduced feed-in tariff incentives for solar energy. The Coalition Programme explicitly addresses each of these goals as follows:

- The Renewable Heat Incentive (RHI) will come into effect in July 2011. The RHI will operate as a feed-in tariff. Operators of renewable heat will receive up to 8.5p for every kWh of heat generated and used.
- An initial investment of £3-billion in the Green Investment Bank, which is expected to deliver an additional £15-billion in private sector funding by 2015. The fund will initially focus on renewable energies, such as offshore wind, waste, and industrial energy efficiency. The bank is expected to start lending as of April 2012.
- The solar energy Feed-in Tariff has seen significant cuts. For larger installations of solar energy (greater than 250kW), incentives have been cut by over 70%.

Bringing Emphasis to the Local Level

Overall, the new government sees local authorities as the most likely bodies to understand what their districts need most. With this in mind, their emerging Localism Bill focuses on policies which give greater power to councils, neighbourhoods, and local communities. The coalition has also mentioned that "incentives for local authorities to deliver sustainable development" will be introduced. They have gone so far as to give local authorities increased financial autonomy to "do anything they consider likely to promote the economic, social and environmental well-being of their areas unless explicitly prohibited elsewhere in legislation." Regional Spatial Strategies are due to be abolished once the Localism Bill is enacted.

Feed-in Tariffs (FITs) were introduced in April 2010 to replace the support provided by the Low Carbon Buildings Programme and stimulate increased vigour in the take up of installation of small to medium scale renewable electricity generation.

The scheme includes:

- Fixed payment from the electricity supplier for every kWh generated (the "generation tariff").
- A guaranteed minimum payment additional to the generation tariff for every kWh exported to the wider electricity market (the "export tariff").
- Generators receiving FITs will also benefit from on-site use: where they use the electricity they generate on-site, they will be able to offset this against electricity they would otherwise have had to buy.
- Technologies included: wind, solar PV, hydro, anaerobic digestion and non-renewable micro CHP.
- Tariffs are tax free and will be paid for 25 years for new projects.
- The tariff levels proposed have been calculated to ensure that the total benefits an investor can be expected to achieve (from the generation tariff, the export tariff and/or the offsetting benefit) should compensate the investor for the costs of the installation as well as provide financial return.
- The government intends to set tariffs at a level to encourage investment in small scale low carbon generation. The rate of return will be established between 5% and 8%.
- The proposed tariff levels for new projects will decrease by predetermined rates each year ("degression"). The tariff rate agreed at the project outset will be maintained for the 20 year period providing guaranteed returns for each installation.

Since its introduction, however, the Government has mentioned that it will come under review in 2013. In March 2011, the coalition government cut the incentive for larger scale solar installations (greater than 50kW) by more than 50%. While this will not directly impact micro-generation installations, it does suggest that as a relatively new policy, FITs may continue to undergo changes going forward.

In 10 March 2011, the Government confirmed that the *Renewable Heat Incentive (RHI)* was to open for applications for the first phase of funding on 30 September 2011. At the time of writing this report, however, phase one has been slightly delayed, but a revised date has not been set. The first phase of funding will focus on supporting large emitters in the non-domestic sector. As part of this phase, the Government will also initiate the *Renewable Heat Premium Payments (RHPP) programme*, which is a £15m pilot programme to test installing renewable heating systems in homes. The RHPP will run between August 2011 and March 2012. A second phase of funding will be introduced in 2012 alongside the Green Deal for Homes (see below).

The RHI represents over £850m of government investment. There is no upper limit to the size of heat equipment eligible under the Renewable Heat Incentive and anyone who installs a renewable energy system producing heat after July 15th 2009 is eligible. The following technologies are included in the scheme;

- Solid and gaseous biomass, solar thermal, ground and water source heat-pumps, on-site biogas, deep geothermal, energy from waste and injection of biomethane into the grid.
- Unlike FITs, tariffs will be paid not on the basis of a metered number of kWh generated, but instead on a "deemed" number of kWh, namely the reasonable heat requirement (or heat load) that the installation is intended to serve.

- Tariff levels will be calculated to bridge the financial gap between the cost of conventional and renewable heat systems at all scales, with additional compensation for certain technologies for an element of the non-financial cost and a rate of return of 12% on the additional cost of renewables, with 6% for solar thermal.

Starting in October 2012, the UK government will introduce the UK *Green Deal* to improve the energy efficiency of all properties in the country. The funding enables owners to install energy efficient improvements with no upfront cost. Instead loans will be provided which are paid back as a surcharge on the energy bills. The scheme is attached to the address, rather than a specific person, which means that there is no financial loss when selling a building. All energy efficiency improvements made to homes or businesses qualify provided that they meet the 'Golden Rule' where the lifetime financial savings outweigh the capital cost plus finance cost, resulting in lower overall energy bills.

2.2 REGIONAL AND LOCAL POLICY

The recent change in National Government has resulted in the proposals to revoke Regional Spatial Strategies through the Localism Bill. However, preceding regional policy and their baseline studies are included here as they provide an important context for how Central Lincolnshire and Lincolnshire County as a whole are expected to perform in relation to other areas of the East Midlands.

As set out by the draft PPS on 'Planning for a Low Carbon Future in a Changing Climate', resource assessments for renewable energy and low carbon developments are to be considered at a regional level in order to inform local action. Although soon to be abolished, The *East Midlands Regional Plan (March 2009)* contains a suite of policies relating to climate change and renewable energy. Policy 39 stresses the importance of energy efficiency for local authorities and energy generators:

"Local authorities, energy generators and other relevant public bodies should:

- *Promote a reduction of energy usage in line with the 'energy hierarchy'; and*
- *Develop policies and proposals to secure a reduction in the need for energy through the location of development, site layout and building design."*

Policy 40 sets out criteria for the adoption of various renewable energies on a variety of sites, including:

- The promotion of CHP and district heating networks, fuelled by local and renewable resources, in achieving regional targets
- Implementing *low carbon energy proposals where environmental, economic and social impacts can be addressed satisfactorily*
- Specific considerations for wind turbines, with the aim to balance their ability to contribute to renewable energy targets with their negative impacts, including noise and visual impacts as well as impacts on the built and natural environments.

The Regional Strategy also sets out regional renewable energy targets for electricity for each source. Currently, the renewable energy resources contribute approximately 2% to the Region's capacity. The Regional targets called for 20% renewable energy mix by 2020, achieved through energy efficiency, challenging micro-generation targets and large scale renewables. These targets are outlined in the table below.

Table 5: East Midlands renewable energy targets

Renewable Energy Technology	Capacity (2006) GWh/y	Capacity (2006) MWe	Target for 2020 GWh/y	Target for 2020 MWe
On shore wind	142	54	460	175
Biomass	38	5	1,264	168
Hydro	14	3	62	14
Micro-generation	0	0	2,850	3,253
Landfill gas	438	53	438	53

In 2009 AECOM published *Reviewing Renewable Energy and Energy Efficiency Targets for the East Midlands*. This report tested the findings of the East Midlands Regional Strategy (the March 2009 Regional Plan?). The report highlighted Central Lincolnshire as having the largest opportunity for CO_2 savings by 2031. Mainly as a result of onshore wind potential, Central Lincolnshire is predicted to contribute between 15 and 20% of the capacity for East Midlands CO_2 reduction.

Following on from this report the *EM Low Carbon Energy Study* (2011) was carried out. This report outlined the technical potential for renewable energy in Central Lincolnshire. Its results form the basis of what is technically feasible for Central Lincolnshire and is discussed and interrogated in Chapter 5 of this report.

2.3 BUILDING REGULATIONS AND THE TRAJECTORY TO ZERO CARBON

The *Building Regulations* were first introduced to improve the energy efficiency of buildings in the 1960s and the latest revisions to the Building Regulations Part L (Conservation of Fuel and Power) continue to improve standards. In 2002, the focus started to turn towards reducing CO_2 emissions and further revisions to Part L in 2006 brought the UK Building Regulations in line with the EU's Energy Performance of Buildings Directive (EPBD), introducing, amongst other things, the requirement for Energy Performance Certificates (EPCs).

The current 2006 Building Regulations Part L requires that CO_2 emissions calculated for a new development should be equal to, or less than a Target Emission Rate. This is generally in the region of 20% lower than CO_2 emissions from a building which complies with the 2002 Building Regulations, depending on the specific building type.

Following consultation, the Government's *Building a Greener Future: Policy Statement* announced in July 2007 that all new homes will be zero carbon from 2016. In the Budget 2008, the Government also announced its ambition that all new non-residential buildings should be zero carbon from 2019 (with earlier targets for schools and other public buildings). , Again, these improvements will be implemented through the Building Regulations.

The *Definition of Zero Carbon Homes and Non-Residential Buildings* consultation in 2009 sought to clarify the definition of zero carbon that will be applied to new homes and buildings through proposed changes to the Building Regulations. A statement by John Healey, Minister for Housing and Planning, in July 2009 confirmed the policy to require all new homes to be zero carbon by 2016 and set out the proposals which will be taken forward to implement this policy. This addressed the concern that the original definition, (which followed the definition of Code for Sustainable Homes Level 6 and required both regulated and un-regulated emissions to be off-set on site), would not be feasible or viable on many sites.

Prior to the introduction of the zero carbon requirement, the following intermediary step changes are proposed to the requirements of Part L of the Building Regulations for dwellings:

- 2010: 25% improvement in regulated emissions (relative to 2006 levels). This is expected to broadly correspond to the energy and CO_2 element (there are nine elements in total) of Level 3 of the Code for Sustainable Homes.
- 2013: 44% improvement in regulated emissions (relative to 2006 levels), corresponding to Code Level 4
- 2016: Zero carbon (initially defined as regulated and unregulated emissions, but under recent government announcements this has been revised down to just include regulated emissions).

The definition for zero carbon homes was updated in March 2011 following further analysis of costs and viability. The Government now defines zero carbon to include the 'as-built performance' of the building, including heating, fixed lighting and hot water (regulated emissions). Unregulated emissions from cooking and 'plug-in' appliances such as refrigerators, computers, and televisions have not been included within in the definition of zero carbon and it is expected that other regulations aimed at appliance efficiency will help improve these energy consuming sectors.

The Government has published a hierarchy for how CO_2 emissions should be reduced to achieve the zero carbon emissions standard (see Figure 9)

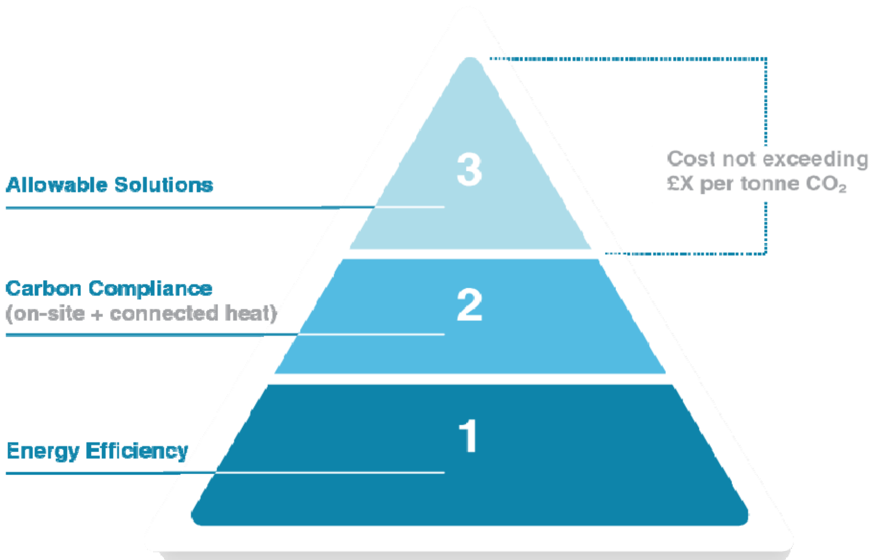

Figure 9: The Government's hierarchy for reducing CO_2 emissions

The hierarchy in Figure 9 shows the proposal that a minimum energy efficiency standard should be achieved for fabric and services. Following this, renewable and low carbon energy must be supplied on-site to meet the CO_2 reductions required for Carbon Compliance (the levels proposed are based around the maximum viable savings which can be achieved across a range of developments). Above carbon compliance, further CO_2 reduction can be made either on-site, or though off site savings (known as Allowable Solutions). The policy around allowable solutions is still being developed by the Government but likely allowable solutions include:

- Further CO_2 reductions on and off-site;
- Energy efficient appliances;
- Advanced forms of building control system which reduce the level of energy use in the home;
- Exports of low carbon or renewable heat from the development to other developments; or
- Investments in low and zero carbon community heat infrastructure.

Recent research by the Zero Carbon Hub titled 'Allowable Solutions for Tomorrow's Homes' (July 2011) outlines the latest proposals and recommendations for how allowable solutions could be embedded in policy and administered. The document highlights the key role of local authorities in the process, and options for developing policy that will ensure allowable solutions funds are directed towards locally approved projects. In the absence of local policy, developer contributions will be delivered through a national list of allowable solution projects. Recommendations for allowable solutions policy are further discussed on page 205 in the policy recommendations section of this report.

A key aspect of allowable solutions will be for the LPA to collect allowable solutions financial contributions from developers. Communities and Local Government announced in August 2010 that the government would implement a community energy fund, which would allow developers to make payments to the LPA or community. This provides local councils with the ability to create policy which determines how funds can best be used to meet government standards in a way that suits local circumstances.

2.4 KEY CONSIDERATIONS EMERGING FROM THIS CHAPTER

The sections above have considered the wider policy context, and some key findings have emerged that should be considered in the development of local policies for Central Lincolnshire:

- There are very strong and challenging policy drivers for both the reduction of CO_2 emissions and the inclusion of renewable and low carbon technologies from a national level;
- As identified in regional studies, Central Lincolnshire has the largest potential to reduce the region's CO_2 emissions and deliver renewable and low carbon energy. The LDF will, therefore, play a critical role in meeting the region's carbon reduction and renewable energy targets. While Regional policy is scheduled to be revoked, these studies still indicate the relative theoretical potential for carbon reduction and renewable energy in the area.
- Central Lincolnshire's Local Development Framework (LDF) should be the basis for the implementation of policy relating to building related CO_2 emissions. This study is being conducted at a stage where it can directly recommend policy for inclusion in the Core Strategy;
- The PPS1 Supplement requires LPAs to identify the potential for the inclusion of renewable and low carbon technologies in their LPA area, and to identify strategic sites where there is good potential for additional CO_2 reductions. Whilst it is likely that the NPPF will supersede the PPS, PPS1 is at present still a consideration and therefore, LPAs need to both consider

policies on an area-wide scale and policies for specific sites where additional opportunities exist for additional CO_2 reductions.

- With proposals for allowable solutions leading to requirements for developers to contribute to a centralised funding pot that can support off-site and near site renewable energy projects, the Central Lincolnshire planning authorities will need to consider how such a fund can be best implemented locally and used to fund the delivery of renewable and low carbon schemes in the area.
- With the new Government's ambitions towards stronger local decision making, it is important to establish an evidence base from analysis of local circumstances, and to identify local partners to take actions forward.

3 Energy and Carbon Profile

This chapter examines current levels of energy use, CO_2 emissions, and energy efficiency within the Central Lincolnshire area. This information allows a baseline to be established which can be used to inform future strategy.

3.1 INTRODUCTION TO THIS CHAPTER

Before policy and actions for reduction of energy-related carbon can be developed, it is important to understand the carbon baseline of Central Lincolnshire. This chapter considers the existing and future performance of homes and buildings in Central Lincolnshire in terms of demand for energy (both electricity and heat). First, it considers the current performance of existing buildings, and then considers how this energy demand is likely to change over time. Secondly, it considers the level of growth expected over the Core Strategy period (until 2026[5]) and the additional energy demand this growth will entail. The energy modelling described in this Chapter was undertaken using AECOM energy use models and building typologies developed through professional research projects.

3.2 ENERGY AND CO_2 EMISSIONS – THE CURRENT STATUS

The Department of Energy and Climate Change (DECC) monitor carbon emission data on a local authority basis. The data for 2008 has been used to compare CO_2 emissions in Central Lincolnshire's three local authority areas with the rest of the UK. The breakdown of emissions by sector can be seen in the table below. It shows that CO_2 emissions per capita in Central Lincolnshire were approximately 20% less than the average for the UK in 2008, with those for Lincoln City being substantially less. The variance in Lincoln City's carbon profile compared with North Kesteven's and West Lindsey's can be mainly explained by the urban and rural character of the local authority areas. The industrial, commercial and domestic sectors in Lincoln are responsible for nearly 90% of city's carbon emissions. For the two rural districts', road transportation is responsible for a much larger percentage – between a quarter and a third – of carbon emissions. The result is that opportunities for carbon reduction and renewable energy will, therefore, be different for Lincoln compared to North Kesteven and West Lindsey. While this study only considers emissions related to energy consumption in the built environment, policy for reduction of carbon emission from transport should also be a key consideration for planning.

[5] The Central Lincolnshire Core Strategy period may be extended to 2031.

Table 6: Comparison of Carbon Emissions (in Kilotonnes, Kt) for Central Lincolnshire Districts and the UK ($KtCO_2$ – kilo (1000) tonnes of CO_2)

	Lincoln		North Kesteven		West Lindsey		Central Lincolnshire		UK Average	
	$KtCO_2$	%	$KtCO_2$	%	$KtCO_2$	%	$KtCO_2$	%	$KtCO_2$	%
Industry & Commercial	266	51%	263	36%	228	45%	199	31%	730	38%
Domestic	194	37%	238	32%	149	29%	225	35%	657	34%
Road Transport	65	12%	235	32%	131	26%	221	34%	522	27%
Total Emissions	**525**		**737**		**508**		**645**		**1,907**	
Total Per Capita	**6.0**		**7.4**		**7.9**		**6.8**		**8.2**	

3.3 ENERGY PERFORMANCE OF EXISTING BUILDINGS

The following sections consider the current performance of existing homes and other buildings.

3.3.1 Residential Buildings

Energy Demand of Existing Homes

Table 7 shows the residential electricity and gas demands for Central Lincolnshire in 2008 (latest complete figures available), and compares them to the averages for the East Midlands and the UK. The two rural districts, West Lindsey and North Kesteven, have an electricity use per customer which is above the East Midlands and National average, while Lincoln City is substantially less. The same urban/rural pattern is evident for gas use, though West Lindsey shows a significantly higher average use than North Kesteven considering the districts are broadly similar in character.

Table 7: Energy consumption per residential consumer (DECC, 2008)

	Average electricity sale per consumer	Average gas sale per consumer
	Residential kWh	Residential kWh
Lincoln City	3,543	14,909
West Lindsey	4,389	17,005
North Kesteven	4,436	16,765
Central Lincolnshire	4,130	16,120
East Midlands Average	4,135	17,075
UK Average	4,198	16,906

For the purposes of this project, the Core Strategy period has been used as the timeline for analysis using a base year of 2006. Table 8 gives the total residential energy demands used as the model baseline. It should be noted that electricity from the grid is more carbon intensive than gas supply; therefore while electricity and gas demand are roughly equivalent in terms of gigawatt-hours (GWh) of energy use, the CO_2 emissions associated with electricity are approximately double.

Table 8: Annual Energy demand from residential buildings (DECC, 2006)

	Electricity		Gas	
	Energy, GWh	$KtCO_2$	GWh	$KtCO_2$
Lincoln City	166	70	619	128
West Lindsey	182	77	528	109
North Kesteven	216	91	596	123
Central Lincolnshire	564	238	1,743	359

Figure 10 and Figure 11 show the average electricity and gas use spatially to demonstrate how building types and user behaviours can change use of energy. The spatial variation of electricity and gas use gives us an insight into the areas of existing stock which are least efficient and should be a priority for improvement. Generally the urban centres of Lincoln, Gainsborough and Sleaford show a higher efficiency of use of both gas and electricity, though there is considerable variability within Lincoln itself. Electricity use is very high in some rural areas, and this is likely to be a reflection of homes utilising electricity for space heating where there is no connection to the gas grid available. This is particularly true of the rural area to the south of Sleaford. However, some rural areas east of Gainsborough, surrounding Market Rasen and to the south and west of Lincoln show very high consumption of both electricity and gas on a per customer basis.

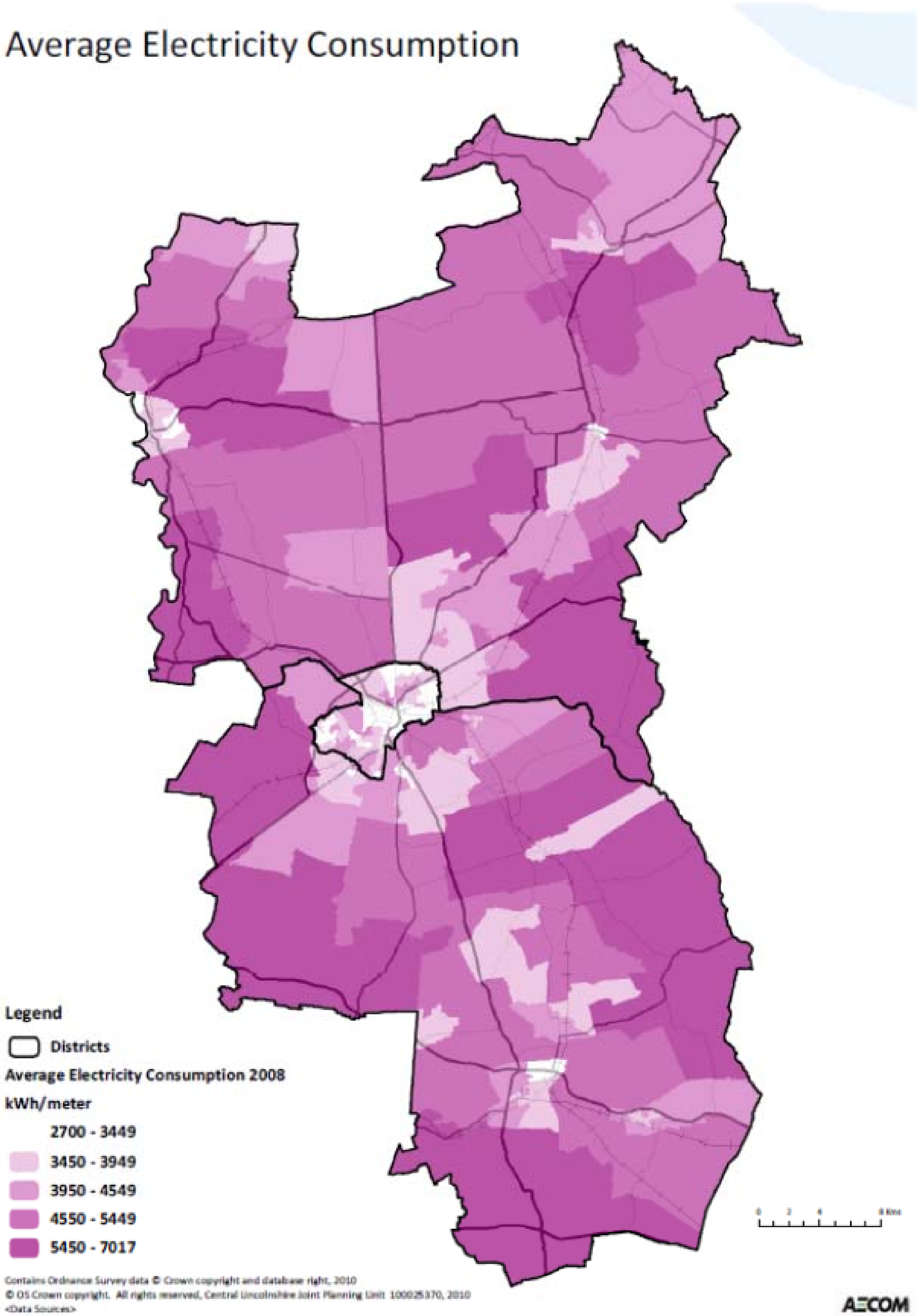

Figure 10: Average Electricity Consumption per meter in Central Lincolnshire

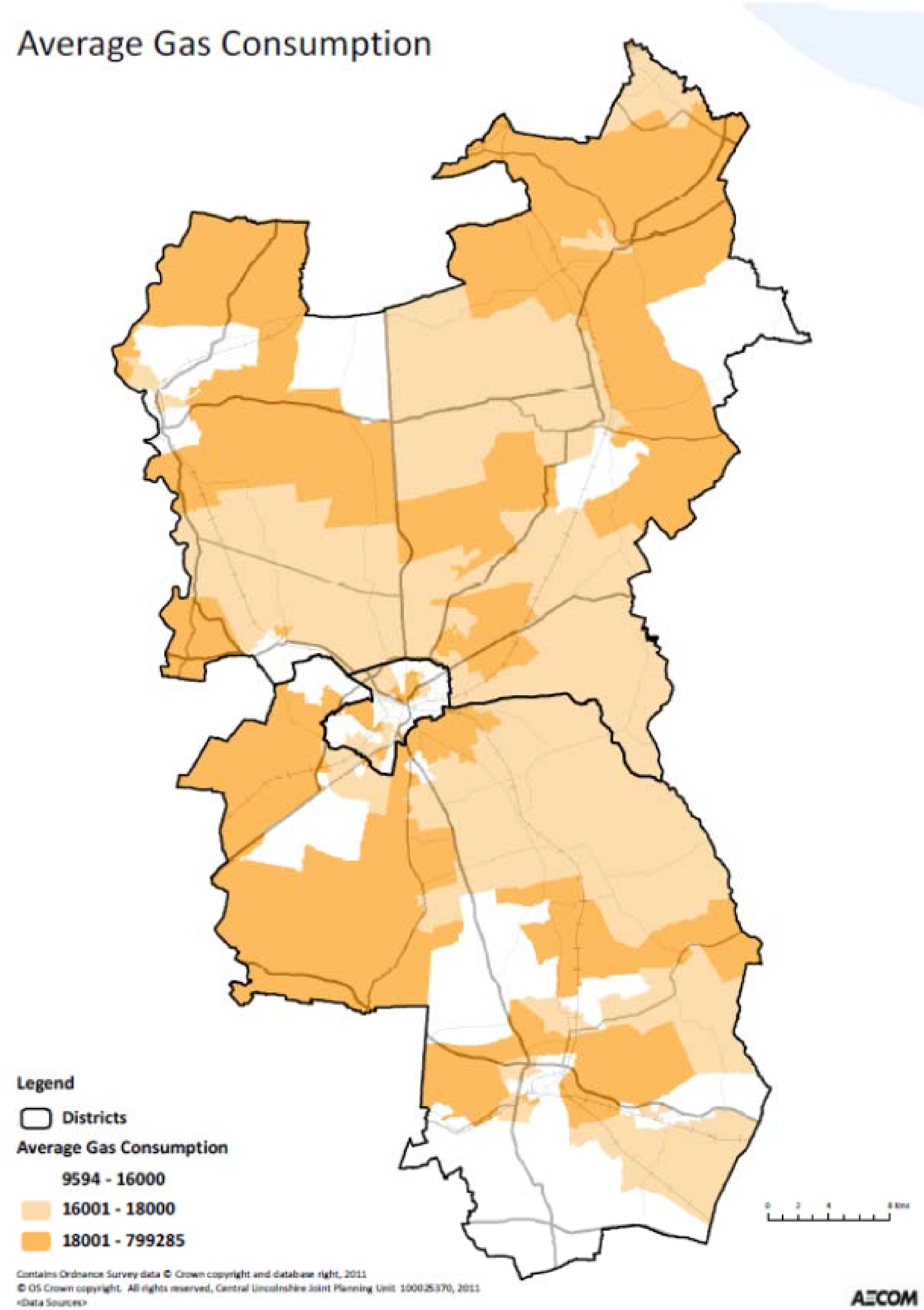

Figure 11: Average Residential Gas Consumption per meter in Central Lincolnshire

Access to the gas grid is varied in rural areas across Central Lincolnshire, but most rural areas have less than 50% of homes without the option to use gas as their main source of heating. In these locations, sustainably sourced biomass may be a suitable alternative to conventional heat sources as its carbon emissions are significantly lower than other heating alternatives.

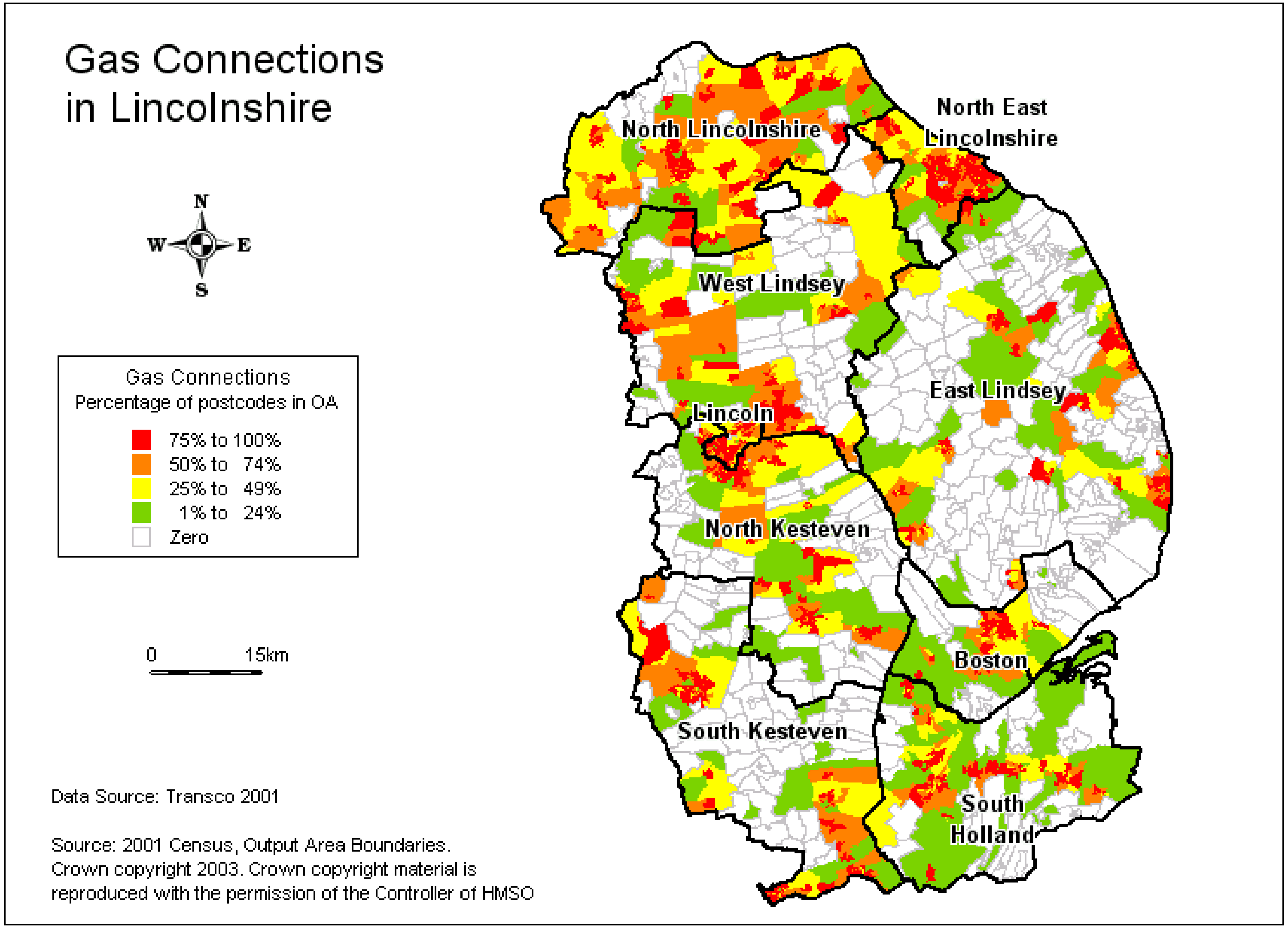

Figure 12: Off-Grid Homes in Lincolnshire[6]

[6] Rural Fuel Poverty Tool. Available: http://www.ruralfuelpoverty.org.uk/rural2.php?mopt=1&pid=gas_areamap&step=3&county=42

Understanding Performance of Existing Homes

The efficiency levels of the existing housing stock vary widely for a number of reasons:

- The **age** of the stock is a key factor in efficiency with more recent dwellings in general having higher levels of thermal efficiency. The main transitions in efficiency occurred around 1920 – 1930 when there was move from solid walls to cavity walls (and also a general reduction in the size of dwellings), and then again in the 1980s and 1990s when Building Regulations started to make large improvements. Figure 13 shows the national results of SAP ratings[7] from the English House Condition Survey by tenure illustrating this trend.
- The **tenure** of the stock can also have an impact. In general (as seen in national datasets such as the English House Condition Survey), housing owned by private landlords has the worst levels of thermal efficiency, private housing has a very large range from poor to excellent, and social housing is all reasonable (but not exceptional) due to schemes such as Decent Homes mandating minimum levels of performance for social housing providers.
- The levels of **retrofit** can vary significantly across the stock, particularly in the private sector. Simple cost effective measures such as loft insulation and cavity wall insulation are starting to achieve their potential, although this has taken around 40 years since the introduction of these measures. However there are still significant levels of potential for many other measures, and despite numerous support schemes and incentives, the uptake is relatively slow.

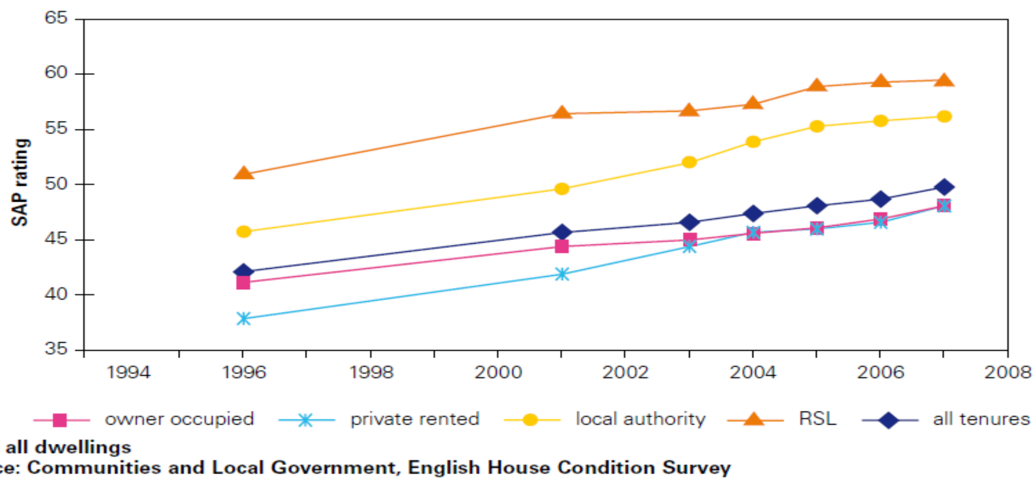

Figure 13: Average SAP (Standard Assessment Procedure) ratings for each tenure (England), 1996 – 2007 (Source: CLG, English House Condition Survey)

The most up-to-date information describing the energy efficiency of existing housing stock in Central Lincolnshire can be found in the statistics available on the Housing Intelligence for East Midlands (hi4em) website[8]. This contains a range of information split by local authority area, based on surveys, stock models and simulations. Other sources of information (which are used to inform the hi4em datasets) include:

[7] The Standard Assessment Procedure (SAP) is the Government's recommended method for rating the energy efficiency of homes and is used for Building Regulations Part L compliance. The procedure calculates the annual regulated energy demands for a home and the associated CO_2 emissions. These are used to estimate annual energy costs which is used to provide a SAP rating from 1 (high energy costs) to 100 (no energy costs).

[8] http://www.hi4em.org.uk/

- Home Energy Lincolnshire Partnership (HELP) scheme annual reporting data. This is a county-wide scheme operated by the Energy Saving Trust which provides loft insulation and cavity wall insulation free to over-60s and at reduced rates to everyone else.
- Home Energy Conservation Act (HECA) reporting data. HECA challenged local authorities to improve the efficiency of existing housing stock by 30% between 1995 and 2011.

This section provides an overview of current efficiency levels across Central Lincolnshire and the potential for improvements. Due to the methods in which data is reported, it can be difficult to accurately determine the levels of energy efficiency in the stock, and so the discussion is qualitative. In particular the Standard Assessment Procedure (SAP) rating is often used as a measure of efficiency. This is actually a measure of cost, and whilst it can provide a simplistic view of the state of a dwelling, it cannot be used to determine current technical standards.

Breakdown of housing stock

The energy demand of a home varies greatly based on building type. Buildings with a high amount of adjoining exterior walls (like flats or terraced housing) are more efficient due to reduced heat loss. Differences in energy efficiency due to house-types are demonstrated in Figure 14 below. Figure 15 shows that Lincoln has a higher proportion of terraced houses and flats compared to North Kesteven and West Lindsey. This is to be expected given the higher densities associated with a City. The scope for reducing emissions from these forms is less than for the less efficient forms (they are already inherently more efficient due to built form), but the age needs to also be considered (see Figure 16). It is likely that the terraced homes are in general, relatively old (pre 1920) and therefore could offer potential for some improvement. However if they are of solid wall construction, it will be challenging to make significant improvements to thermal loss without using internal or external insulation, both expensive, and potentially intrusive, measures.

The house types in the two rural authorities are predominantly detached and semi detached. These inherently less efficient built forms may offer a greater potential for having thermal efficiency improvements made. The age data in Figure 16 shows that the dwellings are generally more modern in these two authorities than Lincoln, with the majority built post 1955. Whilst these homes will have a baseline efficiency which is better than the older homes, they may also offer a greater potential for improvement (in particular cavity wall insulation).

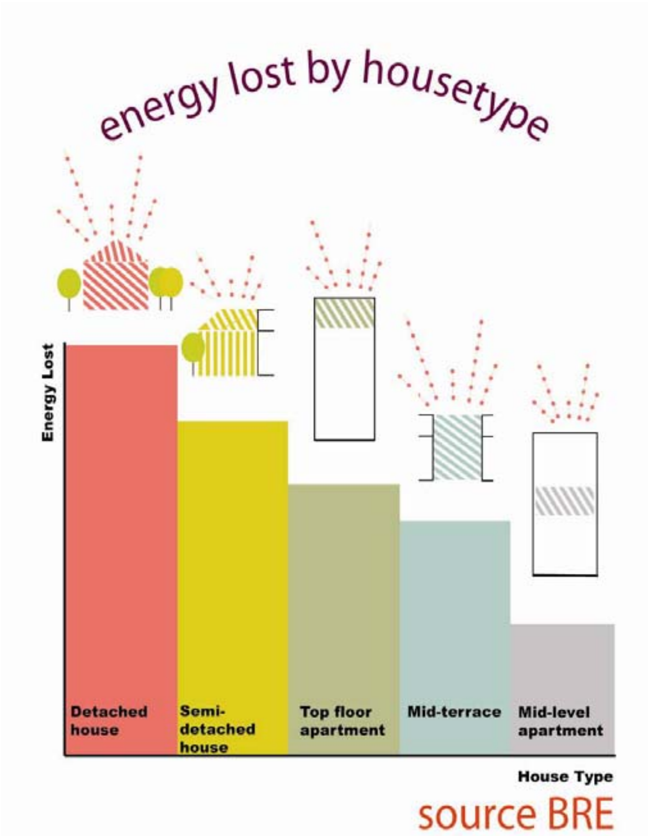

Figure 14: Energy efficiency of different housing types

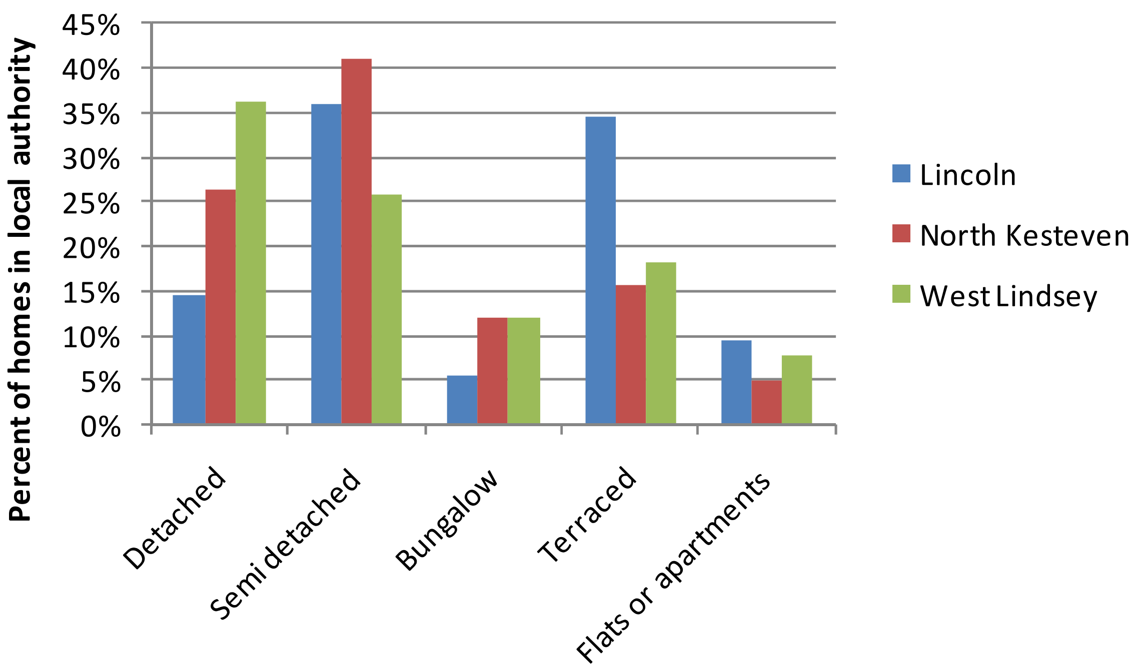

Figure 15: Breakdown of housing stock in Central Lincolnshire by type. (Source – hi4em)

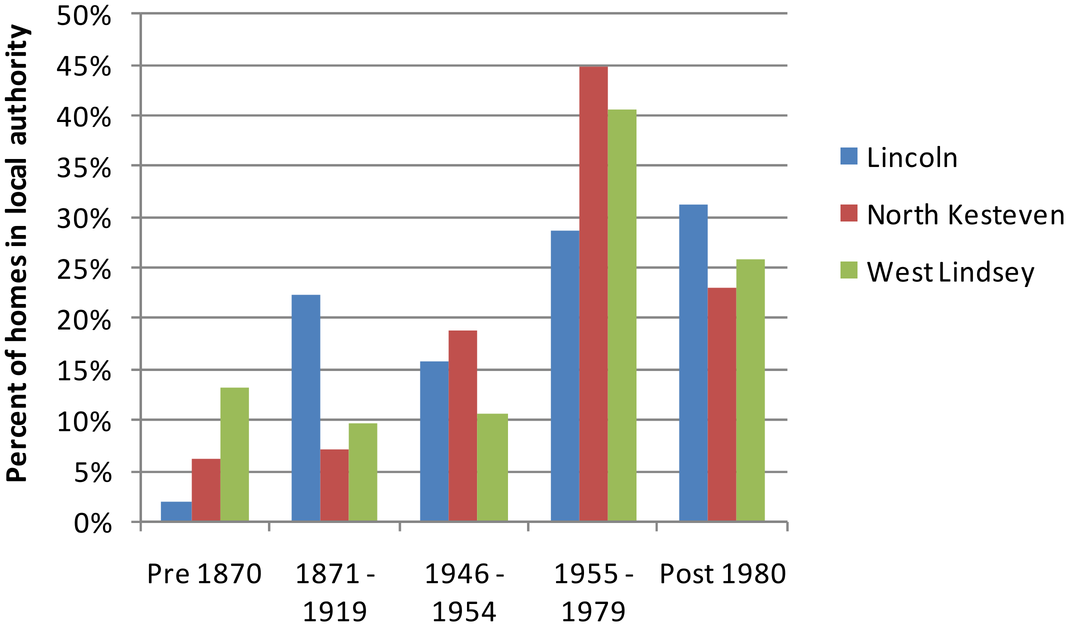

Figure 16: Breakdown of housing stock in Central Lincolnshire by age. (Source – hi4em)

SAP ratings

SAP ratings can be used to give an indication of overall efficiency levels. The SAP rating number is a cost index based on how much it costs to heat and power (regulated loads only) the dwelling per square meter. A low number generally means that the efficiency is low and therefore cost is high. However this does depend on the types, and therefore costs, of fuels available.

The data in Figure 17 shows the number of private sector dwellings with a SAP rating of 30 or less in each authority. Without knowing the overall spread of SAP ratings, it is difficult to determine the overall levels of efficiency, but this can provide a rough guide.

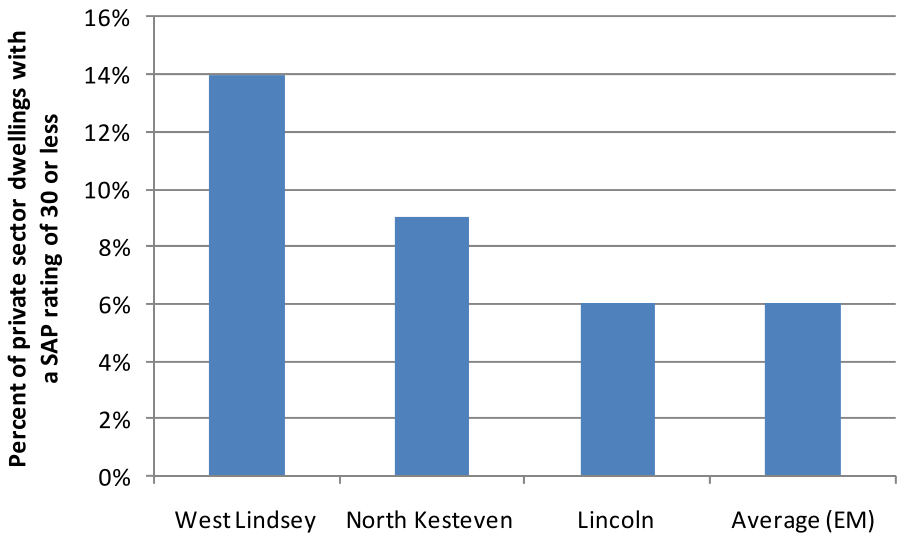

Figure 17: Number of private sector dwellings in each local authority with a SAP rating of 30 or less. (Source hi4em)

The average across the East Midlands is for 6% of private homes to have a SAP rating of less than 30, and Lincoln is at this average. This may be because Lincoln has average levels of efficiency. However it may also be because with having a tight city boundary, most homes are on the gas network (hi4em data suggests that 18% of homes in Lincoln do not have access) and gas is one of the cheaper heating fuels (giving better SAP ratings).

North Kesteven and West Lindsey are both above the average at 9% and 14% respectively. This suggests that overall efficiency levels might be lower (although this is not possible to verify without having the full spread of SAP data – the average for these could be higher than the regional average). However both of these authorities have high numbers of homes not connected to the gas grid (around 40%) and so it may be the presence of higher cost fuels (oil, electricity, and LPG) which may be reducing the SAP ratings.

Fuel poverty

A home is determined to be in fuel poverty when 10% or more of the income is used for energy expenditure. A number of indicators are needed to find fuel poor households – SAP ratings and efficiency levels are not an indication because the homeowner may be sufficiently wealthy for energy expenditure to not be an issue. Therefore surveys combined with a number of other social and demographic indicators are used to determine levels of fuel poverty.

Data from the UK government suggests that on average, 16% of homes are in fuel poverty in England with a standard deviation of around 5% at local authority level. Lincoln and North Kesteven both have average levels of 18% and so are only slightly above the national average. This is perhaps to be expected given that the average will be skewed by overall employment and wage levels which are in general higher in the south of England. West Lindsey has a level of around 23% and is therefore within 2 standard deviations of the average. It is therefore not performing significantly poorly, but is worse than the other two authorities. One reason for the increase in West Lindsey is that around 33% of homes have solid walls compared with 24% in North Kesteven. This may help explain the difference between the two rural authorities. Whilst Lincoln has the highest level of solid walls (34%), the access to lower cost fuels combined with more efficiency forms prevents fuel poverty being such a problem.

The map in Figure 18 shows the spatial distribution of fuel poverty across Central Lincolnshire. Whilst the distribution may appear relatively even, there are synergies between the levels of higher fuel poverty and the absence of a gas grid as shown earlier. This demonstrates that fuel poverty eradication does not only require energy efficiency to be addresses, but also the availability of alternative fuels and the costs of energy.

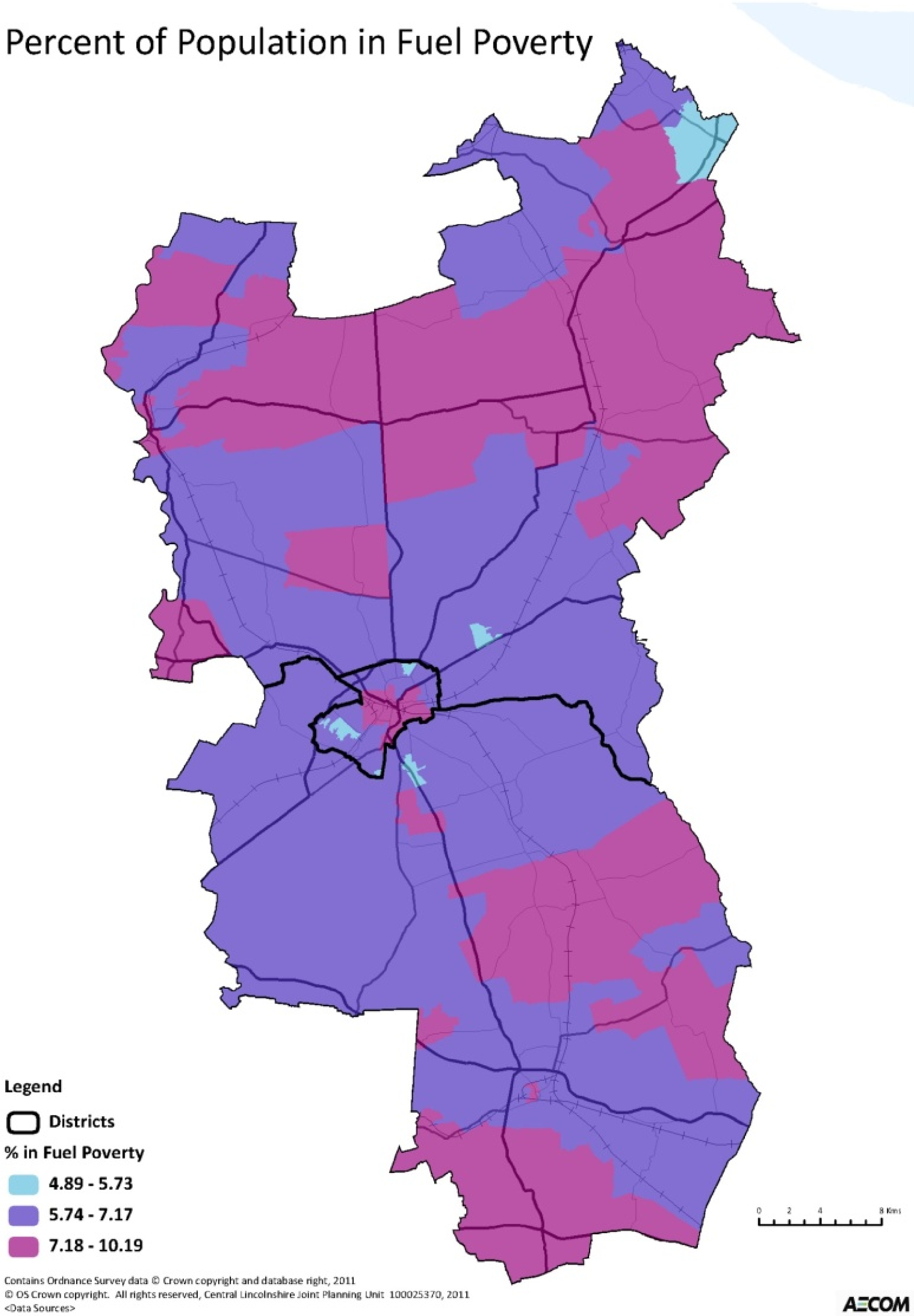

Figure 18: Fuel Poverty in Central Lincolnshire

3.3.2 Non-Residential Buildings

The energy demands of non-residential buildings in Central Lincolnshire are shown in the Table 9 below. Relative to other parts of the UK the non-residential contribution to energy demand is fairly high, particularly in Lincoln City. This is due to the industrial heritage and the high concentrations of energy intensive industries in each of the local authority areas.

Table 9: Annual Energy demand from non-residential buildings (DECC, 2006)

	Electricity		Gas	
	Energy, GWh	$KtCO_2$	Energy, GWh	$KtCO_2$
Lincoln City	325	137	382	79
West Lindsey	228	96	195	40
North Kesteven	283	119	219	45
Central Lincolnshire	836	353	796	164

Understanding Performance of Existing Non-Residential Buildings

The assessment of energy efficiency in the non-domestic sector is difficult due to the range of building forms, construction, and usage types. A large amount of advice is available from bodies such as the Carbon Trust on reducing building and process energy, but it is not simple to quantify the current UK levels, or the remaining potential for making energy efficiency improvements. Unlike the domestic sector where there are a number of surveys covering energy efficiency and a national and local level, there are no equivalent surveys for the non-domestic sector.

One way in which approximate energy efficiency levels can be examined is through the use of Energy Performance Certificates (required for all new buildings and those for sale or rent), but these are not available in database format and obtaining them requires visiting each building to obtain the unique reference number.

Display Energy Certificates are required for all public buildings and should be displayed in a position where they can be viewed publicly. They are calculated by assessing the actual energy consumption against a set of standard benchmarks of typical building types, with adjustments allowed for changes in occupancy and special uses. As with EPCs, access to the DEC database is limited and only information covering Government buildings is published. However a freedom of information request by the BBC in 2009 was used to obtain the entire dataset which existed at the time[9]. Whilst this is now 2 years old, it still provides a representative picture of the public building stock. The data shown in Figure 19 compares the ratings for Central Lincolnshire (ratings were filtered by the post towns of Lincoln, Sleaford, and Gainsborough) with the national average. At both scales the average rating is a D, but there is a slight skew towards the higher (better) ratings for Central Lincolnshire over the national trend.

[9] http://www.bbc.co.uk/blogs/opensecrets/2009/08/comparing_the_energy_efficiency_of_public_buildings.html

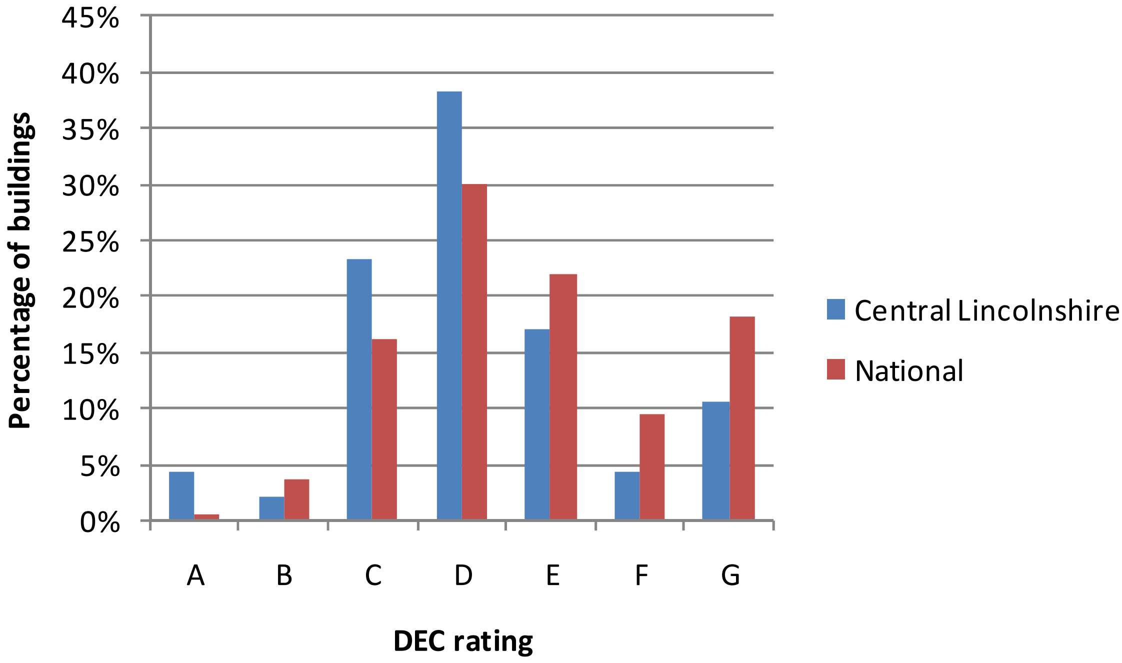

Figure 19: Comparison of Display Energy Certificate ratings for Central Lincolnshire and the national average.

The small number of data points for Central Lincolnshire (47) means that it is impossible to analyse the results in more detail or draw conclusions about the non-domestic stock as a whole. However the results do suggest that overall, the public sector buildings in Central Lincolnshire are no worse (and perhaps a little better) than the national average in terms of efficiency.

In the commercial sector, Lincolnshire County Council is providing support through the SUSTAIN Lincolnshire programme for businesses in the form of free advice on resource efficiency and the provision of training and materials, and supporting the development of new resource efficiency products and services in the local area.

Use of other fuels

The use of different fuel types used in Central Lincolnshire has been broken down in the following table. West Lindsey and North Kesteven show a relatively high use of other fuels such as oil and coal. These fuels have relatively high carbon emissions (per unit of energy), and hence the use of other fuels in Central Lincolnshire makes up a significant portion of the carbon profile from a relatively small number of users. The full existing carbon profile relating to all energy sources used in buildings in Central Lincolnshire is shown in Table 10 and Figure 20.

Table 10: **Other fuels consumption (DECC, 2006)**

Energy	Oil (GWh)		Coal (GWh)	
	Residential	Non-Residential	Residential	Non- Residential
Lincoln City	2	91	0	0
West Lindsey	112	95	9	3
North Kesteven	48	166	3	19
Central Lincolnshire	162	352	12	22
CO_2 emissions	Oil (ktonnes CO_2)		Coal (ktonnes CO_2)	
	Residential	Non- Residential	Residential	Non-Residential
Lincoln City	0.5	24.1	0.0	0.0
West Lindsey	29.7	25.2	2.6	0.9
North Kesteven	12.7	44.0	0.9	5.5
Central Lincolnshire	42.9	93.3	3.5	6.4

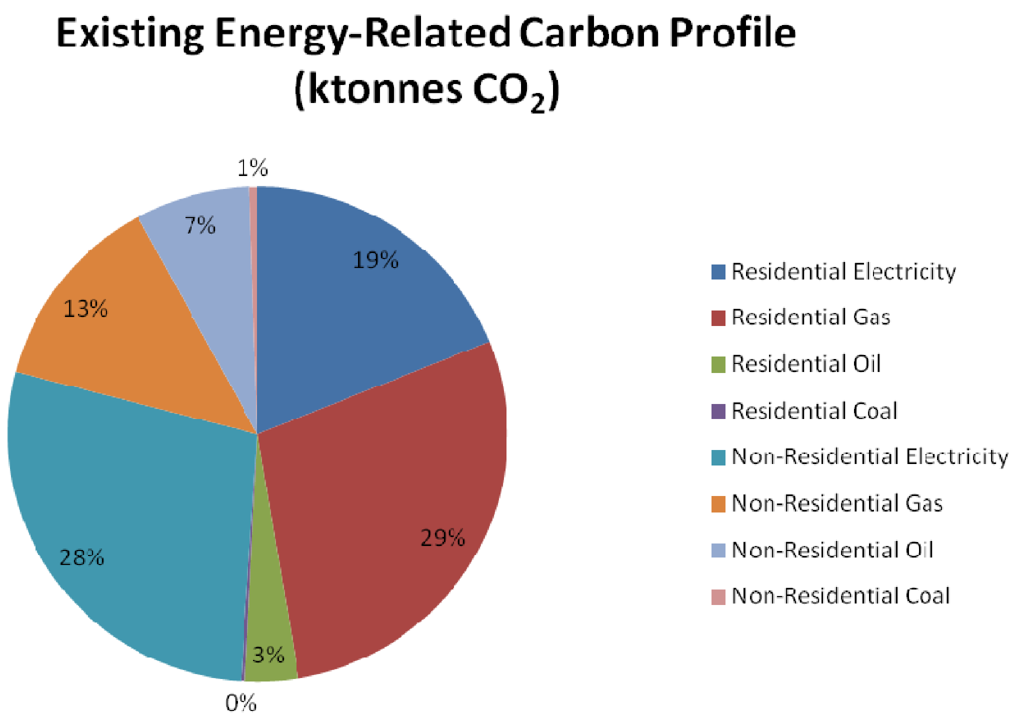

Figure 20: Relative carbon impact of fuel uses in Central Lincolnshire

3.4 FUTURE PERFORMANCE OF EXISTING BUILDINGS

Existing buildings' energy demand and efficiency measures, which will impact their cumulative carbon profile, are likely to change over time. An increased adoption rate of micro-generation technologies to supply homes and businesses with renewable energy, change in behaviour, and switching to fuels which emit fewer greenhouse gases will all reduce carbon emissions. This section considers the change in energy demand profile of existing buildings to 2026.

3.4.1 Residential

The current adoption of energy efficiency measures in existing housing stock is relatively low, with most measures taking a number of decades to reach saturation. Schemes such as the Energy Efficiency Commitment (EEC) and its successor, the Carbon Emissions Reduction Target (CERT), require utility companies to promote and facilitate energy efficiency improvements with the aim to increase adoption rates of renewables. The original CERT programme, which ran from 2008 to 2011, was recently extended to run until December 2012. CERT (2011-2012) is more ambitious than the previous programme, requiring greater carbon reduction from 185 Mega-tonnes carbon dioxide (Mt$CO_{2)}$ to 293 MtCO_2. At least two-thirds of the increase in the target must be achieved through professionally installed housing insulation. The expectation is for this measure to lead to energy supplier investment of approximately £5.5bn between 2008 and 2012.

Suppliers must focus 40% of their activity on a 'Priority Group' of vulnerable and low-income households, including those receiving certain income/disability benefits and pensioners over 70. By increasing the energy efficiency of UK households, CERT will not only help households from falling into fuel poverty but is also expected to help alleviate fuel poverty.

Funding to retrofit housing insulation is available for all Central Lincolnshire residents. The Home Energy Lincs Partnership (HELP) provides free loft and cavity wall insulation to all households in need, and subsidised installations for all other households. Similarly, the Warm Front Scheme, a partnership between the UK Government and Energy Savings Trust, provide grants worth up to £3,500. The grants can be used for all insulation types, and some other heating needs.

Estimates for energy efficiency in Central Lincolnshire have been based on a study of the likely penetration of measures by 2020, which are based on historic, current, and new uptake schemes[10]. These predictions have been done on a nation-wide scale and utilise expected uptake of a range of energy efficiency measures. Extrapolating these expected rates of energy efficiency increase from the 2006 energy demand baseline, as shown in Figure 21 and Figure 22 below, it can be seen that electricity demand is likely to increase slightly, as demand for more energy intensive appliances outweighs energy efficiency measures. Heat demand on the other hand is likely to decrease as energy efficiency measures are applied. The figures below demonstrate the expected change in electricity and heat consumption over time in line with 'business as usual' rates of improvement of existing buildings, as predicted by BRE.

[10] Delivering Cost Effective Carbon Saving Measures to Existing Homes. BRE for DEFRA. 2007.

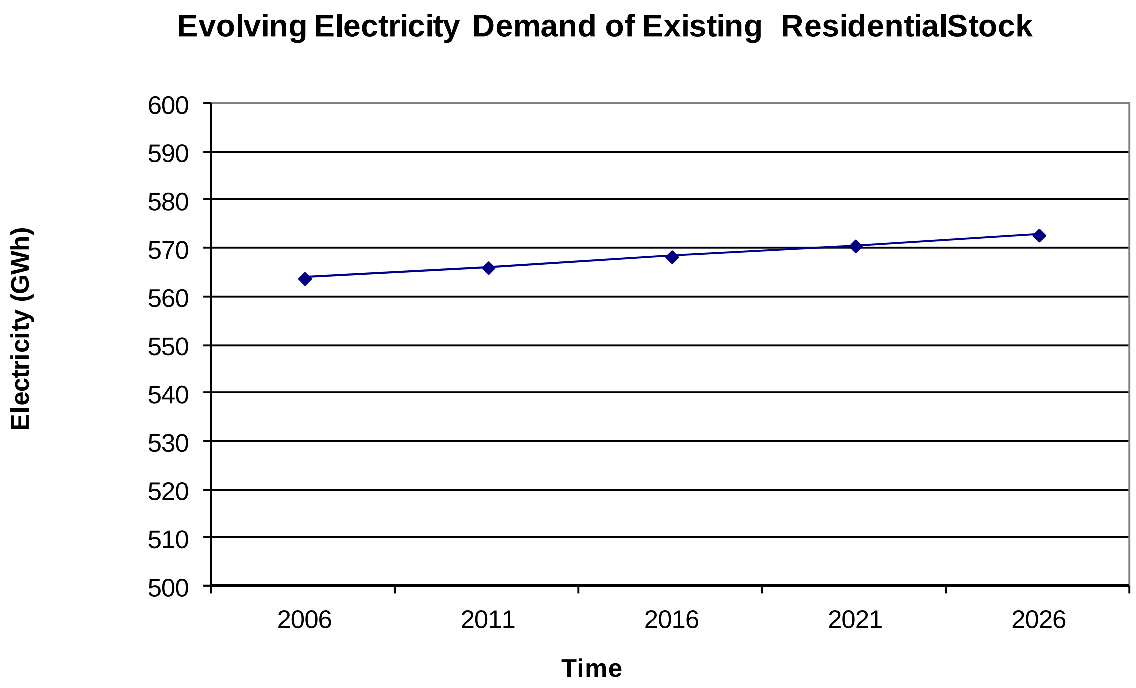

Figure 21: Expected changes in electricity demand from existing residential buildings over the core strategy period.

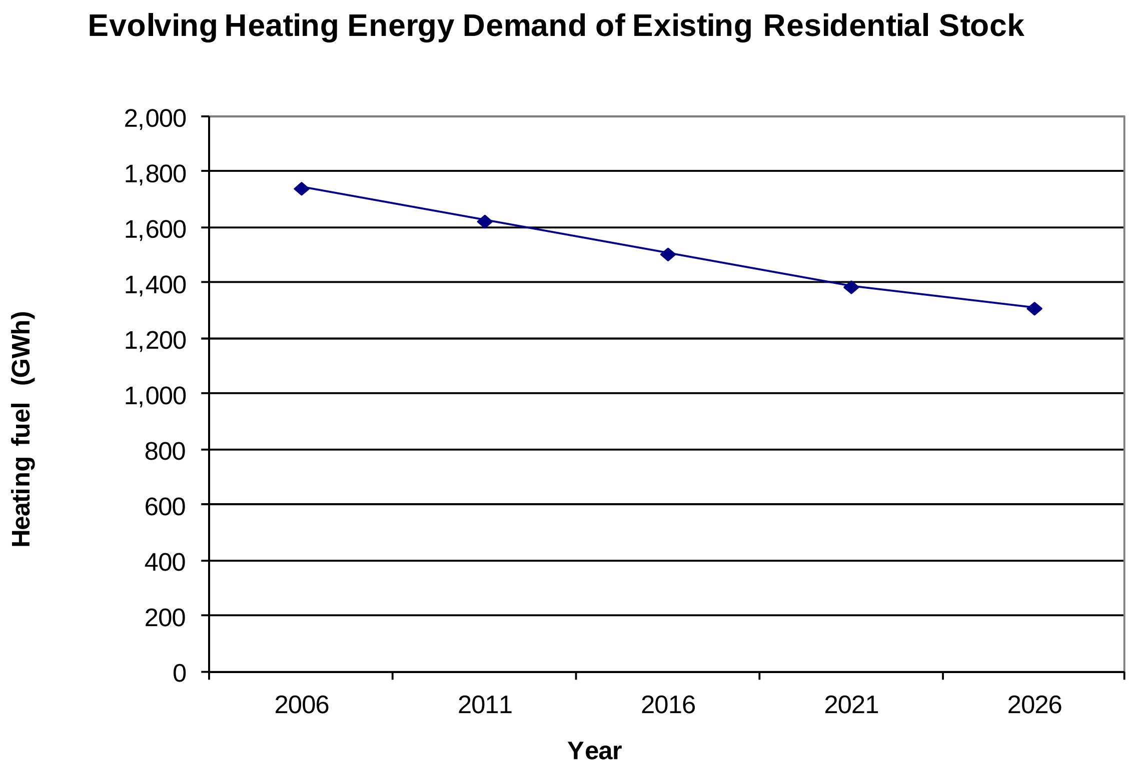

Figure 22: Expected changes in heating fuel demand from existing residential buildings over the core strategy period.

Rural properties also use a substantial amount of heating oil and coal. It is expected that over the Core Strategy period a proportion of these properties will switch their fuel source to either a gas or biomass heating source or to electricity. For the purposes of this study it is assumed that the use of coal is reduced by 5% every 5 years with immediate effect, while the switch away from heating oil will begin in 2021 decreasing at the same rate.

3.4.2 Non-residential

Based on Carbon Trust targets for non-residential buildings, this study has developed estimates for energy efficiency improvement expected through behavioural change, and through capital cost measures. The trend for commercial and industrial development is one of increased efficiency in both electricity and gas use as set out in Figure 23 and Figure 24 on the following page.

While the Carbon Trust has developed targets for energy reduction in non-residential buildings, the initiatives are less visible and less coordinated than those for residential buildings.

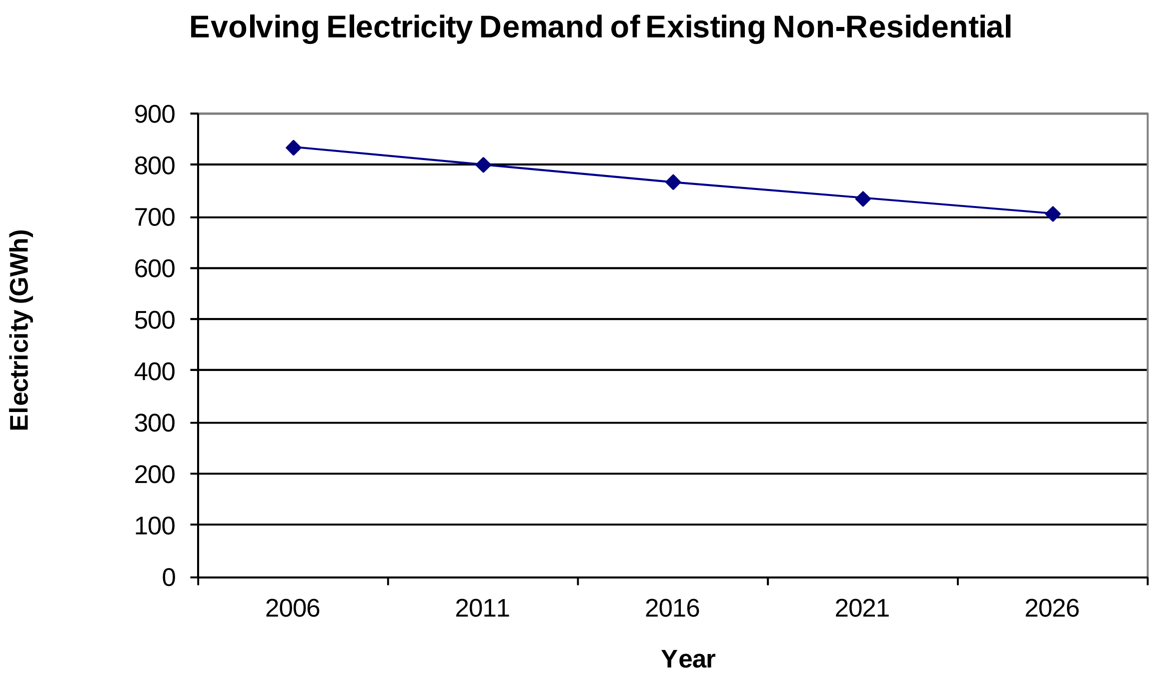

Figure 23: Predicted Change in Electricity Demand of Non-Residential Buildings

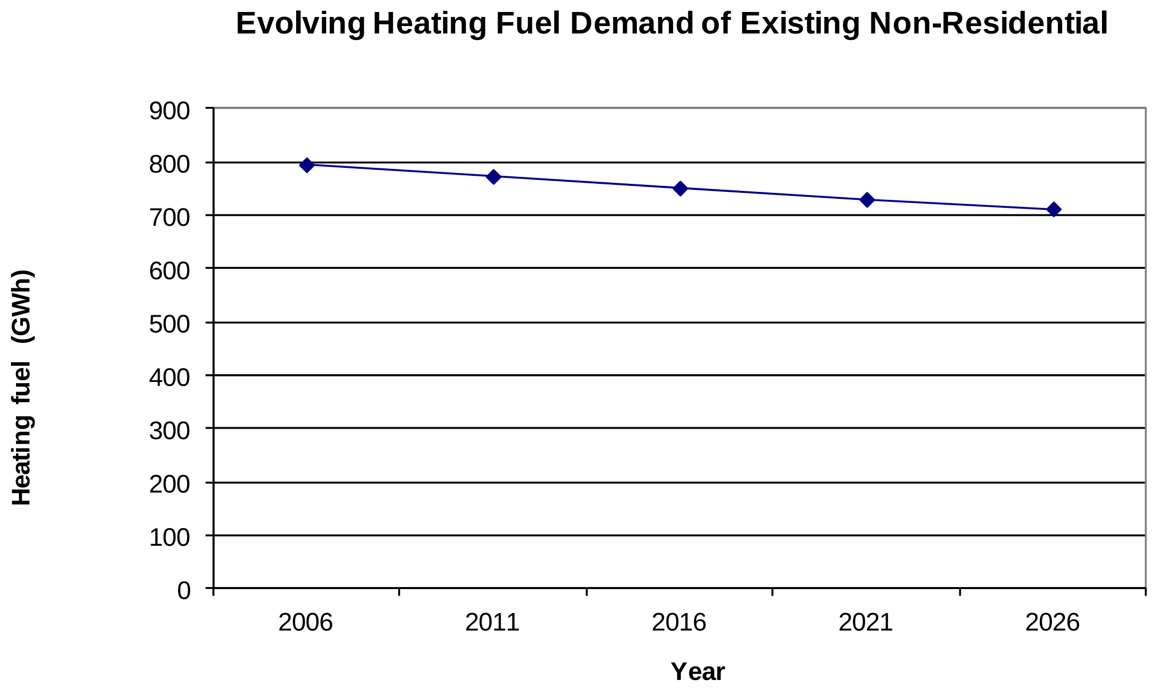

Figure 24: Predicted Change in Gas Demand of Non-Residential Buildings

3.5 ALL BUILDINGS SUMMARY

Figure 25 demonstrates the expected change in total energy demand of existing buildings over the study period (2006-2026), due to nationally driven energy efficiency measures in both residential and non-residential buildings.

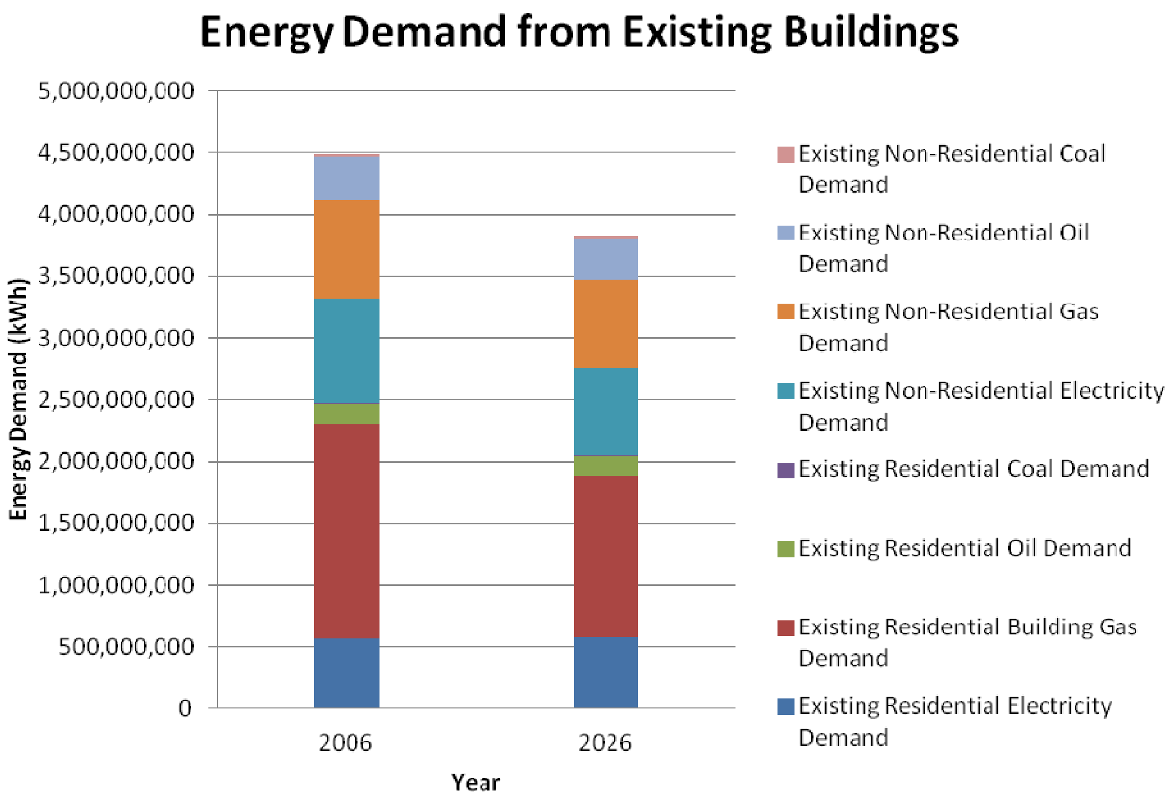

Figure 25: Expected change in electricity and gas demand over Core Strategy period

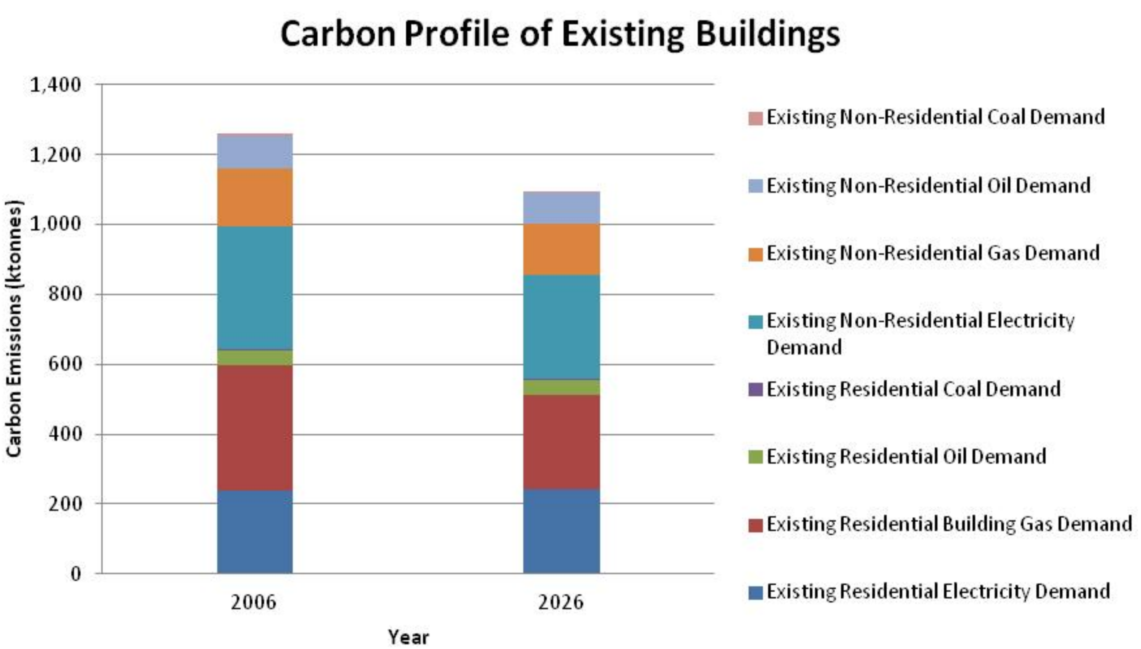

Figure 26: Expected change in CO_2 emissions over Core Strategy period

3.6 FUTURE GROWTH IN CENTRAL LINCOLNSHIRE

This section outlines expected growth in the Central Lincolnshire. Understanding the scale of expected development is crucial to understanding the probable changes in the energy profile.

3.6.1 Residential Growth

While Regional policy has been recently revoked, the East Midlands Regional Plan still indicates the relative potential for carbon reduction in the area and growth targets are currently being tested locally through the LDF process. The East Midlands Regional Plan (March 2009) set a housing target for Central Lincolnshire of 40,600 homes to be delivered between 2006 and 2026[11]. The Joint Planning Unit, in developing the Central Lincolnshire Core Strategy, is setting out options for where that growth could take place and how much growth each area could accommodate. A key document in this process is the Strategic Housing Land Availability Assessment (SHLAA), which is the main mechanism for identifying potential housing sites and assessing their deliverability. Growth testing suggested that 19,800 could be delivered in the Lincoln Principle Urban Area (PUA) and 25,170 in the Lincoln Policy Area (LPA) between 2006 and 2026 (see Figure 27). It should be noted that identified SHLAA sites do not guarantee development, but simply scopes development options.

[11] At the time of writing this report it is recognised that regional housing targets no longer exist. However, in the absence of any locally derived housing target and given that the housing target from the East Midlands Plan is consistent with housing delivery rates in Central Lincolnshire over recent years it seems prudent to use the 4,400 figure, between 2006 and 2026, for the purposes of this study.

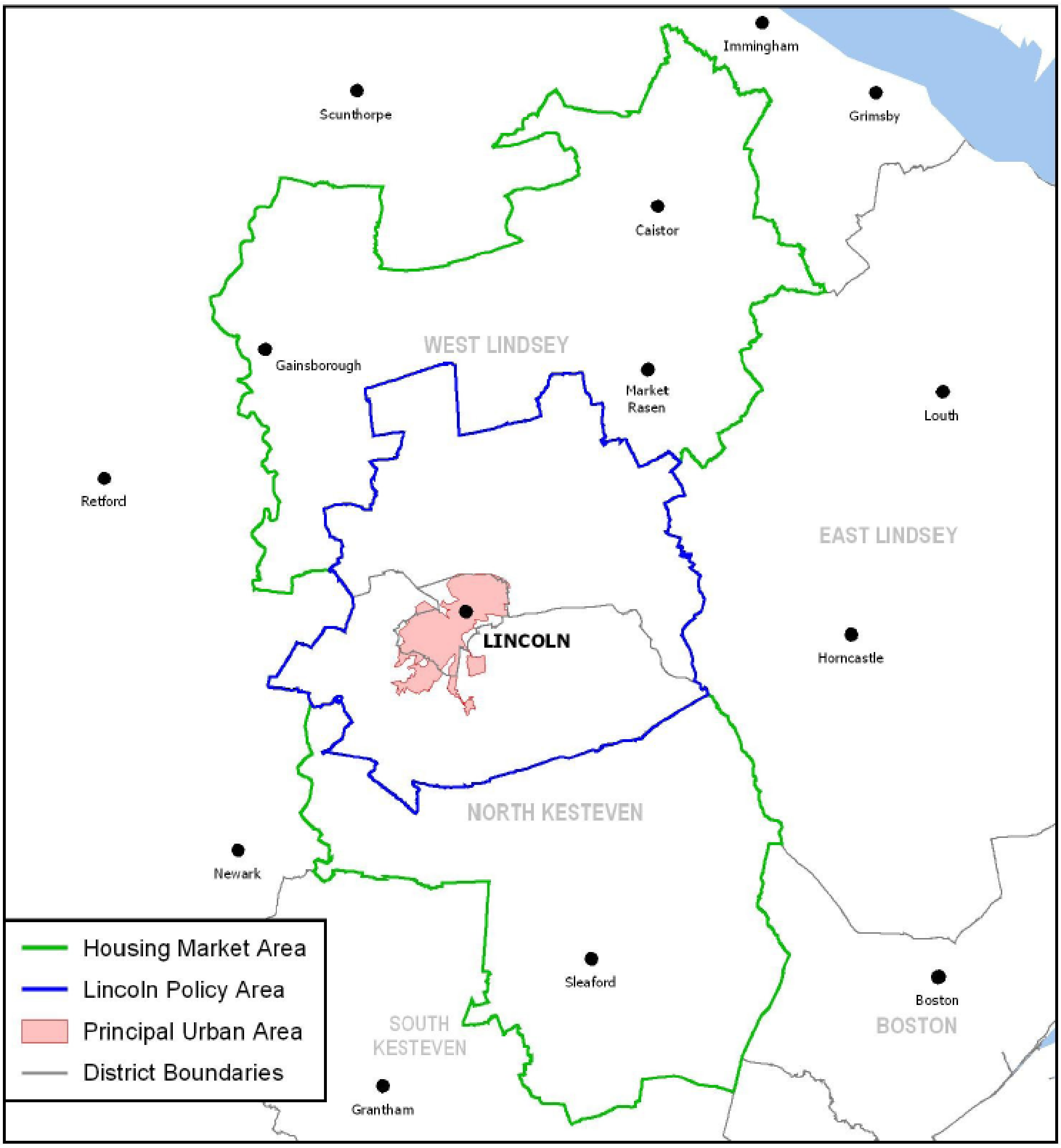

Figure 27: Central Lincolnshire Housing Market Boundaries

For the purpose of this study, it is assumed that the RSS targets are met, and 40,600 homes are delivered over the Core Strategy period. For the purposes of this study, linear growth has been assumed over four 5 year periods from 2006 to 2026. Growth has been roughly proportioned between the three authorities, with 50% of growth in Lincoln City, and 25% in both West Lindsey and North Kesteven.

3.6.2 Non-Residential Growth

The amount of non-residential growth that will accompany housing growth is less certain, so broad assumptions have been made in this study. The Central Lincolnshire authorities completed an Employment Land Review (ELR) for their housing market area in September 2010, and the results will underpin and inform the LDF for the planning period to 2026. The report's findings suggest that:

- Public sector economic development will focus on regenerating the Lincoln PUA, with a second tier of development in the Sleaford and Gainsborough.

- Growth in rural areas will be limited
- Demand for industrial sites – storage, distribution, and assembly of goods – will be required.
- Demand for office space will be limited to the urban areas – Lincoln, Gainsborough, Sleaford
- The HMA will require 190 hectares of employment land to 2026.

This review suggested a shortfall of approximately 100,000m^2 of employment space. For the purposes of this study, delivery of 30,000m^2 of new employment space per 5 year period has been assumed. Central Lincolnshire has yet to prepare its Infrastructure Delivery Plan (IDP). Hence, it has not been possible to establish whether or not additional schools, community or health care facilities will need to be provided (beyond what has already got planning permission). For the purposes of this study, we have assumed the only non-residential growth will be of an employment nature.

3.7 EXPECTED ENERGY DEMAND FROM NEW DEVELOPMENT

New development will increase energy demands in Central Lincolnshire. Part L of the Building Regulations is expected to require that buildings meet increasing minimum energy efficiency standards. These standards have been applied to the assumed number and mix of future housing set out previously in this chapter and modelled using AECOM residential profiles prepared for DCLG, and Chartered Institution of Building Services Engineers (CIBSE) industry benchmarks for non-residential development. In addition, increased energy performance in line with the proposed changes to Building Regulations Part L requirements, which changed in October 2010 and are expected to continue progressing in 2013 and 2016, have been taken into consideration, along with the expected changes to regulations affecting non-residential buildings leading up to zero carbon in 2019. The expected additional energy demand is set out in Table 11 and Table 12 below.

3.7.1 Residential Development

The density of housing and the mix of house types expected in new development has a considerable effect on energy demand. The housetype mix assumptions are based on the Strategic Housing Market Assessment (SHMA) for Central Lincolnshire, and equates to a density of around 42 dwellings per hectare.

Table 11: Modelled House type Mix

Housetype	Detached	Semi-Detached	Terraced	Flat
Assumed Mix	36%	31%	14%	19%

Changes in density and the mix of housetypes will affect the energy demands of the area. Higher density areas with greater proportions of flats and terraced housing will naturally have a lower energy demand due to inherent insulation provision. Land use planning and development density can affect CO_2 emissions, and hence even higher densities should be encouraged where suitable. Where lower density sites are being considered, the inherent increase in carbon emissions should be considered in options testing by the Central Lincolnshire authorities.

Table 12: Cumulative energy demand from new residential development (GWh)

	2011	2016	2021	2026
Electricity Demand	37	75	117	159
Gas Demand	67	124	166	208

3.7.2 Non-Residential Development

CIBSE TM46 benchmarks were used to model energy demand of future non-residential buildings, increased energy efficiency measures mirroring expected changes to building regulations for non-residential buildings. This is illustrated in Table 13 below.

Table 13: Cumulative energy demand from new non-residential development (GWh)

	2011	2016	2021	2026
Electricity Demand	2	4	5	7
Gas Demand	9	17	23	25

The figure below demonstrates the effect of new development on the expected energy profile. It demonstrates that while new development will make up a significant proportion of the energy demand profile, it is still far outweighed by energy demand from existing development.

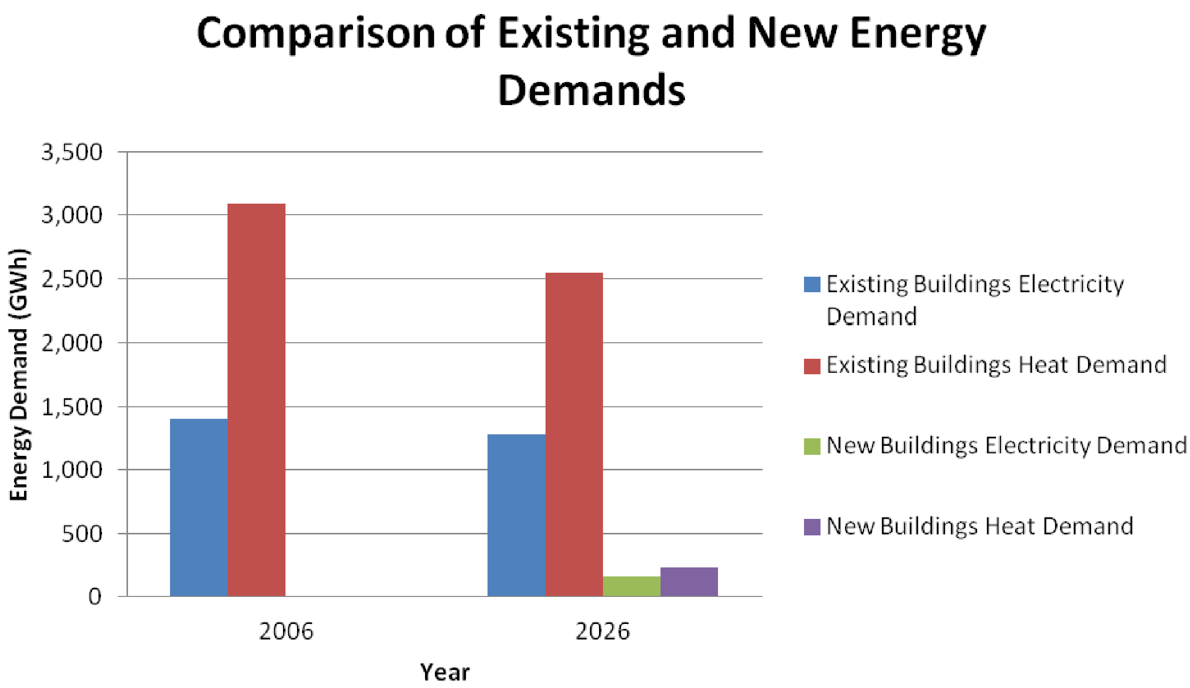

Figure 28: Comparison of energy demand from existing and new buildings

3.8 TOTAL ENERGY DEMAND PROFILE

The tables below summarise the combined energy demand profile of Central Lincolnshire, along with the individual authorities over the Core Strategy period.

Table 14: Expected Cumulative Energy Demand in Central Lincolnshire over time (GWh)

	2006	2011	2016	2021	2026
Existing Residential Electricity Demand	*564*	*567*	*569*	*572*	*575*
Existing Residential Building Gas Demand	1,743	1,626	1,508	1,390	1,314
Existing Residential Oil Demand	162	162	162	162	154
Existing Residential Coal Demand	13	12	12	11	10
New Residential Electricity Demand	*0*	*37*	*75*	*117*	*159*
New Residential Building Gas Demand	0	67	124	166	208
Existing Non-Residential Electricity Demand	*835*	*802*	*769*	*736*	*707*
Existing Non-Residential Gas Demand	796	774	752	731	713
Existing Non-Residential Oil Demand	352	352	352	352	335
Existing Non-Residential Coal Demand	22	21	20	19	18
New Non-Residential Electricity Demand	*0*	*2*	*4*	*5*	*7*
New Non-Residential Gas Demand	0	9	17	23	25
Total Electricity Demand	*1,399*	*1,407*	*1,416*	*1,430*	*1,448*
Total Heat Demand	3,088	3,022	2,946	2,854	2,777

Table 15: Expected Cumulative Energy Demand in West Lindsey (GWh)

	2006	**2011**	**2016**	**2021**	**2026**
Existing Residential Electricity Demand	182	183	183	184	185
Existing Residential Building Gas Demand	528	493	457	421	398
Existing Residential Oil Demand	112	112	112	112	106
Existing Residential Coal Demand	9	9	8	8	8
New Residential Electricity Demand	0	9	19	29	40
New Residential Building Gas Demand	0	17	31	42	52
Existing Non-Residential Electricity Demand	228	219	209	201	193
Existing Non-Residential Gas Demand	195	189	184	179	174
Existing Non-Residential Oil Demand	95	95	95	95	91
Existing Non-Residential Coal Demand	3	3	3	3	3
New Non-Residential Electricity Demand	0	0	1	1	1
New Non-Residential Gas Demand	0	2	3	4	4
Total Electricity Demand	*410*	*411*	*412*	*415*	*419*
Total Heat Demand	944	921	894	864	836

Table 16: Expected Cumulative Energy Demand in Lincoln City (GWh)

	2006	2011	2016	2021	2026
Existing Residential Electricity Demand	166	166	167	168	168
Existing Residential Building Gas Demand	619	577	535	493	466
Existing Residential Oil Demand	2	2	2	2	2
Existing Residential Coal Demand	0	0	0	0	0
New Residential Electricity Demand	0	18	37	58	79
New Residential Building Gas Demand	0	33	62	83	104
Existing Non-Residential Electricity Demand	325	312	299	286	275
Existing Non-Residential Gas Demand	382	372	361	351	342
Existing Non-Residential Oil Demand	91	91	91	91	86
Existing Non-Residential Coal Demand	0	0	0	0	0
New Non-Residential Electricity Demand	0	1	2	4	5
New Non-Residential Gas Demand	0	6	11	15	17
Total Electricity Demand	491	498	505	516	527
Total Heat Demand	1,094	1,081	1,062	1,035	1,017

Table 17: Expected Cumulative Energy Demand in North Kesteven (GWh)

	2006	2011	2016	2021	2026
Existing Residential Electricity Demand	216	218	219	220	221
Existing Residential Building Gas Demand	596	556	516	476	450
Existing Residential Oil Demand	48	48	48	48	45
Existing Residential Coal Demand	3	3	3	3	3
New Residential Electricity Demand	0	9	19	29	40
New Residential Building Gas Demand	0	17	31	42	52
Existing Non-Residential Electricity Demand	283	272	260	249	239
Existing Non-Residential Gas Demand	219	213	207	201	196
Existing Non-Residential Oil Demand	166	166	166	166	158
Existing Non-Residential Coal Demand	19	18	17	16	15
New Non-Residential Electricity Demand	0	0	1	1	1
New Non-Residential Gas Demand	0	2	3	4	4
Total Electricity Demand	499	499	499	500	502
Total Heat Demand	1,051	1,022	991	955	924

3.9 KEY CONSIDERATIONS EMERGING FROM THIS CHAPTER

The sections above have considered the energy profile of Central Lincolnshire, both now and in the future. Key considerations emerging from this chapter are:

- The Council plays a key role in increasing energy efficiency of existing buildings. Existing buildings make up the bulk of the future energy demand; therefore retrofitting them should be a priority. There are a number of initiatives, particularly around home insulation, available at both the national and county level.
- Energy demand from rural homes off the gas grid which is currently met by heating oil and coal has a significant impact on the carbon profile of Central Lincolnshire. Efforts should be made to switch these users to lower carbon fuels.
- New development will increase the energy demand in the area, but will have a relatively low affect on carbon emissions due to increasing requirements for energy efficiency delivered through Building Regulations.
- The electricity and heat demand profiles produced in this section can be directly used within policy to set targets for delivery of a proportion of energy demand through renewables and to measure performance in comparison to national targets.

4 Existing Renewable Energy Audit

This chapter examines the current levels of low and zero carbon generation in Central Lincolnshire as well as relevant activities that have, or are taking place.

4.1 INTRODUCTION TO THIS CHAPTER

With the current and expected future CO_2 emissions in Central Lincolnshire understood, it is also important to understand the current level of delivery of renewable and low carbon energy. This chapter analyses how much renewable and low carbon energy has already been installed in the HMA relative to the surrounding districts and boroughs and provides some insight into what installations are expected to be delivered in the short term and potential delivery barriers that might exist in the long term.

This chapter also considers the capacity of energy network infrastructure in Central Lincolnshire. An understanding of energy networks is important to identify infrastructural barriers to the deployment of large renewable energy generation that requires connection to the electricity grid, but also to identify areas where decentralised energy systems could be beneficial to provide energy security.

4.2 AUDIT METHODOLOGY

Without one comprehensive and up-to-date database for renewable energy installations in the UK, developing one for Central Lincolnshire required drawing on a number of resources. The databases consulted include:

- Renewable Energy Statistics Database for the UK (RESTATS)
- Department of Energy and Climate Change (DECC)
- East Midlands Regional Assembly (EMRA)
- RenewableUK (Formerly BWEA)
- International Small Hydro Atlas
- British Hydro Power Association
- Natural England
- Non-fossil Purchasing Agency (NPFA)
- Best Foot Forward
- British Bioenergy Map
- Central Networks (the local distribution network operator, DNO)

The combination of these databases has provided a robust baseline of renewable energy projects in operation, as well as in planning in Central Lincolnshire. The level of installed capacity is however constantly changing and with all of the datasets being out of date to some extent, it is not possible to obtain a truly accurate figure of installed capacity.

It should be noted that because it is difficult to determine an exact amount of energy produced from micro-generation installations, an estimate has been used. As the majority of micro-renewables do not require planning permission, records of their installations are imprecise. While uptake has been modest historically, it has substantially increased since April 2010, when the FIT incentives were introduced. Feed-in Tariffs have particularly encouraged solar PV technology, which has resulted in a large increase in these installations, and the FIT database can be used to determine the number of installations (of electricity producing micro renewables) by taking the regional number of installations, and breaking down to Local Authority level by population split. To estimate the number installed before the introduction of FITs, a similar approach based on population was used to break down the estimated 100,000 national installations to local authority level. [12]

4.3 RENEWABLE ENERGY INSTALLED CAPACITY IN CENTRAL LINCOLNSHIRE

Central Lincolnshire currently generates around 40GWh of renewable energy per year, roughly equivalent to 0.2% of total annual energy demand[13]. With 83% of Central Lincolnshire's renewable energy generation, North Kesteven contributes substantially more than either West Lindsey (16%) or Lincoln (1%). The majority of this generation comes from the two landfill gas plants in North Kesteven, which are responsible for nearly 2/3 of Central Lincolnshire's renewable energy installed capacity. Contributing more than 6GWh of energy generation, biomass is the next largest renewable resource. North Kesteven has a handful of biomass schemes, while West Lindsey has one in the village of South Carlton. The anaerobic digestion plant at the Branston Potato factory is the only such facility in the HMA, while the solar farm in Stow (West Lindsey) is the area's first solar farm.

Table 18: Summary of renewable energy capacity (kW) installed or in the delivery process in Central Lincolnshire

Technology	Applications Submitted	Applications Approved	In Operation	Total
Anaerobic Digestion	-	-	300	
Wind	57,900	-	-	57,900
Biomass heat / power /CHP	-	40,280	500	40,780
Hydro	-	-	-	-
Energy from Waste	-	11,000	-	11,000
Landfill gas	-	-	5,075	5,075
Solar	2,300	-	1,000	3,300
Microgen*	NA	NA	2,089	2,089
Total	**60,200**	**51,280**	**8,664**	**120,144**

Gas fired Combined Heat and Power (CHP) is not included in the audit of renewable installations presented in Table 18. Whilst gas CHP plant is a viable low carbon, energy efficient alternative to conventional energy production, it still uses a non-renewable resource as its input and therefore cannot be included as a renewable technology. However, Central Lincolnshire does currently produce 4.3GWh of energy using gas CHP plants, representing approximately 10% of all low carbon energy produced in the Central Lincolnshire region.

[12] Environmental Change Institute. Oxford University. Available from: http://www.eci.ox.ac.uk/research/energy/downloads/bmt-evidence-micro-generation.pdf

[13] It is important to understand the difference between capacity and generating potential. Megawatts (MW) and gigawatts (GW) are units of power or capacity , which measure the output from the systems. Megawatt-hours (MWh) and gigawatt-hours (GWh) describe the amount of energy generated (usually over an annual period) which takes into account the amount of time the systems are operating a year (the load factor). The two are not directly comparable, and different technologies operate with different load factors. .

Renewable Energy Installed Capacity in Surrounding Authorities

In order to gain an understanding of how well Central Lincolnshire is performing, it is important to compare the delivery of renewable energy in surrounding Districts. Of the surrounding Districts, North Lincolnshire is the best performing, contributing 275 GWh of energy to the 710 GWh produced by all surrounding Districts. North Lincolnshire's renewable energy mainly comes from landfill gas (116 GWh), energy from waste plants (110 GWh) and onshore wind (42 GWh). Boston Borough contributes the second most – the majority of their energy is from large biomass installations (51 GWh) and onshore wind (68 GWh). Among the top renewable energy producing Districts surrounding Central Lincolnshire, it is clear that none of them rely on one source, but rather harness their local renewable strengths to produce low carbon energy. However, of the five most productive Districts, four of them rely on wind to make up a substantial portion of their installed base of renewable energy. The following map shows the breakdown of renewable energy across Central Lincolnshire and the surrounding districts.

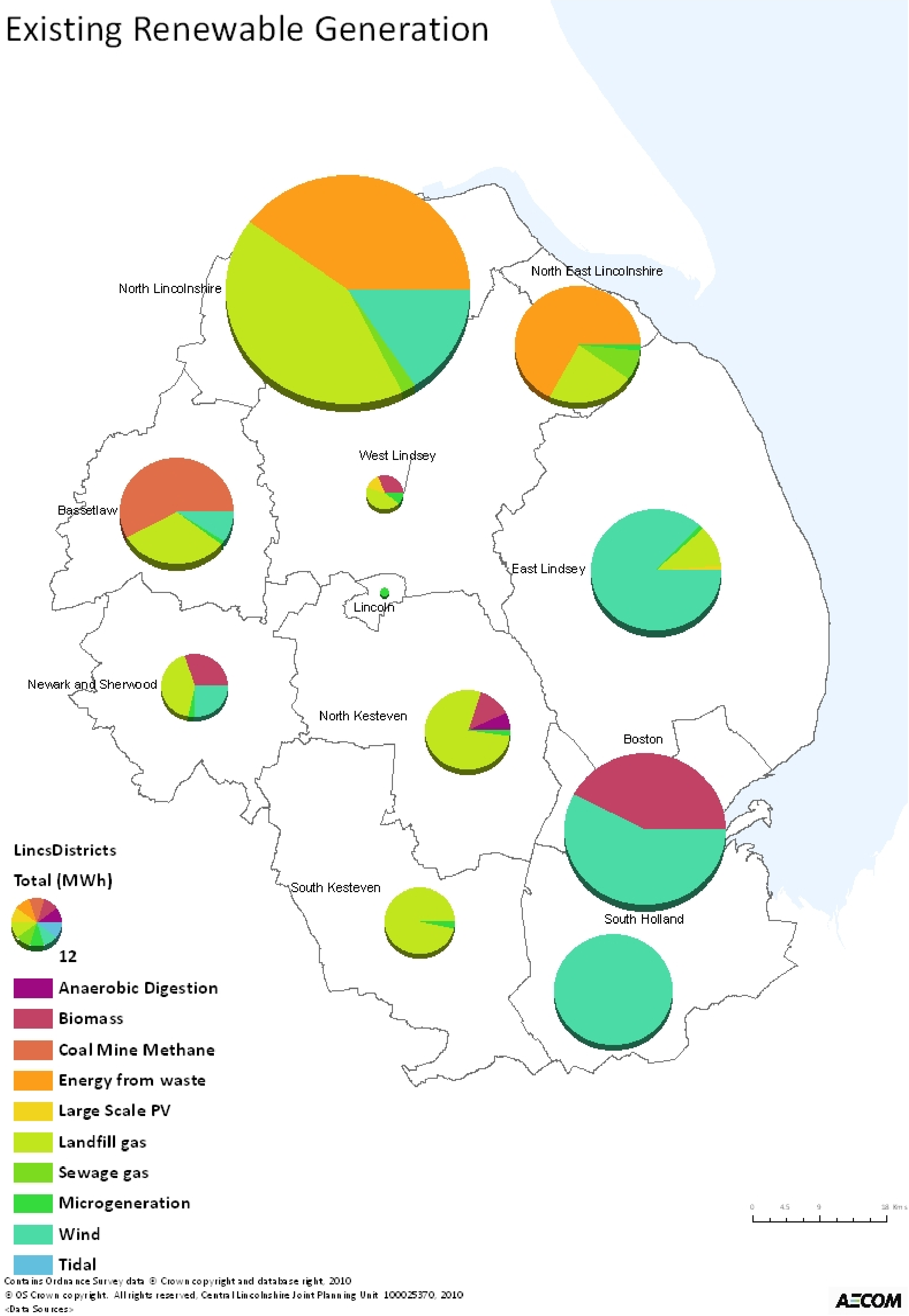

Figure 29: Breakdown of Renewable Energy in Central Lincolnshire and Surrounding Area

When compared with surrounding Districts, all of the Central Lincolnshire authority areas perform below average and are the worst performing authorities. The upside, however, is that there are a number of renewable installations that are currently in the planning process. In fact, if the two wind farms currently proposed at Heckington Fen and Lodge Farm, as well as the biomass plant in Sleaford are installed, the amount of installed renewable energy will increase by 467 GWh. The Whisby Landfill gas project and North Hykeham Energy from Waste plant represents an additional 98 GWh generated from renewable resources. In all, these projects would account for 565 GWh, bringing the total amount generated in the HMA to over 600 GWh, increasing the amount of renewable energy to around 14% of the total demand (based on 2011 data in the Table 14).

Table 19: Renewable energy delivered in Central Lincolnshire and surrounding districts

GWh	Central Lincolnshire	Lincoln	North Kesteven	West Lindsey	Bassetlaw	Boston	East Lindsey	Newark and Sherwood	North East Lincolnshire	North Lincolnshire	South Holland	South Kesteven
Anaerobic Digestion	2.4	-	2.4	-	-	-	-	-	-	-	-	-
Biomass	6.1	-	4.2	2.0	-	51.2	-	6.3	-	0.5	0.4	-
Coal Mine Methane	-	-	-	-	34.1	-	-	-	-	-	-	-
Energy from waste	-	-	-	-	-	-	-	-	47.3	110.4	-	-
Landfill gas	28.7	-	25.9	2.7	19.3	-	8.2	8.3	16.7	115.8	-	21.8
Sewage gas	-	-	-	-	-	-	-	-	5.7	4.9	-	-
PV	0.9	-	-	0.9	-	-	0.9	-	-	-	-	-
Tidal	-	-	-	-	-	-	-	-	0.7	-	-	-
Wind	-	-	-	-	5.3	68.3	67.8	5.3	-	42.0	63.1	-
Micro-generation	1.8	0.4	0.7	0.7	0.7	0.4	0.9	0.7	1.0	1.0	0.5	0.8
Total (MWh)	**39.9**	**0.4**	**33.2**	**6.3**	**59.3**	**119.9**	**77.8**	**20.6**	**71.4**	**274.6**	**64.0**	**22.6**

4.4 ENERGY NETWORKS REVIEW

As part of this study a high level review of transmission and network constraints was undertaken. This review gave an overview of the area, but focused on areas where strategic growth might be concentrated, such as Lincoln, Gainsborough, Sleaford, and Market Rasen. The purpose of the review was undertaken to gain a better understanding of the capacity and upgrade requirements for Central Lincolnshire. This overview is intended to provide snapshot of the gas and electricity infrastructure in the area – a more detailed study would be required on a site by site basis before any decisions regarding the deployment of energy are made.

Electricity Transmission Infrastructure

Much of the electricity network in Central Lincolnshire will likely require upgrading before any additional development can be supported. In Lincoln, increasing the capacity to accommodate development would require improvements to the grid, with costs ranging between £8million and £12.5million. The cost is less to the north of Lincoln, but still would require a substation or substantial upgrades. Substantial upgrades to the grid are also required around Sleaford. The area surrounding Market Rasen will also require some upgrades to accommodate new development. Gainsborough is the only area where substantial growth could be accommodated without the need to increase capacity.

These infrastructural constraints concerning electricity infrastructure could also be a barrier to deployment of large renewable energy schemes such as wind energy and solar farms in some areas, meaning that additional infrastructure will add to their cost and may affect economic feasibility.

Gas Supply Infrastructure

According to Fulcrum, an independent gas transporter (IGT) in the area, there appears to be capacity for gas connection for much of the Central Lincolnshire area. However, some challenges might be faced in supplying the Market Rasen area, and some parts of Gainsborough, and Sleaford. These challenges are not thought to be insurmountable, but may result in increased expense. In development areas that are not currently serviced by the gas grid, there may be additional impetus to deliver alternative fuels such as biomass to provide heating.

4.5 KEY CONCLUSIONS FROM THIS CHAPTER

The key considerations from the renewable energy audit in Central Lincolnshire are:

- All three Central Lincolnshire districts are currently ranked in the bottom half of surrounding districts for delivering renewable energy.
- Installed capacity of renewables in Central Lincolnshire substantially improves if all renewable energy projects either approved for planning, or awaiting construction in Central Lincolnshire get built.
- From the high level review, which focused on areas where growth is likely to be concentrated, the gas grid will require upgrading in Market Rasen, Gainsborough, and Sleaford to accommodate development. Alternative heating sources such as biomass may be more deliverable in these areas as well as in rural areas that do not have access to the gas grid.
- Electricity infrastructure upgrades are required locally around most of the main urban areas to accommodate growth and development in Central Lincolnshire with the exception of Gainsborough. Similar electricity infrastructure constraints may be a barrier to delivery of large wind or solar schemes across the area.

5 Review of Technical Potential for Renewable Energy

Examines the potential for low and zero carbon energy sources in Central Lincolnshire. The EM Low Carbon Energy Study conducted for East Midlands Councils in 2011 is used for technical potential and supplemented with local information to provide a more accurate picture of how much of each resource can theoretically be delivered.

5.1 INTRODUCTION

This chapter seeks to clarify the 'technical potential' for renewable energy in Central Lincolnshire. The 'technical potential' is a theoretical estimation of the maximum amount of renewable energy that could be delivered in the area based on the amount of resource and space available. The technical potential is a useful starting point to compare the scale of potential of various resources.

The starting point for this analysis is a review of the EM Low Carbon Energy Study completed in 2011 following the regional methodology set out by DECC. This study reviews the results of that study and reflects upon their viability within the Central Lincolnshire context.

5.1.1 Literature review

This study aims to build on the work of existing capacity studies, making sure the information is correct and up to date, but most importantly, providing the evidence base on which future strategy can be developed for the long term energy vision of Central Lincolnshire. Where possible, information from existing studies is built upon, rather than repeated, allowing an emphasis on delivery and policy options.

The most relevant previous piece of work is the recently completed EM Low Carbon Energy Study conducted using the DECC Methodology [14] [15]. In addition to this, the following reports are also considered:

- Reviewing Renewable Energy and Energy Efficiency Targets for the East Midlands[16].
- Lincoln Energy Study [17]

5.1.2 EM Low Carbon Energy Study

The recently completed review of renewable and low carbon energy potential across the East Midlands, *Low Carbon Energy Opportunities and Heat Mapping for Local Planning Areas Across the East Midlands,* completed for the East Midlands Councils makes use of the DECC regional assessment methodology. The DECC methodology sets out a number of steps for a resource assessment and provides detailed assumptions and calculations for some of these steps along with recommended data sources. The methodology is based around a sequential constraint methodology, where constraints are progressively applied to reduce the natural resource (i.e. the maximum theoretical potential) to what is practically achievable. The stages in the methodology are numbered from 1 to 7, with stages 1 to 4 representing physical, technical, and regulatory constraints and stages 5 onwards representing delivery constraints such as supply chains and the economies of provision and operation. Figure 30 shows the various the various stages.

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[14] *Low Carbon Energy Opportunities and Heat Mapping for Local Planning Areas Across the East Midlands*, for East Midlands Councils. 2011.
[15] *Renewable and Low Carbon Energy Capacity Methodology for the English Regions,* for DECC. 2010.
[16] *Reviewing Renewable Energy and Energy Efficiency Targets for the East Midlands,* for East Midlands Regional Assembly. 2009
[17] Lincoln Energy Study. For City of Lincoln Council. 2007.

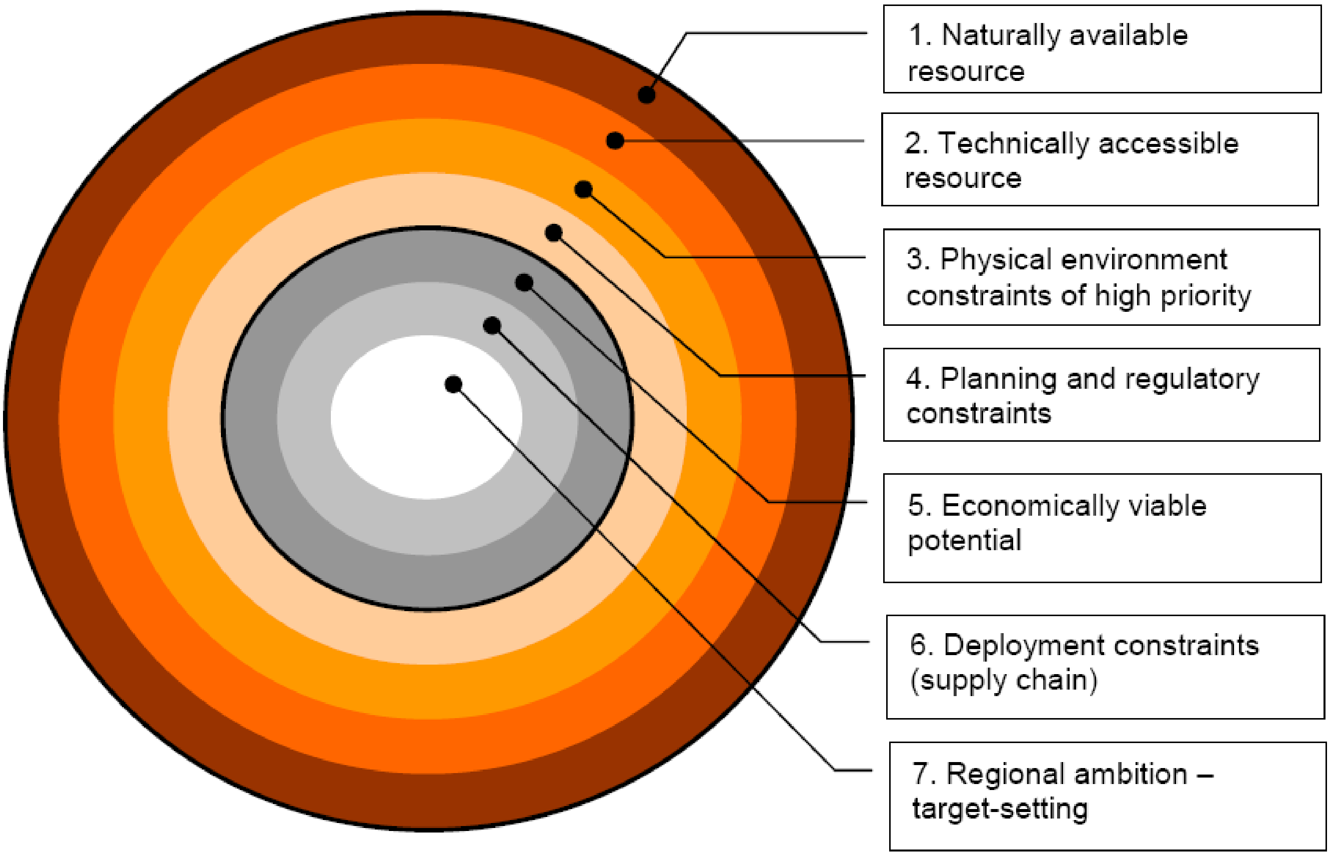


Figure 30: Stages for developing a comprehensive evidence base for renewable energy potential (Source: Renewable and Low-Carbon Energy Capacity Methodology for the English Regions, SQW Energy, January 2010)

The DECC methodology only provides method statements for stages 1 to 4, and each study is required to set out assumptions for stage 5 onwards. The DECC methodology is designed to assess potential resource capacity (the energy which may be obtained, e.g. kW) but it does not specify how to calculate potential energy resource (the energy that can be obtained in a year, e.g. kWh). Capacity is not necessarily related to the resultant energy output, and it is important that energy output is considered to allow the contribution from renewable and low carbon energy resources to be compared with the baseline demands.

The EM Low Carbon Energy Study is the most recent work covering the Central Lincolnshire area. The consultants who conducted the work followed the DECC methodology closely and therefore whilst it represents a consistent view across the East Midlands as a whole, and the three local authorities of Central Lincolnshire, the results include the effect of many potential errors and inadequacies of the DECC methodology, particularly when used at a local level.

The results from the report are split in to two main sections: heat mapping, allowing the assessment and identification of potential community heating schemes, and technology and resource potential, including tables (at local authority level) and detailed mapping. The following sections provide a summary of this work. All tables and maps extracted from the EM Low Carbon Energy Study are presented in Appendix A. As alluded to earlier, with the EM Low Carbon Energy Study serving as the evidence base for technical potential, this report will focus on stages 5 to 7 of the DECC methodology. This report will, however, provide a second opinion of technical potential where we believe there is opportunity to improve upon the EM Low Carbon Energy Study's calculations.

The technical resource potential identified in the study for the Central Lincolnshire authority areas is illustrated in

Table 20 below. Table A1 in Appendix A provides a full breakdown by resource type.

Table 20: Technical resource potential by 2020 and 2030

	Heat Capacity (MW)	Electricity Capacity (MW)
2020		
Lincoln	213	54
North Kesteven	288	1,997
West Lindsey	227	2,218
2030		
Lincoln	243	64
North Kesteven	306	2,001
West Lindsey	238	2,221

The high level results at local authority level show that in 2020, West Lindsey is expected to have the largest renewable energy resource potential, followed by North Kesteven and then Lincoln. For the two rural districts, the role of heat is limited around 10 – 20% of the expected renewable potential, whereas in Lincoln, renewable heat is the majority of the renewable energy capacity potential.

The patterns between urban and rural, and heat versus electricity are clearly shown in Figure A1 (Appendix A). In rural areas, the potential for large electricity producing technologies (such as wind turbines) is high, but the low density of buildings makes larger scale heating schemes less viable. In urban areas, there is little or no potential for large scale electricity generation from wind, but higher potential for community heating schemes. This explains the high level differences between Lincoln City, and North Kesteven and West Lindsey.

Technical potential for each renewable resource will be discussed in more detail in the following relevant sections.

It is clear from the results in the EM Low Carbon Energy Study that there is potential for a mix of low and zero carbon technologies across Central Lincolnshire, with a split in strategies for urban and rural areas. However the main technology identified by the report is large scale wind and this will need to be examined closely in further work due to the significant potential.

5.1.3 Reviewing Renewable Energy and Energy Efficiency Targets for the East Midlands

This study was conducted by AECOM for the East Midlands Regional Assembly in 2009 for the purpose of drafting regional renewable energy targets. The study aimed to provide a comprehensive and up to date set of targets by reviewing existing recent studies examining resource availability in the region, in combination with some new analysis. This review included a check for consistency in assumptions and methodology, and therefore whilst a number of different studies fed into this work, the outputs are relatively consistent.

This review aimed to develop targets in the form of ranges at different technology scales, with the purpose of providing realistic scenarios without being prescriptive and inflexible. The technologies were split by delivery mechanisms into development driven (renewables installed as a result of new development and future building regulations), regional renewable (independently installed technologies – predominantly commercial), and heat networks.

5.1.4 Development driven generation

The requirement for on-site low and zero carbon generation on new development will be heavily influenced by future building regulations. The original definition of zero carbon developed in 2006 from the UK Government proposed that "zero carbon" homes from 2016 would be net-zero carbon for both regulated and un-regulated emissions using on-site technologies. These proposals have subsequently been changed and the current proposals are that homes will be net zero carbon for regulated loads only using a mix of on-site and off-site CO_2 mitigation.

To address the uncertainties in future requirements, the East Midlands review study examined a number of scenarios. These scenarios estimate that on-site generation will deliver CO_2 savings from the baseline of between 2% and 7% by 2031. These savings are relatively small, but reflect that fact that new development will be highly efficient compared with existing development and make up a small fraction of the overall stock, and therefore the opportunities for CO_2 mitigation from the baseline is limited.

5.1.5 Regional scale renewable energy

The review study highlighted Central Lincolnshire as having the largest potential for CO_2 mitigation from independently developed renewable energy technologies. Savings of between 15% and 20% CO_2 are estimated for 2031 based on the technical potential and uptake analysis. Three other HMAs have a potential of over 10% and the remainder are limited.

Within the mix of renewable technologies, commercial scale onshore wind accounts for around 80% by capacity or 60% by generation, with the remainder coming from a range of other technologies including poultry litter, straw combustion, and anaerobic digestion.

The combination of the largest potential for CO_2 savings in Central Lincolnshire and the dominance of wind within this potential highlights the importance of onshore wind generation in Central Lincolnshire for both local and regional renewable energy generation and CO_2 reduction.

5.1.6 Lincoln Energy Study

The Lincoln Energy Study (2007) was conducted by Delta Simons to support Lincoln City Council in the preparation of the Local Development Framework.

The study assesses at a high level a number of technology options for the city and comes to the following conclusions for each:

- Anaerobic digestion. The study rules out AD on the basis that all MSW will be used in the proposed Energy from Waste plant at North Hykeham. It is possible that a separate food waste collection combined with sourcing feedstock from the non-domestic sector could still mean that an AD scheme is viable for the city.
- Large scale wind. The study makes no comment in relation to the potential for wind within Lincoln City. It states that "public opinion is usually in support of wind turbines". Whilst this may be true in terms of overall numbers, public opposition is one of the key barriers to wind turbine development.
- Biomass. The study identifies sources of waste wood (5,300 tonnes per year) and aboricultural waste (500 tonnes per year). In addition, the potential for energy crop growth on low-grade farm land is discussed with the acceptance that market conditions are not favourable for energy crop growth.
- CHP and district heating. The report discusses a range of CHP technologies in terms of performance, costs, and status, but does not assess the suitability of these or the potential of these for the city. A discussion is provided on how biomass CHP could be theoretically phased on the Western Growth Corridor, but this does not consider viability, either economic or technical.

Overall, the Lincoln Energy Study appears to suggest that the most suitable resources or technologies for the city lie in biomass and CHP use, but there is little evidence to support the findings in the form of technical or economic viability, or resource assessment.

5.1.7 Literature review summary

This section provides a brief overview of three existing studies identified which cover the Central Lincolnshire area. Due to the level of analysis and recent completion, the EM Low Carbon Energy Study provides the most up to date and robust assessment of resource potential, and the information within this and the supporting datasets will be used as the basis of analysis in this work.

The review of regional targets provides a high level theoretical overview of potential, based on existing analysis and reports and has largely been surpassed by the recent EM Low Carbon Energy Study. The Lincoln City Energy Study is restricted both in terms of geographical area, but also level of analysis, and will not be considered further in this work.

5.1.8 Spatial Analysis and Review of EM Low Carbon Energy Study Results

The following section outlines the opportunity to explore and incorporate various renewable and low carbon energy resources and technologies in Central Lincolnshire. Each sub-section begins with a discussion of the technical potential for each renewable and low carbon energy source. This technical potential analysis is based on the EM Low Carbon Energy Study. The assumptions and results from this study are then tested and discussed in the context of Central Lincolnshire. At times, where appropriate, we have provided an alternative perspective on the area's technical potential if there is information available at a local level which suggests this needs modifying.

Whilst the technical potential is obviously important as a starting point in understanding what can be delivered, this report focuses on the potential for delivering renewables in the area. Often there is a large disparity between technical potential and deliverable potential and the final uptake can be entirely dependent on the latter. This section outlines the opportunities and constraints specific to the Central Lincolnshire geography and provides case studies where relevant to support the analysis. Each section then summarises the potential for renewable energy generation and carbon emission savings, and concludes with an examination of how planning can stimulate increased adoption of renewable and low carbon technology.

5.2.1 ONSHORE LARGE SCALE WIND

EM Low Carbon Energy Study's Results for Technical Potential

The term 'Large scale wind' describes the development of commercial scale wind turbines and wind farms. These typically comprise turbines of 1 MW or more with hub heights of circa 100m or more. The EM Low Carbon Energy Study presents a set of wind opportunity maps for the region using a series of constraints and designations to map where large scale wind may be viable. The study highlights that wind speeds in Central Lincolnshire are generally feasible for large-scale wind development, with the highest wind speeds present along the central spine in the Lincoln Cliffs area. However, as wind speeds across Central Lincolnshire are consistently above 5.5m/s (the general threshold for economic viability), other constraints are the key consideration in determining technical viability. At the regional level, the EM Low Carbon Energy Study did not consider visual impact or landscape impact (apart from certain AONB and National Park designations such as the Lincolnshire Wolds), nor did they consider cumulative impacts, which also determine the technical capacity of the landscape to deliver wind generation. Delivery options are not considered under technical capacity, and this will have a significant impact on the eventual uptake of wind.

The wind opportunity map for Lincolnshire (Figure A2) shows negligible land availability in the City of Lincoln, as would be expected. The available land could at a maximum potentially deliver around two large scale turbines but this would have a significant visual impact in a built up area.

The two rural authorities (North Kesteven and West Lindsey) can potentially accommodate a joint capacity of around 2.5GW by 2020 based on the mapping process. In both of these authorities, the maps show that radar interference and airfields could be key constraints, and a clearer understanding of these is required at a local level to determine their applicability. The potential importance of North Kesteven and West Lindsey in delivering wind energy is demonstrated in Figure 31, which shows them as two of the authorities with some of the highest levels of resource, roughly equivalent to 3 power stations. This study, therefore, needs to carefully examine the barriers and opportunities to wind to enable the Central Lincolnshire authorities to maximise the benefits from wind, robustly assessing the potential with detailed local information, and exploring how this potential can be met using local delivery routes, and providing a benefit to local communities.

The mapping methodology at a local level needs to examine in more detail the impact of buffer zones, in particular around smaller residential areas and individual dwellings, and the sensitivity of technical potential to the buffer assumptions. It also needs to assess the impact that airfields may have on the overall potential, and examine ways in which the radar issues can be overcome or accommodated.

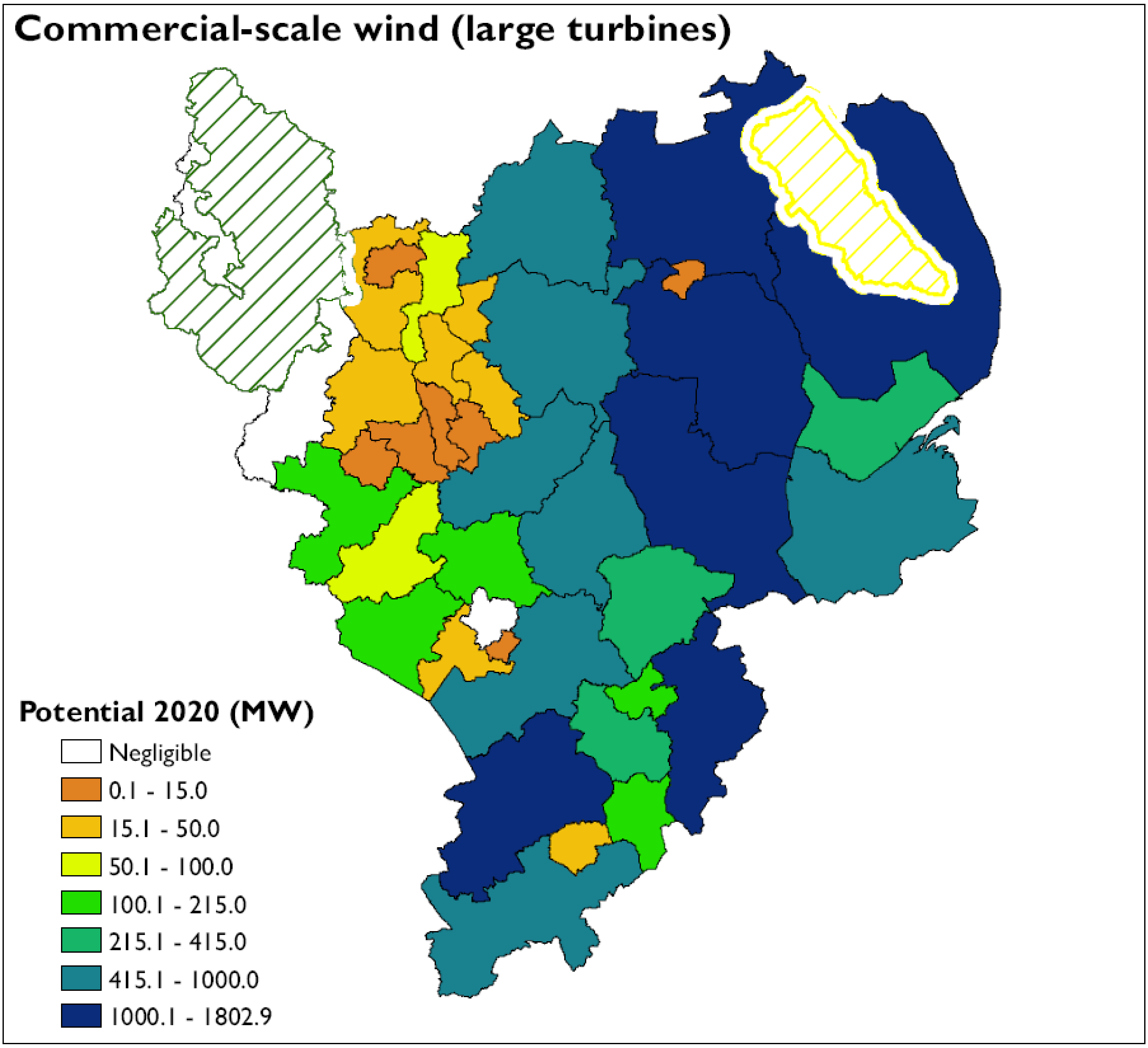


Figure 31: Relative potential of large scale wind across the East Midlands region[18].

[18] *Low Carbon Energy Opportunities and Heat Mapping for Local Planning Areas Across the East Midlands*, for East Midlands Councils. 2011.

Review and Testing of Technical Potential at a Local Scale

When considering the maximum technical feasibility for all renewables in the area, wind represents nearly 60% of the opportunities in North Kesteven and West Lindsey. The process of physical constraint mapping has been used to identify which sites are likely to have potential for large wind turbine location. Through GIS analysis, the constraints that have been included are listed below and conform with the DECC guidance:

- Non-accessible areas
  - Roads (A, B and motorways)
  - Railways
  - Water bodies
  - Built up areas
  - Airports
- Exclusion areas
  - Ancient semi-natural woodland
  - Sites of historic interest (but no buffer to be applied)
  - Buffer around road and rail line = turbine tip height +10%
  - Buffer around built up areas = 600m
  - Buffer around airports and airfields = 5km
  - Civil Air Traffic Control constraints
- Designated landscape and nature conservation areas, including the following classifications.
  - National Park
  - AONB
  - SAC
  - SSSI
  - RAMSAR
  - SPA
  - NNR
  - SINC
  - BAP habitats

Guidance specifies National Parks and Areas of Outstanding Natural Beauty as having the highest status of protection. In some cases, the Infrastructure Planning Commission (IPC) has the ability to grant consent to development in these areas. If the development is demonstrated to be in the public interest[19] Local development document policies and evidence discussing landscape character, including Historic Landscape Characterisation, should be considered. Local landscape designations, however, should not be used in themselves to refuse consent, as this may unduly restrict acceptable development.[20]

While AONBs often present barriers to wind turbine development, the Lincolnshire Wolds' position on renewable energy does not preclude wind turbines or any other form of renewable energy. The Wolds' Management plan states that *the JAC [Joint Advisory Committee] and Countryside Service can highlight the landscape value of the AONB and assess the potential impact that any proposed scheme may have on the character of the Wolds.* This suggests that the Lincolnshire Wolds will assess each renewable energy application on a case by case basis, including wind turbines.

The map in Figure 32 shows the wind opportunity areas using the data and methodology from the regional assessment. The darker orange areas are identified as potentially suitable for large scale wind development based on the methodology and assumptions used. It should be noted that this study is not a sufficient evidence base for

[19] DECC (2009) Draft Overarching National Policy Statement for Energy (EN-1). Available: http://data.energynpsconsultation.decc.gov.uk/documents/npss/EN-1.pdf
20 DECC (2009) Draft Overarching National Policy Statement for Energy (EN-1). Available: http://data.energynpsconsultation.decc.gov.uk/documents/npss/EN-1.pdf

the actual siting and delivery of wind turbines, but it gives a high level assessment of promising geographical areas to look into further.

The map in Figure 32 using the regional data assumes a 600-metre buffer from all existing residential development. This is to allow for impacts such as noise and shadow flicker which may affect residents. In reality, this is a conservative buffer and it may be possible to develop turbines closer to residential development if it can be demonstrated that noise and flicker can be controlled (there are established methodologies for doing this such as the ETSU-R-97 assessment procedure for noise). It can be seen from the map that the 600m buffer has a significant impact on the land area availability for wind turbines. Because this buffer zone can be reduced in many cases without any adverse impact on residents, and because it is not a physical constraint, a more realistic view of technical potential can be estimated by removing this buffer from individual homes (but retaining for groups of homes in towns and villages). The map in Figure 33 shows the increased technical potential which is obtained.

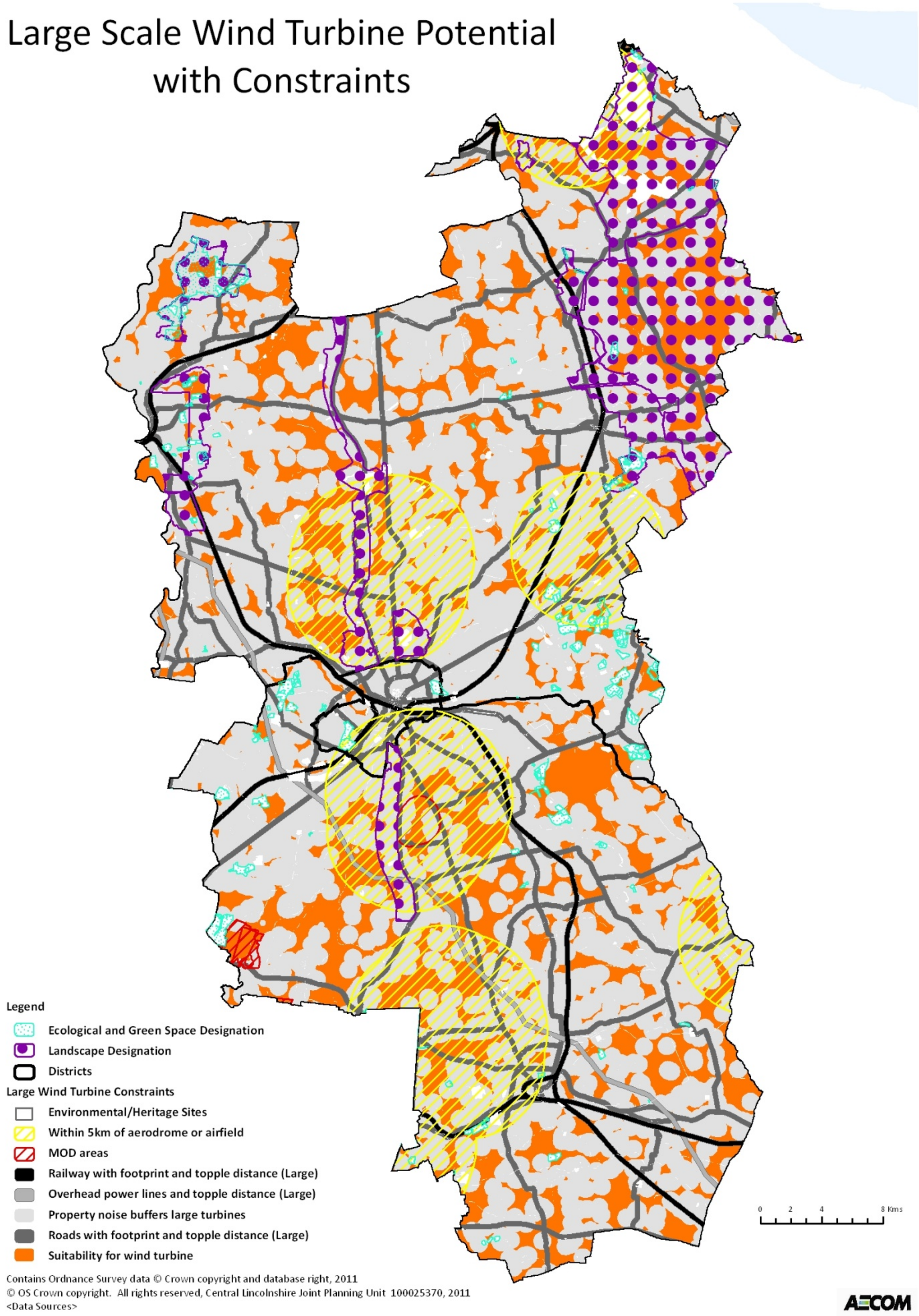


Figure 32: Large scale wind turbine opportunity with 600-metre buffer around all residences

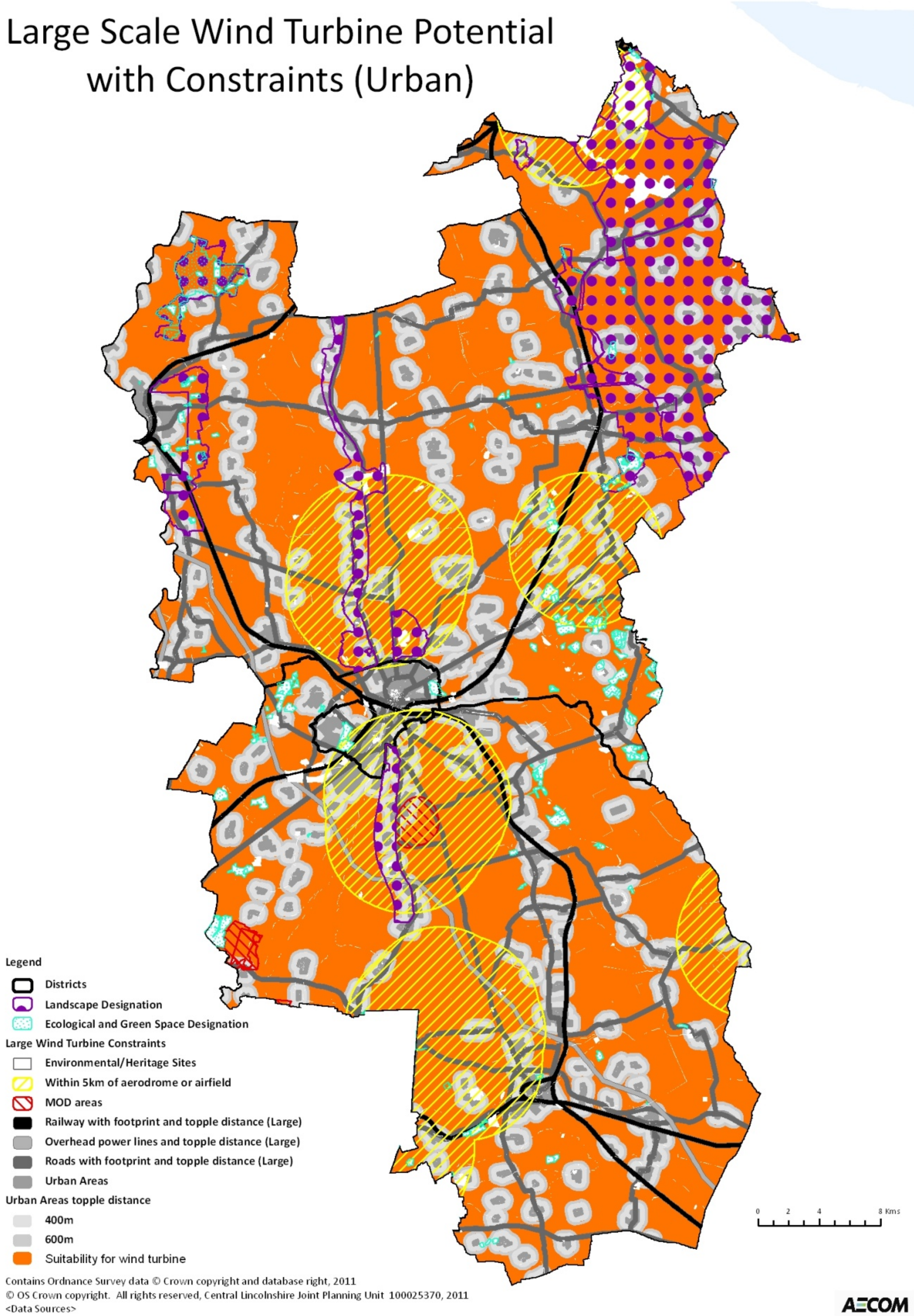


Figure 33: Large scale wind turbine opportunity with 600-metre buffer around all villages and hamlets

By reducing or removing the blanket buffer around individual residential buildings, these two maps show that the total large scale wind potential could be significantly greater than the 1,500MW technical capacity suggested in the EM Low Carbon Energy Study. It should be noted, however, that this methodology is designed to present a level platform for assessment, and the inclusion of other effects such as cumulative impact and landscape impact will heavily reduce this difference.

The mapping shows that in general, Central Lincolnshire is technically well suited to the development of onshore wind, with an adequate wind resource, and large areas of open land where the impact on local residents will be minimal. The entire area of Central Lincolnshire has favourable wind speeds for wind turbines with the north-south spine along the Lincoln Cliffs containing the most favourable wind speeds.

Further detailed feasibility studies would have to consider a number of additional siting constraints in addition to these before any site could be confirmed, including the issues below. The draft NPPF refers to the issues sited in the National Planning Statement for renewable energy, which outlines all considerations in detail.

- **Local Wind Resource Survey** - Wind speeds of 5m/s or above at turbine hub level are needed to operate a large scale wind turbine efficiently. The national dataset for wind speeds at a height of 45m above ground level was used to examine wind speeds across Central Lincolnshire. This study is not a sufficient evidence base for the actual siting and delivery of wind turbines, but it gives a high level assessment of promising areas to look into further. Applications for individual sites will usually include a period of wind speed testing using pole-mounted anemometers which means that local effects such as topography can be investigated.

- **Noise implications** - Concerns over noise can be related to perception rather than actual experience[21]. The noise impact of large scale wind turbines will depend on local background sources of noise such as from major roads, rail lines, industrial areas, etc. More detailed studies will be required to map noise and identify areas of least impact for turbine development. The ETSU-R-97 assessment procedure provides a sound methodology for the assessment of the impact of noise. It is important to note that this is a procedure and not a set of criteria, and includes the use of local background measurements and wind noise data relating to specific turbines, ensuring that the assessment is always appropriate for each application.

- **Aeronautical and Defence Impacts** – Wind turbines may interfere directly with the operation of aeronautical and defence equipment, for example, when located near aerodrome protected surfaces, runway takeoff points or within military low-flying zones. Radar systems associated with airports and military sites are also a significant issue; for example, radar technology that is unable to differentiate between rotating turbine blades and an approaching aircraft have contributed to the rejection of a number of wind applications in the UK. Consultation will have to be undertaken with MoD and nearby airport authorities to determine particular constraints in the area and possible mitigation strategies, such as software upgrades to the radar technology. It is emphasised that the presence of local airports or military sites is not necessarily a critical constraint when considering the exploitable wind resource, but consultation is advised on a case by case basis. Further discussion regarding wind turbines and radar interference is discussed below in the *Examining Delivery* section.

- **Grid connection and Sub Station Requirements** –It will be necessary to carry out a detailed assessment of the opportunities and constraints presented by existing infrastructure in relation to each turbine site. This information should feed into any development programme for turbines. The potential for connection to the grid needs to consider both the technical potential relating to the capacity of the existing infrastructure to accept the renewable generation, and also the locational aspects and additional infrastructure. Planning policy and guidance can be used to guide the location of wind farms to ensure that the impact of additional infrastructure is minimised. This may require developers to consider sites which are close to the existing infrastructure, or methods of mitigation (such as building underground sub

[21] Rand and Clarke (1990) The environmental and community impacts of wind energy in the UK. Wind Engineering 14, 319–330.

stations and connections). However as the grid connection and associated costs are a technical issue, planning should not aim to influence renewable developments using fixed criteria in this area.

- **Landscape and Visual Impact –** A detailed visual and landscape impact assessment with regard to wind turbine sensitivity has not been conducted at this stage due to the high level nature of this work. Landscape impact can be a key factor in assessing the suitability of a site for wind turbine location, and is one of the most controversial aspects for opposition groups. Therefore any specific applications need to be carefully considered to ensure that turbines do not detrimentally impact key view corridors and that they do not detract from the surrounding landscape. Special designations such as AONBs, should not automatically preclude the development of wind turbines where it can be demonstrated that the visual impact is not significant.
- **Flood risk -** PPS 25 currently restricts development of wind turbines on areas of high flood risk; however, the recently revised PPS 25 has reclassified wind turbines as essential infrastructure[22]. In principle, this largely permits turbine development in flood zones and, as such, flood zones have not been considered a constraint in the above analysis. From a technical perspective, it is possible to build turbines in areas liable to flooding provided that suitable access arrangements are available.
- **Blade Glint Modelling** – Blade glint is the reflection of light from a turbines blade. This can be an issue at certain times of day when the wind is blowing, but effects can usually be mitigated, for example by using matt surfaces on the blades, and its effects have not been specifically considered at this stage. This would also need to include driver distraction issues, in partnership with the Highways Agency and local highways services.
- **Flicker** – Flicker is an issue when a turbine is located between the sun (early morning or late evening) and a sensitive receptor. The rotating blades mean that the path of light from the sun is periodically “chopped” resulting in a flashing effect. The sun’s path is very predictable and can easily be modelled, allowing an assessment to be made of when this may be an issue, and the turbines to be temporarily shut down. This means that the impact can be minimised without reducing the number of turbines or restricting the location.
- **Telecommunication Impacts** - Wind turbines can potentially interfere with radio signals, television reception and telecommunications systems. This has not been specifically assessed at this stage, however consultation measures with relevant telecommunication companies can be put in place to mitigate these effects.
- **Bird Migration** - An important element that will need consideration is the annual migration of birds, particularly due to the presence of important environmental sites in the area. A detailed migration survey should be conducted over a year period. Overall wind turbines are only responsible for 0.01% of all the bird deaths attributed to human activity.
- **Transport Access Assessment per turbine** – The blade section is the longest/largest full section of a wind turbine to be delivered to a site. Some sites are restrictive, and consideration is required of local transport infrastructure as well as access to and on the site.
- **Impact upon land use and land management** - The amount of land consumed by wind turbines is relatively small due to their small footprint requirements and other activities such as farming can continue in the area. However additional land is required for access roads and potentially substations, and a study should be carried out to ensure that the turbines do not have a negative effect upon land use potential.
- **Ground Condition Survey** – The feasibility of the construction of a large turbine would have to be supported by geotechnical investigations to ensure that the ground conditions are suitable for locating the foundations and access roads.

[22] Planning Policy Statement 25: Development and flood risk, Annex D http://www.communities.gov.uk/documents/planningandbuilding/pdf/planningpolicystatement25.pdf

- **Gas pipelines and other sub terrain analysis** – As the relevant information was not made available, the current assessment has not analysed the presence of utility pipelines beneath the sites which could have a considerable impact on the ability to site turbines.
- **Archaeological Constraints** - Any impacts on archaeology in the area will have to be assessed in more detailed studies depending on the level of ground works required.
- **Listed Building and Conservation Area impact** – A detailed impact assessment has not been conducted at this stage and would be required for any further study. Whilst a turbine will not directly impact a listed building or conservation area, it needs to be considered in the context of the setting.

Examining Delivery – case studies, opportunities and constraints

Case Studies

Community engagement - Learning from Orby Marsh Wind Farm

Proposed in the neighbouring authority of East Lindsey, the Orby Marsh Wind Farm provides an example of some of the barriers that a large wind farm proposal can experience. Now in its 3rd application, much can be learned from the Orby application process. Perhaps the most salient barrier is the opposition from community members. Some of the complaints include:

- "The minimal amount of electricity gleaned from the turbines, will then have to travel 10 miles through people's property and near homes."
- "Due to many other developments taking place offshore and on it will exacerbate the industrialisation of the area."
- "The substation would be the height of 6 double-decker buses, set in acres of land. This will blight the beautiful countryside... affecting the Tourism industry. All this industrialism in a rural area, ruining local people's lives and livelihoods."
- "...significant cumulative visual effect."
- "Wind turbines do not generate enough power to be cost effective. They never operate at full capacity and the cost will be met by all of us when it is added to our power bills."
- "It seems that Lincolnshire is being targeted for all the wind farms."
- "There are enough offshore wind farms on our coastline without putting them on green field sites in our beautiful fields."

While some of these issues are reasonable and need to be addressed, others could be addressed through consultations. A large number of the comments relating to technical performance and the need for wind turbines should not be considered at the planning stage – policy guidance states that the need for low carbon generation is made in national policy, and that technical performance is a consideration for the developer only (it is they, after all, who will lose out financially if the wind farm does not perform and they are unlikely to make mistakes on this issue).

The following is a number of strategies wind farm developers and Councils can employ to mitigate wind turbine concerns and relax community fears:

- Identify and work with communities that are in favour of wind turbines to avoid confrontation.
- Establish public-private partnerships with local community organisations to ensure benefits of the development can be shared with the local community. For example ensuring that a proportion of the profits are fed back into local communities.

- Engage the community early in the design to discuss options and mitigate any negative impacts. This has been done well in Browns Holt in West Lindsey.
- Provide facilitation at a local level to ensure that those in favour of wind farms have a balanced representation alongside those who oppose. Ensure that all local residents are allowed to give their point of view and not just the opposition movement.
- Provide clear and objective advice which openly discusses and dispels many of the myths around wind farms.

Wind Farms and Radar Interference

Radar interference issues represent important technological barriers to wind farm development. This represents an issue for RAF sites as there is potential for wind farms to interfere with the tracking of smaller aircraft. As radars monitor smaller aircraft, wind farms might shield these planes when in the vicinity. While there are plans to upgrade many RAF sites' radars by 2015, their wind farm resilience is still uncertain. If developers wish to get RAF's approval to erect turbines, it is their responsibility to fund technological improvements that demonstrate 80% probability of aircraft detection within the wind farm's vicinity.

Technological solutions, however, do exist. In fact, Vestas, the world's largest wind turbine manufacturer has recently unveiled "stealth turbines". These turbines use technology developed for stealth bomber aircraft to effectively make wind farms invisible to radar. In the meantime, while stealth turbines are being developed, there are other technologies that can mitigate radar issues.

One recent development is in the area of 3D holographic radar, where a patch from one radar is fed into another, and the two images are fused together thus providing a complete picture. The MoD has accepted planning conditions at the Hook Moor wind farm, due to its planned use of this technology. However, due to other objections, the Hook Moor wind farm is still under consideration.) This same 3D technology is being used at a site near RAF Leamond in Yorkshire, and is planned to be implemented for Prestwick Airport in Scotland.

In North Lincolnshire's Draft Renewable Energy SPD (August 2011), they have recognised that it is possible to mitigate issues related to radar interference stemming from wind turbines. Their Aircraft and Radar policy (11) states, "Development will not be permitted unless it is shown that close liaison has taken with the above bodies and that any highlighted impacts on radar and/or aircraft operation can be appropriately mitigated."[23]

[23] North Lincolnshire Council (2011) Planning for Renewable Energy Development: Draft Supplementary Planning Document

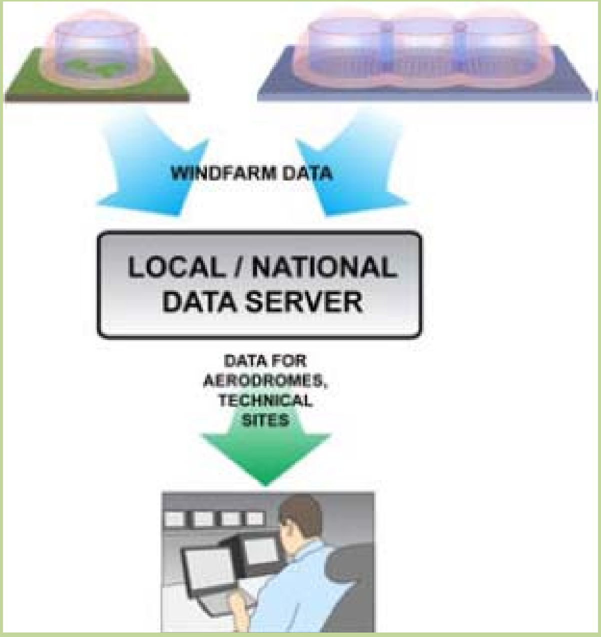


Figure 34: 3D Holographic Radar Solution[24]

Opportunities

The majority of the landscape in Central Lincolnshire has the potential to support large scale wind energy based on the criteria used, and therefore the opportunities for this resource are significant and important nationally, regionally and locally. Areas where opportunity may lie include:

- **Mitigating wind farm radar issues** – While the case study above discusses new technology, simply upgrading the radar is another solution. This has been done successfully at Robin Hood Airport in Doncaster. At another airport, Bristol International, part of its radar display is provided from radar at Filton Airport, opening up surrounding area to wind farm development. Problem solving and identifying opportunities through planning can mitigate radar as a potential constraint and increase turbine uptake in Central Lincolnshire.
- **Communities groups** – There are a number of community groups that are interested in establishing community-owned wind turbines. Profits from wind energy generated would then be invested into the community. The Rauceby Little Footprint Initiative is one such local group. This might be an initiative completed in partnership with a wind developer to determine the most appropriate site.
- **Farmland** – Central Lincolnshire's vast amount of farmland is a major opportunity to deliver large scale wind. This would likely require partnering with wind developers who would lease the land from farmers, earning farmers an additional income stream in the process, one of the many revenue options open to farmers. Wind has a relatively minor impact on overall land utilisation and can be compatible with existing farming practices.
- **Wind farm design** – Mimicking how schools of fish arrange themselves when swimming through the water, researchers found that by placing vertical axis turbines close together can reduce drag and deliver up to 10 times the energy output of a conventional wind farm. These wind farms are less intrusive as they can be placed closer together, and developed at heights of less than 30 feet[25]. Whether new innovative

[24] http://www.nationalwind.org/assets/blog/Blackman_for_Cambridge_Consultants.pdf
[25] http://dabiri.caltech.edu/publications/Da_JRSE11.pdf

designs in the future, or current commercial turbine designs, developers should work with planners strategically to ensure that the potential can be maximised without incurring cumulative impact constraints.

Constraints

There are a number of potential constraints to wind farm development, some of which are specific to Central Lincolnshire:

- **Lincolnshire Wolds AONB** – The Wolds AONB presents the greatest landscape constraint to large scale wind farm development. However given the overall scale of opportunity in Central Lincolnshire, and the highly suitable nature of other areas, the Wolds are not critical in developing a large local resource. This should not preclude the development of turbines in the Wolds where it can be demonstrated that there is no significant landscape or visual impact.
- **Vistas and Sight-lines** – Central Lincolnshire's rural character, often with long open views, means that wind turbines might adversely impact on important vistas and sight-lines. Identifying locations should include an assessment of the capacity of the landscape to host the wind turbines and existing infrastructure. Visual impact and decisions regarding impact on openness is subjective. The presence of existing infrastructure such as power lines, power stations, industrial buildings, and large scale commercial farming activities can mean that further development in the form of wind farms is more acceptable, making a comparatively small additional impact.
- **Historic Sites** – As outlined English Heritage's, *Wind Energy and the Historic Environment*, issues such as their scale and potential to visually dominate historic sites need to be considered[26]. Given Central Lincolnshire's relatively flat topography, this is an issue which will require attention throughout much of its geography.
- **Inadequate Energy Infrastructure** – The energy infrastructure within Lincolnshire can present a barrier to connecting wind farms to the grid. Ofgem's Low Carbon Network Fund has awarded Lincolnshire Low Carbon Hub £3 million to improve and increase the connection of renewable energies in the county. Using these funds, or applying for more for Central Lincolnshire specifically, can help improve infrastructure requirements.
- **Wind Energy Action Groups** – Objections from anti-wind energy groups is one of biggest challenges to the wind development in the area. Sometimes these groups have legitimate concerns and their grievances need to be addressed. Often, however, their concerns result from misconceptions and myths around wind turbines, especially relating to noise, technical viability, and the alternative options. Engaging the community early in the process in dialogue where complaints can be addressed is the best way to relax fears.

Influence of planning

For areas outside the AONB, the planning authority should encourage wind development where it is appropriate. With an expansive rural landscape across North Kesteven and West Lindsey, policies might encourage turbine installations on appropriate farmland and other areas outside settlements. To ensure wind energy development is delivered appropriately, planners and the Central Lincolnshire planning authorities should work with developers to make sure wind turbines are well placed. Given the gap between the potential and current delivery for wind energy in Central Lincolnshire, the local authorities should consider developing a wind energy supplementary planning document (SPD), which provides a robust evidence base, dispels myths, and encourages its fast paced delivery. Cumbria has produced a similar document, which is discussed in the policy section of the report.

[26] English Heritage (2005) *Wind Energy and the Historic Environment*

5.2.2 MEDIUM SCALE WIND TURBINES

Technical Potential

The EM Low Carbon Energy Study also assessed the potential for medium and small scale wind turbines. These are turbines which operate in a stand-alone mode and not mounted on a building. They may provide electricity to a single customer (for example a farm) or be connected directly to the grid for export. Turbine sizes vary widely, and medium scale could include single or a small number of community owned which are approaching commercial scale. Indeed community schemes often use second hand commercial turbines with systems of around 225 kW being popular based on a common Vestas turbine design. However most of the analysis in the EM Low Carbon Energy Study is based on smaller scale turbines with a 6 kW capacity (these have a hub height of circa 10 – 15 m and can often be found installed in small commercial sites, schools, and remote rural locations).

There has been much debate on the quality of the DECC methodology for medium and small scale wind and the uptakes resulting from the methodology are very optimistic and based on high uptake assumptions. In the case of the East Midlands, there is a suggestion that small wind has a technical potential of around 1.4 GW of capacity across the two rural authorities. This corresponds to around 230,000 6kW turbines which is the equivalent of more than one per house. Local assessment will clearly need to examine the realistic potential for small scale wind in more detail and the capacity of the landscape to deliver this.

The balance between smaller scale wind and large commercial wind turbines also needs to be understood. Whilst medium and small scale turbines are much less effective and potentially correspondingly more expensive than large commercial turbines, the acceptability could help increase the overall potential for wind in the area. However the comparison with large scale wind is important when considering cumulative impact. For example, around 800 6 kW turbines would be required to displace a single 2.5 MW turbine.

Review and Testing of Technical Potential at a Local Scale

While the EM Low Carbon Energy Study appears overly optimistic on medium and small scale wind potential and the likely deliverable potential will be much lower, they could still have a role in Central Lincolnshire. The low energy output per turbine, poorer performance, and correspondingly higher cost means that medium and small scale wind is unlikely to be delivered on a commercial basis, and the relatively low capacity means that the overall output is likely to be small in comparison with large scale wind. However medium and small scale wind can still help contribute to local energy generation and CO_2 savings, in particular where it can be delivered in areas and by stakeholders who cannot deliver larger scale wind. Recent reports have shown that medium-and small scale wind is generally not suited to urban or suburban locations due to the effects of turbulence at low levels on power output. However, they could be delivered where there is sufficient open land (for example low level industrial areas), or in rural areas by farmers and local communities, and with smaller buffer zones (closer to residential properties) than would be acceptable with large scale turbines.

Figure 35 shows the wind speeds across Central Lincolnshire at a height of 10m and can be used to identify areas with higher wind speeds which may be more suitable for small and medium scale wind. Areas within the central spine and in the northeast of Central Lincolnshire represent the best opportunities for small-scale wind in terms of wind speed although other considerations such as landscape also need to be considered. However the viability of turbines is very dependent on local conditions which cannot be mapped on an authority wide basis and a case by case assessment will always be required.

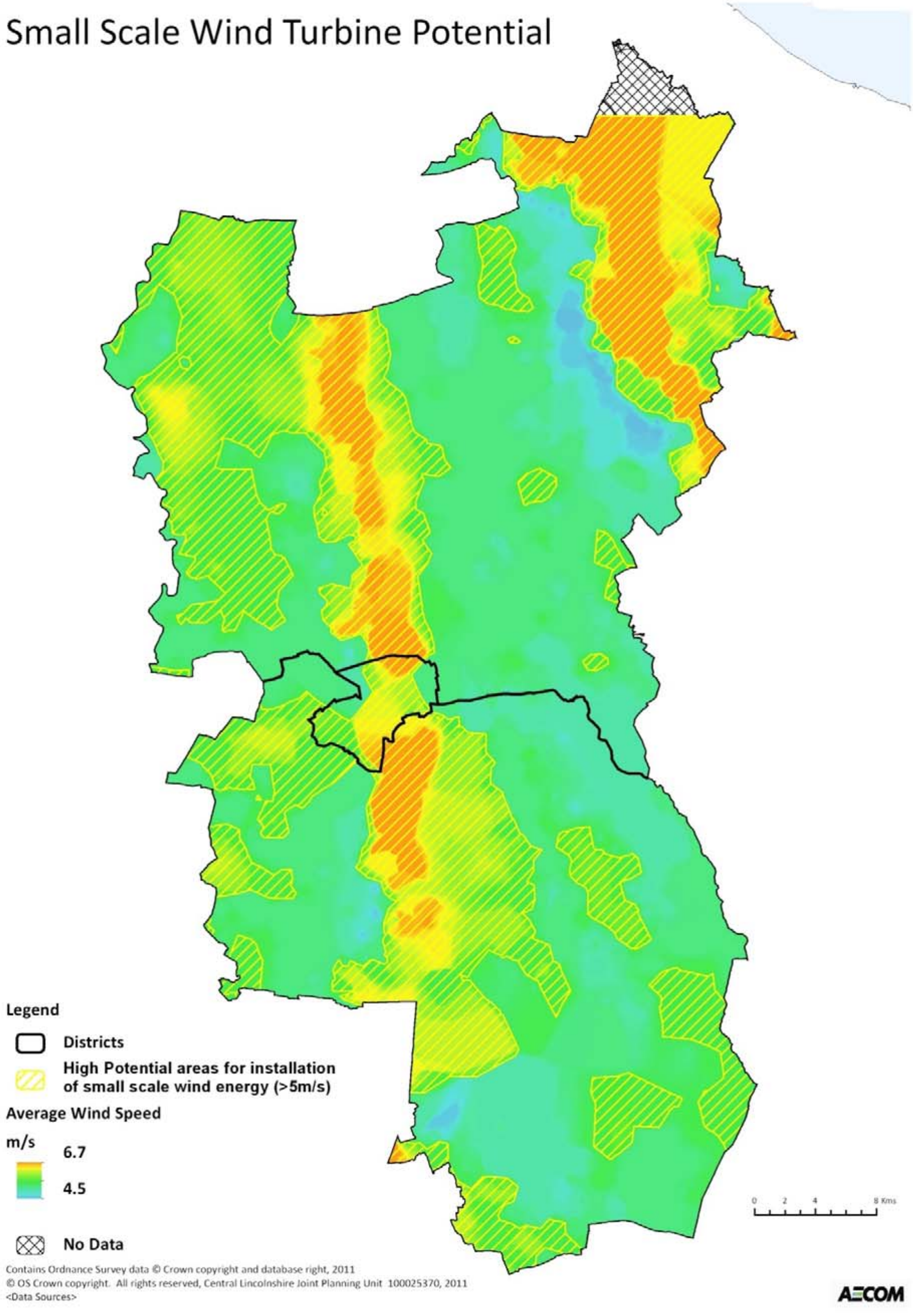


Figure 35: Wind speeds at 10 m height. This is one factor which can be used to help determine optimum locations, but local wind conditions taking into account topology and turbulence will need to be considered.

Unlike large wind farms, medium and small scale wind installations will often not have the resources to carry out yearlong wind studies for each site prior to turbine installation. These sites, therefore, need to rely on existing wind information describing speed and direction from meteorologists, which can be presented in the form of a wind rose. The closest wind rose available from the Met Office is for Coltishall. As can be seen from Figure 36, the wind predominantly originates from the southwest which is similar to the rest of the country. Therefore, small and medium scale turbines should consider this predominant wind direction when being located.

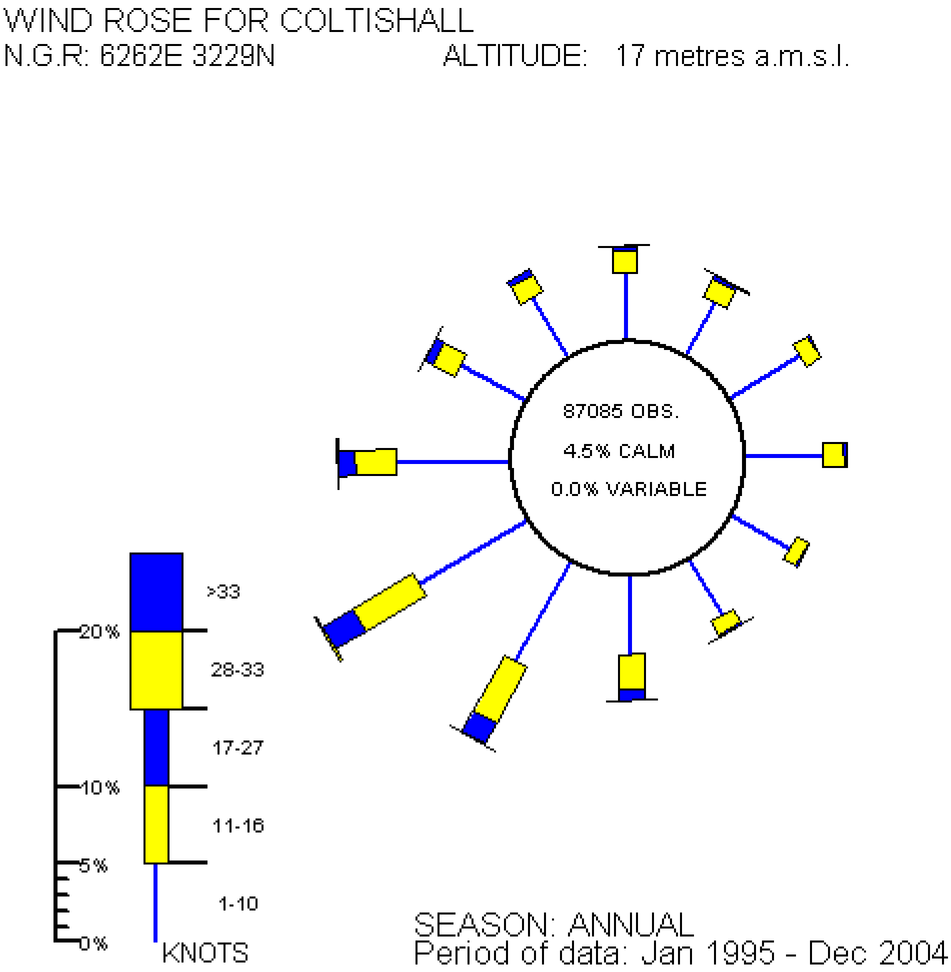


Figure 36: Met office wind rose for the Coltishall, England[27]

[27] http://www.metoffice.gov.uk/climate/uk/ee/

Examining Delivery – case studies, opportunities and constraints

Case Studies

B&Q in Bassetlaw – Making use of industrial space

In January 2009, Nottinghamshire erected its first large scale wind turbine at the B&Q distribution centre near Worksop. The 2 MW turbine is owned and operated by Ecotricity. The project is calculated to produce enough energy for more than 1,100 homes and reduce carbon emissions by 5,000 tonnes per year, or more than 150,000 tonnes over its predicted 30 year lifespan. Located with less sensitive industrial and commercial uses as neighbours, the turbine demonstrates that wind energy development can be acceptable in areas often considered to be out of bounds. The delivery of this turbine underscores what is possible for wind energy in industrial and commercial areas of a city.

Opportunities

- **Farmers –** Central Lincolnshire's large area of rural farmland means that much of the land has potential for medium and small scale wind power. On sites for which large scale turbines are inappropriate or where it is unlikely that they can be commercially delivered, medium and small scale turbines could be viewed as a "next best" option. Another advantage to farmers can be the provision of power to isolated buildings where the cost of a turbine may be less than for a grid connection.
- **Industrial sites –** On sites that are not located close to residential housing, but do not have the required space, medium and small scale turbines can often be accommodated. As the Bassetlaw case study illustrates, industrial land is one such land use, which can be well suited to incorporating these turbines.
- **Fewer community objections –** As medium and small scale turbines are less intrusive than large commercial machines, they may not be as likely to impact on the landscape resulting in less community objection. Locating the turbines amongst other infrastructure and on built sites (such as industrial sites) is also likely to result in fewer objections.
- **Establishing partnerships** – Turbine providers and installers can help leverage economies of scale. Installers could take the form of local councils, community groups, non-profit organisations, or other organisation. Combined, they might represent a large group of buyers.
- **Feed-in tariff –** The feed-in tariff (FIT) provides an additional revenue stream for wind generated electricity. The tariff depends on the capacity of the wind turbine and tariffs are currently available ranging from 26.7p/kWh (for generators between 1.5 and 15 kW) to 4.5p/kWh (for generators between 1.5MW and 5 MW). The FITs are available over a 20 year period and are designed such that the installation provides an acceptable financial return over its lifetime. For a small scale device of less than 15 kW, the FIT could be worth around £5,000 per year depending on level of output. This compares with an installation cost of circa £40,000 - £50,000, demonstrating that payback may be achieved within the 20 year FIT lifetime.
- **Renewable Obligation Certificates (ROCs)** – This incentive is open to all renewable electricity generating schemes, and is the market mechanism used in the electricity generation industry to incentivise the uptake of renewable electricity generation. A ROC is typically worth around 4.5p/kWh and therefore more suited to large scale commercial installations. For smaller installations, FITs provide a larger revenue stream due to the higher tariff levels.

Constraints

The conversion of potential to delivery requires consideration of a number of factors including:

- **Finance** – While the Feed-in Tariff can help improve the financial implications for a turbine while it is in operation, a significant barrier to investment in smaller scale renewables is the upfront investment. As such, some form of fiscal support such as an 'energy loan' may be required to provide funding. There are organisations, such as SALIX[28] who provide funding to public sector projects that reduce CO_2 in a cost effective manner. In addition to funding such a service would need to provide information and advice and expect a return in investment from energy saving and revenue streams including electricity sales and incentive tariffs. .
- **Cumulative impact –** Landscape and visual sensitivity will be issues in rural Lincolnshire, particularly in relation to their potential cumulative impact, should too many be located in the same area. This is discussed more in *Influence of Planning* below.

[28] http://www.salixfinance.co.uk/home.html

Influence of Planning

Natural England notes that caution needs to be applied when considering cumulative impacts of small (and medium) scale wind developments.

'The scale of development is a key factor when assessing the degree that wind energy can be accommodated within a protected landscape. Small-scale wind energy developments are generally less likely to compromise the objectives of designation, but this is not always the case, especially if there are cumulative impacts caused by several small-scale developments in the same area.'

In 2009, legislation was released for consultation on 'Permitted development rights for small scale renewable and low carbon energy technologies, and electric vehicle charging infrastructure' (consultation closed in February 2010). At the time, the rights were not extended to wind turbines following a number of legal and practical issues. However permitted development rights will exist (with a number of conditions) from the 1st December 2011 for small / micro scale turbines with a maximum height of 15m (building mounted) or 11.1 m (pole mounted) and a maximum swept area of 3.8 m^2. [29] The swept area limitation effectively limits turbines to the smallest of the small scale devices or micro scale devices, and the legislation is only likely to result in a very small increase in capacity.

5.2.3 HYDRO ENERGY

Small scale hydro turbines can generate electricity from rivers with less environmental harm and disruption to water flow than large scale hydro schemes. The introduction of government targets for renewable energy generation, combined with technological development has increased the feasibility of micro hydro generation, both at historic mill sites and weirs (where an existing head of water exists) or in hilly areas with spring-fed streams.

Micro hydro energy generation has a number of advantages. As well as being a renewable source of power, the ecological impacts of small-scale turbines are usually small compared to large scale, dam-based hydro power. Compared to wind power, micro hydro power sources offer more constant generation with load factors of around 50% typically achieved. In addition, maintenance costs are reasonably low and systems generally have a long lifetime of over 25 years. Moreover, the cost of reactivating historic sites can often be reduced by reusing existing structures such as the weir, minimising the civil engineering works required.

Review and Testing of Technical Potential at a Local Scale

The EM Low Carbon Energy Study has suggested that across Central Lincolnshire a total of 0.14MW of electricity could be produced from small scale hydro by 2030. Using data from the Environment Agency, this report maps the potential locations for small-scale hydro power in Central Lincolnshire, as shown in Figure 37. All of the sites in Central Lincolnshire, apart from a location in Lincoln City, are in the lowest size range of 0 – 50 kW.

The location needs to be considered alongside the environmental sensitivity for each site. A hydro sensitivity map, which considers ecological sensitivity such as fish passage, is shown in Figure 38. It can be seen that the majority of sites are either medium or high sensitivity. This means that there is very little potential for the development of hydro schemes with low impact. The combination of sensitivity and the relatively small number of sites, all in the lowest capacity range, means that hydro power is not a significant renewable resource for Central Lincolnshire.

[29] http://www.energysavingtrust.org.uk/Generate-your-own-energy/Wind-turbines/Choosing-a-site-and-getting-planning-permission

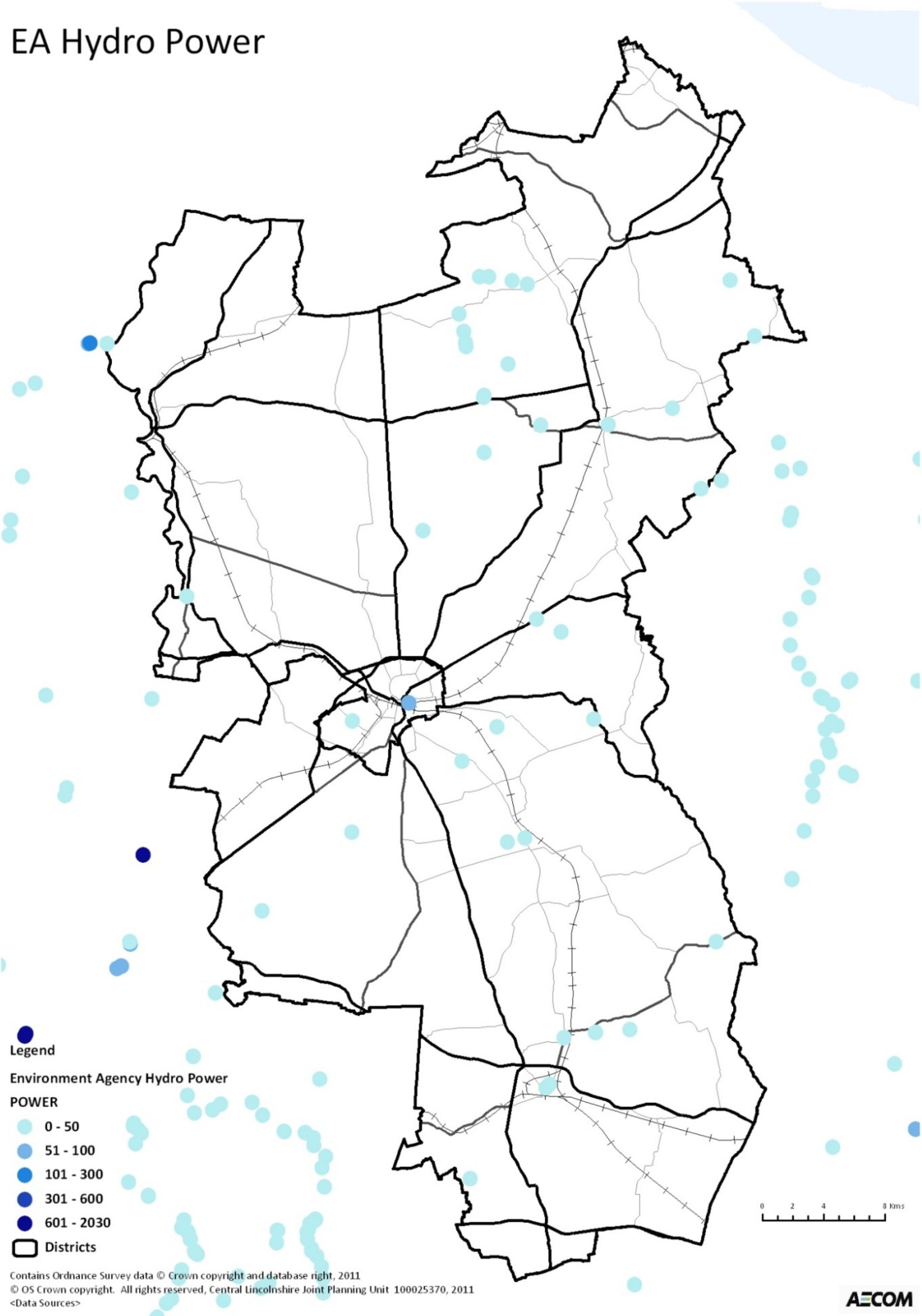


Figure 37: Micro hydro potential in Central Lincolnshire – sites and capacity.

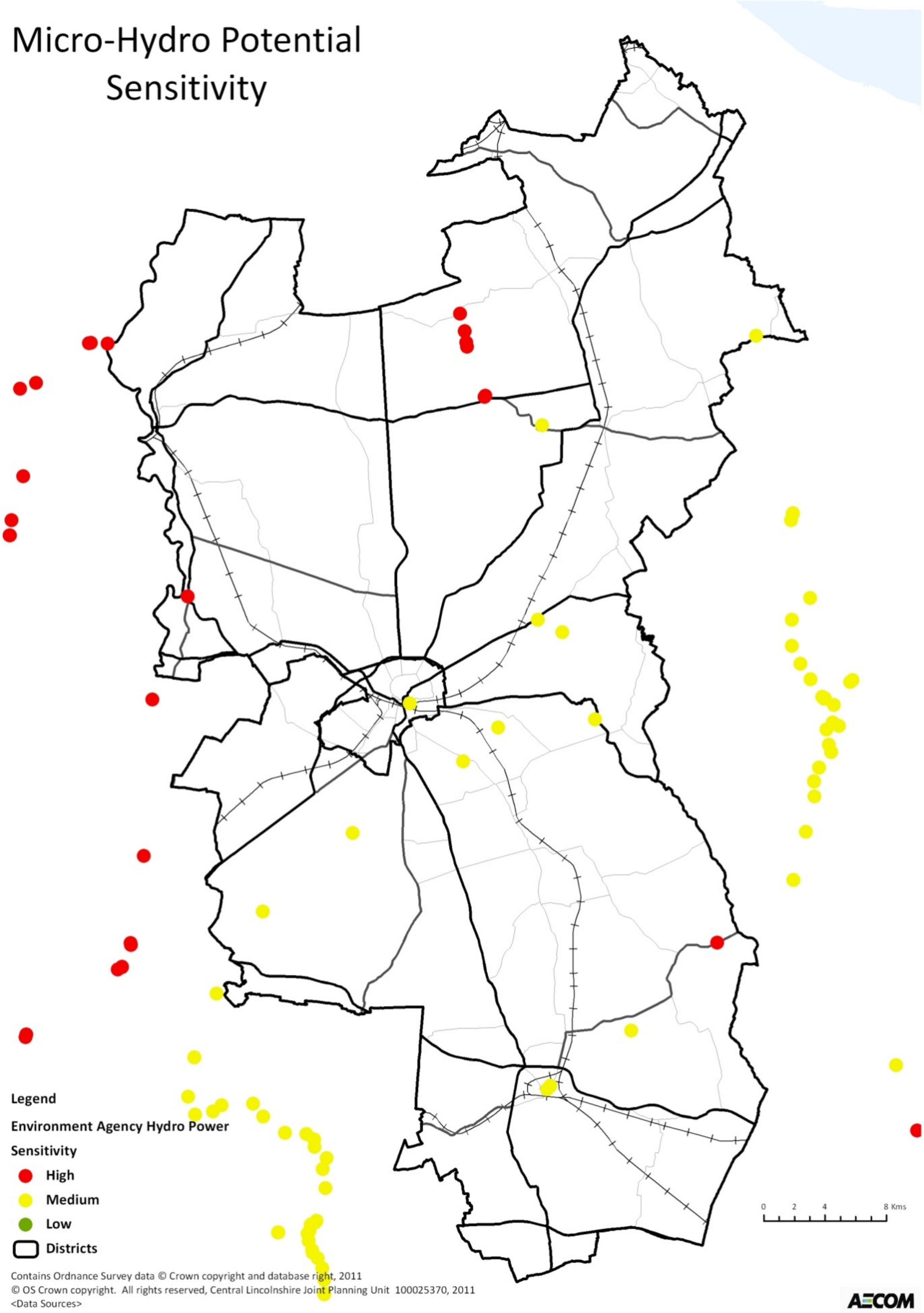


Figure 38: Sensitivity of potential micro hydro sites in Central Lincolnshire

Examining Delivery – opportunities and constraints

Case study

Torrs Hydro

Torrs Hydro, the UK's first community owned hydropower scheme, is situated on the site of a textile mill built in 1790, with the turbine sitting in the original mill pit where the water wheel would have been. Water flowing into the weir from the Rivers Sett and Goyt rotates the blades of the turbine with a maximum output of 63kW given a 3m head and a 3m/s flow. It is the ambition of Torrs Hydro to generate 240,000kWh (240MWh) of electricity which is around 43.5% of the maximum.

The Torrs Hydro scheme cost around £330,000, with the issuing of community shares generating around £125,000 and grant funding from East Midlands Development Agency, the Cooperative Fund and the Sustainable Development Fund provided a further £165,000. Torrs Hydro, New Mills Ltd, an industrial and provident society (IPS), runs the scheme. The IPS was created with the support from a social enterprise, Water Power Enterprises. The shareholders are mostly local people and businesses plus people from further afield who wish to support renewable energy schemes.

New Mills Town Council conceived of the idea with Water Power Enterprises. When the Council decided the project was too financially risky, Friends of the Earth along with others stepped in to keep the project alive. The IPS overcame funding issues using professional PR help, and offering tours of the site.

Lessons learned:

- Developing a small scale community hydro project, which regenerates and emphasises cultural heritage assets is possible
- Energy Schemes which benefit the community are feasible
- Setting up an IPS is challenging, but the average annual profits of £2,500 per year (to increase to £10,000 after loan repayment) will enable the community to invest in other renewable energy and energy efficiency initiatives.

Opportunities

While the potential for hydro power appears severely limited, any potential opportunities in Central Lincolnshire will need to consider the following:

- **Restoration of historic mills and weirs** – this is a potential opportunity to celebrate local heritage, reduce heritage at risk, and generate renewable energy.
- **Community delivery** – micro-hydro projects are an ideal example of schemes that can be led and funded by local communities.
- **Location of new development** – the delivery of schemes could be associated with new developments adjacent to potential sites. This could enable existing weirs and mill sites to be refurbished as part of the new development process.

Constraints

The analysis demonstrates that there is extremely limited capacity for micro hydro in the Central Lincolnshire area, and the sites that have potential are classified as having a high or medium level of sensitivity. While the opportunity for hydro in Central Lincolnshire is limited, should one of the sites be proposed for delivery, other issues to consider include:

- **Land ownership** – access in terms of ownership of land can be an issue for site development. Many of the sites may be located on private land and therefore the schemes will need the collaboration of landowners.
- **Extraction Licence** – required on hydro schemes on rivers via the Environment Agency to ensure the water levels in rivers are not compromised.
- **Fish Passage** – the Environment Agency requires fish passes to be installed which can increase the construction costs of any future schemes.
- **Access** – the accessibility of the sites to construction and maintenance vehicles and machinery is varied. Although some sites have good existing access others would require the construction of potentially costly new routes, for what is a very small scheme.
- **Scheme Design** – each site would require a bespoke design which responds to the unique flow characteristics and site constraints. Existing weirs may require significant modification or refurbishment which could render a hydro scheme uneconomic on its own grounds. However the refurbishment of existing weirs presents an ideal opportunity for the incorporation of a hydro scheme where viable.

Influence of planning

This study highlights the spatial distribution for potential hydro sites. To be most viable they need to be located within reasonable proximity to a grid connection (although due to the scale of the schemes, this does not need to be a large connection), and most potential sites are, naturally, predominantly rural, with little scope to vary the site. Given the spatial options, major new development is unlikely to be situated in a way to take direct advantage of hydro sites, but might make contributions through allowable solutions to help support schemes.

5.2.4 BIOMASS POTENTIAL

Biomass is an organic fuel, which can be used to produce low carbon energy. Whilst burning biomass does release CO_2 emissions, CO_2 is absorbed from the atmosphere during the growth and production and so the net lifecycle CO_2 emissions are zero. In reality, all biomass fuels have an associated CO_2 intensity due to additional energy required for collection, processing, and distribution. Transportation can be a large element of this for raw fuels, whilst heavily processed fuels such as wood pellets may require additional energy input during the process stages.

There are a number of types of biomass fuel available which can determine how energy is generated. The two primary types are woody biomass (wood) and wet biomass (food waste and farm wastes). Woody biomass can contribute to generation of heat through either direct combustion in individual biomass boilers for buildings and district heating systems, and it can contribute to the generation of both heat and power through the use of a combined heat and power system (CHP). Biomass CHP can deliver greater CO_2 reductions due to the offset of high carbon grid electricity. The wet biomass feedstocks are less suited to combustion (unless dried, which requires additional energy input) and are typically used in digestion systems such as anaerobic digesters to generate biogas. This can then be used in a CHP system, or collected for use in other gas consuming applications.

The sourcing of biomass is critical when considering resource potential and sustainability. The general resource availability is extremely limited at a local level, but the potential obviously increases if import potential is included. There is concern that excessive specification of biomass technologies on a site-by-site basis will lead to either longdistance import of biomass material or the sacrifice of food-producing arable land to grow dedicated biomass crops. For this reason, there is a need to take a region-wide approach to biomass sourcing and supply to ensure that biomass is both available for energy use, but that its use is managed and sustainable and that waste biomass sources are utilised first. One way of assessing the potential for energy crops is to consider land which is not suited to food crops. However this is a simple, and only one approach, and a wider study may find that in certain areas, biomass should be given a priority over food.

The following sections consider various types of biomass available, which are:

- Biomass suitable for direct combustion in biomass boilers or biomass CHP
    - Waste wood from domestic, construction and industrial uses
    - Forestry residues
    - Fuel crops including miscanthus and short rotation coppice such as willow
    - Straw
- Organic waste suitable for utilisation in anaerobic digestion processes
    - Pig and poultry farming sectors
    - Meat and Poultry Processors
    - Brewing
    - Water industry

Technical potential for biomass combustible in biomass boilers or biomass CHP

Biomass covers a large range of resources including managed woodland, energy crops, straw and waste wood. The first three are obviously rural resources, whilst the latter is linked to commercial and development activities. Results from the regional report are shown in Figures A5 and A6.

For most of the resources, the authorities perform around average compared with the region as a whole. The notable exceptions are:

- *Waste wood* – Lincoln has a high potential for waste wood, linked to commercial activity and development waste.
- *Energy crops* – North Kesteven and West Lindsey have a high potential for energy crops under the medium scenario. However, the DECC methodology medium scenario is very optimistic and the realistic potential is likely to be much lower, albeit still relatively high for the region as a whole.
- *Agricultural arising (Straw)* – Straw is identified as a potentially high resource for both North Kesteven and West Lindsey. Whilst this may be technically true, the DECC methodology does not adequately account for competing demands and markets, and it is important that the straw supply chain is understood at a local level to assess the real availability.

As with other resources, the potential is split into rural (based on population and human activity) and rural resource types.

Technical potential for organic waste suitable for use in anaerobic digestion

The EM Low Carbon Energy Study assesses the potential of a range of energy from waste (EfW) schemes. The outputs from the report are presented in Figure A3 and show:

- West Lindsey shows a strong potential for wet organic wastes (food waste and animal wastes for use in anaerobic digestion) of up to 10 MW. The potential in North Kesteven is lower, and almost negligible in Lincoln.
- Both North Kesteven and West Lindsey are in the highest regional band for energy from poultry waste, due to the extensive poultry farming. The potential is again negligible in Lincoln.
- Central Lincolnshire performs averagely compared with the region as a whole for municipal solid waste, and commercial and industrial waste.
- There is limited potential for biogas from sewage gas and landfill gas across Central Lincolnshire. These resources are closely linked to large population centres hence their low levels in the area.

In summary, the potential for energy from waste technologies based around rural activities including animal and poultry farming is relatively high on a regional scale, whilst the potential from population related activities (Municipal Solid Waste (MSW), commercial and industrial waste, landfill and sewage) is average or low compared with the rest of the region.

Review and Testing of Technical Potential at a Local Scale for biomass for direct combustion

The EM Low Carbon Energy Study concluded that the biomass potential in Central Lincolnshire has the potential to contribute 98.3MW of energy as either electricity or heat. The report also outlines the potential for poultry litter and wet organic waste to contribute 15.6MW to Central Lincolnshire's renewable energy supply. The majority of this is in the rural districts of North Kesteven and West Lindsey. The map in Figure 39 shows the potential areas for biomass resource in Central Lincolnshire. Areas of the map coloured grey are of a high enough quality to be set aside for agricultural land. The light green areas suggest areas which may have some level of feasibility for biomass crops, whilst the orange areas have the greatest potential for biomass crops. Dark green areas show woodland that could be managed to provide woody biomass. While the map uses data from the EM Low Carbon Energy Study, their methodology for determining yield potential is unclear.

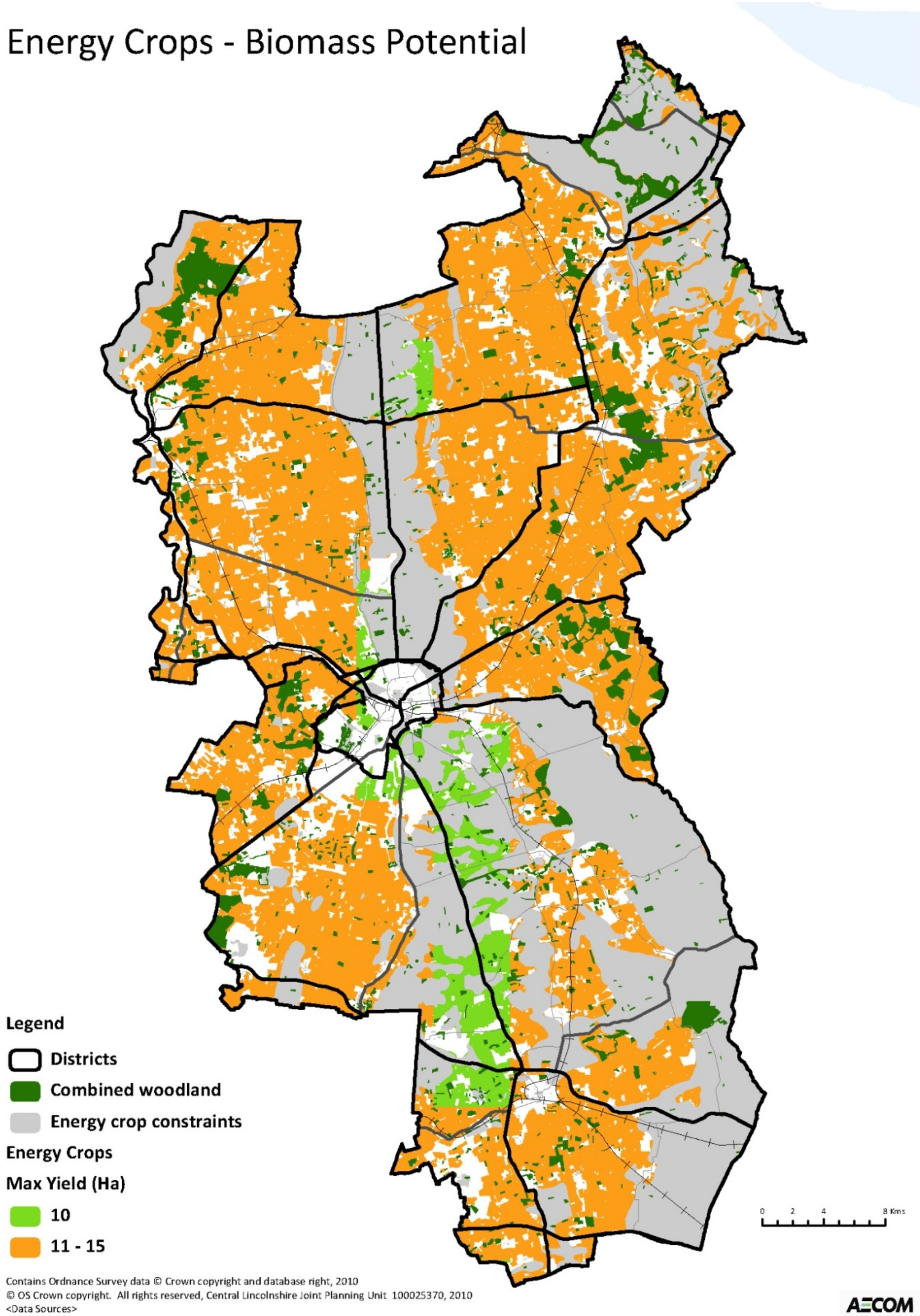


Figure 39: Mapped biomass resource potential in Central Lincolnshire.

Biomass available from woodland management

The EM Low Carbon Energy Study concluded that the managed woodland had the potential to supply 10.7MW of heat or 1.8MW of electricity by 2030. These biomass resources should be managed on a County or Regional scale, as management phasing will mean that different areas of forest have waste arising at different times. Biomass supply chain coordination provides an opportunity for the Lincolnshire authorities to establish a local supply scheme. Hill Holt Wood, a local woodland operating as a social and environmental enterprise, is one organisation that already works with North Kesteven District Council and should continue to be a partner for Central Lincolnshire planning authorities.

It is important to recognise that managed woodland in general is only a small fraction of the overall woodland in an area. Therefore, by increasing the amount of managed woodland, the potential resource can also be increased. However, collecting resource from woodland which is currently not managed may be more challenging – these woods are in general smaller and more dispersed than the managed woodlands, meaning that a large number of landowners will be involved, who may not have the capacity to take on additional roles.

Biomass Potential from Fuel-crops – short rotation coppice (e.g. Miscanthus)

Figure 39 shows the biomass potential for energy crops using grades of agricultural land across Central Lincolnshire. One way to estimate the potential for cultivating bio-crops is through the amount of grade 3 and 4 agricultural land available. Grades 3 and 4 are considered potentially suitable for fuel crops as they preserve grades 1 and 2 – the most productive land for agricultural crops – but are still of sufficient quality for biomass growth requirements. As Central Lincolnshire has a large portion of land graded 3 and 4, there could be a large opportunity for the growth of energy crops.

Considering the time required to secure land and cultivate energy crops, it is expected that they would require more time to provide a secure supply chain than through using existing forms such as woodland trimmings and waste wood which is already available. The market price for biomass will drive the demand for energy crops. The increased competition for limited fossil fuel resources and a rising cost of carbon will drive an increase in the demand for biofuels. In order to achieve the national target of 12% renewable heat, Central Lincolnshire should first seek to harness waste wood and forestry arisings, along with straw before supplementing supply with local bio-crops if viable and land is available. Where local supply-chains are not in place, fuel can be imported from elsewhere, but this may not be as sustainable from a carbon perspective.

Biomass Potential from Straw

The theoretical straw arisings are large and a number of studies examining straw suggest that this could be a significant future energy resource. However, straw is effectively a market commodity with many competing uses, and in reality, it is likely that only a fraction will be available for energy production. The EM Low Carbon Energy Study suggests a potential of circa 39 MW capacity by 2020 from straw, generating approximately 190 GWh electricity per year. This capacity is identical to the proposed Sleaford straw burning plan and therefore this is likely to achieve the potential. It is possible that some of the straw for Sleaford will not be locally sourced but this could change during the lifetime of the plant depending on market conditions.

Further straw use needs to consider the competing uses. Livestock rearing is a significant consumer of locally generated straw for bedding and food and this will reduce the available amount. In addition, high fertiliser prices (fertilisers are fuel intensive and so can be expected to rise in price) are encouraging farmers to increasingly plough the straw back in to condition the soil and add nutrients. Again, this reduces the available amount. The eventual potential for energy from straw burning will depend on the market conditions and the price of straw has been steadily rising over recent years and currently ranges from £38 to £50 per tonne depending on time of year. A high price of straw will limit the viability as a combustion fuel. It is therefore probably safe to assume that the potential will be met by the proposed Sleaford plant unless the market conditions change or there are large imports of straw.

Biomass available from waste wood streams

Municipal and construction waste streams offer potential for source separated fuels (wood fuels) that can be combusted in biomass plants. This can be economically attractive because waste handlers can avoid disposal costs by using waste wood rather than landfilling, and generating energy revenue. The EM Low Carbon Energy Study estimated that Central Lincolnshire has the potential to contribute 1.52MW of heat from waste wood by 2030. Alternatively, this waste wood could be used to generate 1.77MW of electricity.

Currently, in North East Lincolnshire near Immingham, a biomass plant, which uses waste wood as its energy source is under construction. When completed, the plant will be capable of producing 65MW of electricity, displacing 400,000 tonnes of waste wood from landfills in the process[30]. This is clearly a larger capacity than indentified in the regional report and so may be importing waste wood from other authorities, as well as using sources not identified in the regional report.

Potential and constraints for biomass for anaerobic digestion

There are a variety of waste streams available which could be used for energy production in anaerobic digestion (AD) schemes. AD refers to the decomposition of putrescible waste such as food waste, animal slurries and potentially a proportion of garden waste in anaerobic (oxygen-less) conditions. AD produces a biogas made up of around 60 per cent methane and 40 per cent carbon dioxide (CO_2). Anaerobic digesters also produce valuable fertilizer as a by-product which can be recycled back onto the land aiding agricultural productivity. It is important when siting an AD scheme, that the disposal of the feedstock is considered as importantly as the availability of feedstock.

The biogas from AD schemes can be burned to generate heat and electricity in a CHP engine, with revenue streams potentially available from both. Alternatively the biogas can be captured and either compressed for storage and distribution, or upgraded and injected into the gas grid. Biogas is in many ways a good alternative transport fuel – particularly for buses and heavy vehicles. Alternatively, if injected into the grid, biogas can help decarbonise the use of natural gas across all sectors. It is important to note that the AD process itself requires a proportion of the electricity and heat output to maintain the process.

As a transport fuel, the potential of biogas has already been demonstrated in Europe. In the city of Lille[31] in northern France, 120 of the city's 400 buses run on biogas made from locally sourced food waste, with one new gas-power bus commissioned every week. By 2012 all buses will run on a mix of one-third natural gas, two-thirds biogas. The biogas is produced by an anaerobic digester at the bus terminus, which fuels not only the buses but also the lorries that collect the waste. This means there is a high degree of insulation to short term interruptions in the oil supply. In Switzerland there are 3500 vehicles running on biogas, and there are also major programmes in Sweden and Germany. Lincoln recently began operating eleven stagecoaches, which use biomethane sourced from household and animal waste. The converted buses are expected to reduce carbon emissions by 40% compared to traditional diesel buses.

Some British local authorities (Norfolk, South Staffordshire) have commissioned anaerobic digesters as part of their waste strategy, but none have yet exploited the full transport potential of biogas – which is considerable. According to a report by Environmental Protection (formerly the National Society for Clean Air), Britain produces some 30 million dry tonnes of food waste and agricultural manure per year, and this could produce over 6 million tonnes of oil equivalent in biomethane. That equates to about 16% of total transport fuel demand, while public transport consumes less than 5%. In other words, Britain could fuel a public transport network three times bigger than today's on food and agricultural waste alone.

Lincolnshire County Council commissioned a report on low carbon transport, *Developing Lincolnshire's Low Carbon Transport Strategy: Biomethane as a Road Fuel for Lincolnshire*. The report concluded that 37% of the County's

[30] http://www.ft.com/cms/s/0/dbcec306-8b30-11dd-b634-0000779fd18c.html#axzz1UWuHMlre
[31] The Oil Depletion Analysis Centre and the Post Carbon Institute (2009) "Preparing for Peak Oil – Local Authorities and the Energy Crisis" ODAC

carbon emissions are from transport. As a result the report called for biogas to be used in HGV vehicles and buses. The report reasoned that biogas was more efficient as a transport fuel than when converted to electricity; biogas achieves significant air quality improvement and noise reduction; is less expensive than fossil fuels; and estimated the potential to reduce the County's emissions by 9% (168,000 tonnes of CO_2 per year)[32]. Extrapolating based on population suggests that Central Lincolnshire could reduce its carbon emissions by over 46,000 tonnes of CO_2 per year if its buses and large fleet operators converted to biogas.

AD: Potential for household organic waste feedstock

It is possible to estimate the suitable waste arising in the study area based on an understanding of the average household waste per person produced in the authority area, as recorded in the Best Value Performance Indicator, along with the population data for 2008.

Table 21: Waste Arisings from Waste Best Value Performance Indicators

	Annual household waste per person (kg)	Total population waste (t)	Biomass available (t)
Lincoln	432.9	38,268	19,134
North Kesteven	475.0	50,398	25,199
West Lindsey	427.4	37,996	18,998
Central Lincolnshire	446.9	126,662	63,331
Lincolnshire	420.7	427,684	213,842

Table 21 shows that the annual household waste per person is above the Lincolnshire average for all districts in Central Lincolnshire. On a percentage basis, while Central Lincolnshire makes up 28% of the Lincolnshire population, it is responsible for 30% of the County's waste generated. While this is not a substantial difference, efforts should be made to reduce household waste in the HMA. Lincolnshire County Council is in the process of developing its waste and recycling targets, but does list waste minimisation and improved recycling rates as an interim objective.

AD - Potential for utilisation of water industry sludge

The water industry produces both wet and dry sludge in large quantities, which can be recycled for energy recovery. Many of the biomass electricity projects in the UK are sewage gas projects that are less than 2.2 MW in electrical capacity[33]. The EM Low Carbon Energy Study suggests that Central Lincolnshire has the potential to contribute approximately 0.16 MW through sewage gas energy recovery. However, energy from sewage is likely to be delivered at a county level and Central Lincolnshire planning authorities should work with the County authority and utility providers to drive renewable energy initiatives for the sewage plants in this area.

[32] Lincolnshire County Council (2009) Developing Lincolnshire's Low Carbon Transport Strategy – Progress to Date: Biomethane as a Road Fuel Available:
http://www.epic-lincolnshire.org/uploads/files/AD%20Action%20Plan_Mouchel.pdf
[33] East of England Biomass Foundation Study report, Renewables East, November 2005

Examining Delivery – case studies, opportunities and constraints

Case Studies

Anaerobic Digestion – Branston Potatoes

Branston Potatoes installed an anaerobic digestion plant, which uses potatoes unfit for consumption to power its facility. Not only does this reduce waste, but it also reduces the factory's electricity demand and reduces costs for the company in the process. One less heavy goods vehicle, which would otherwise be used to transport the unfit potatoes, is taken off the road each day.

The company's desire to reduce wasted potatoes and reduce fuel costs drove them to install an anaerobic digestion plant using funding grants from the Rural Development Programme for England (RDPE) and DEFRA.

Lessons learned:

- The Branston factory proves that biomass can be used to power large industrial facilities .
- The Local Authority benefits environmentally from the increase in renewable energy installed, and reduction in energy demand and CO_2 emissions. This also helps Central Lincolnshire achieve renewable energy targets.
- There are many sources of biomass. In a rural parts of Central Lincolnshire, different forms of agricultural waste can help provide low carbon power.
-

Opportunities

- **Establishment of a supply chain** – While there is already a biomass resource available, there is no supply chain set up to collect, process and distribute the fuel types. The Central Lincolnshire authorities could help support the set up of a local supply chain. Hill Holt Wood might be an effective partner to help start a chain, but it will eventually require the coordination of a number of different land owners to maximise the resource.

- **Management of Lincolnshire Wolds AONB** – Natural England has developed an extensive analysis of how short rotation coppice and miscanthus might impact on various landscape characteristics within the Wolds. The assessment concludes that the effect of growing biomass in parts of the Wolds AONB may have either a neutral impact or positive impact if certain restrictions are met[34]. The AONB could therefore be used to contribute to renewable energy and CO_2 reduction in a low impact manner, and could be a partner in growing bio-fuel crops in appropriate locations, and managing woodland within the park in a sustainable manner.

- **Household organic waste** – Anaerobic digestion can produce between 75 and 150 kWh per tonne of municipal solid waste, and therefore implementing an organic waste collection within Central Lincolnshire's districts could contribute meaningfully towards renewable energy targets. This would also reduce the amount of waste sent to the landfill with the financial benefit of reducing landfill tax levels.

- **Partner with National Farmers Union –** As the representative body for farmers in Britain, the NFU is an important organisation that can provide guidance on increasing the amount of biomass planted by local farmers. As with all other farming activities which are market driven, it will be difficult to support a local market unless there is support through the development of a local supply chain for biomass.

[34] Natural England. JCA No. 43 – Lincolnshire Wolds. Available: http://www.naturalengland.org.uk/ourwork/farming/funding/ecs/sitings/areas/043.aspx

Constraints

The conversion of potential to delivery requires consideration of a number of factors including:

- **Management of local forests** – Because the ownership and status of local forest varies, a management plan coordinating sites and opportunities could be established in partnership with the Forestry Commission and other land owners (who are in control of the majority of woodland). The management plan could consider how forest management can be delivered to ensure the biomass yield is available for local use. There is potential for this to be undertaken either in partnership with, or at the county level.
- **Management of environmental effects of biomass combustion** - Impacts that are of concern relate to: emissions (in particular Particulate Matter and nitrous oxide (NOx) emissions), flue stack height, transportation environmental costs, odour and potential fire hazards from stored fuel. These issues are covered by the Draft NPS for Renewable Energy Infrastructure.
- **Availability** – The resource availability for all biomass is constrained, and will become more so as demand increases. This introduces future risks in the form of availability and cost, and the development of a local secure supply chain with long term contracts can help to mitigate these.

Influence of planning

The Central Lincolnshire authorities need to consider the balance of agricultural land for the growing of food crops versus energy crops. One general guideline to follow is to focus the development of bio-fuels in land graded 3 and 4. Grade 1 and 2 lands should be protected and only used for growing food crops. However, as each piece of agricultural land is unique, farmers should be involved in these decisions, which may ultimately, be determined by the market for food and energy crops.

It is also important to work with Lincolnshire Wolds AONB to make use of suitable land for growing bio-fuels within their jurisdiction. Natural England has noted that the Lincolnshire Wolds can contribute to wood fuel based renewable energy, and suggests that there may be benefits in growing energy crops in certain areas. As stated, "Energy crops could be accommodated in the arable landscape if care is taken to avoid disrupting the extensive views and by not obscuring features such as landmark woodlands and historic landscapes on higher ground."[35]

In general, the Central Lincolnshire authorities should take a supportive role in establishing biomass supply chains to ensure a local biomass supply is available to new development. This is an opportunity for Central Lincolnshire to get closer to satisfying its renewable energy goals, and providing a secure energy supply.

5.2.5 COMBINED HEAT AND POWER PHYSICAL POTENTIAL AND CONSTRAINTS

Combined Heat and Power (CHP) systems generate electricity and collect the waste heat from the generation process for distribution and use. This means that the overall efficiency of CHP systems is high compared with the incumbent of power stations and boilers. An additional benefit of electricity generation at a local scale from CHP engines is that transmission losses can be reduced, again improving the overall efficiency of the system. A typical gas engine CHP can achieve around 35% reduction in primary energy usage compared with conventional power stations and heat only boilers. However, CHP can also be run using biomass/biogas to provide a low carbon solution, with reductions in emission nearing 100%. Figure 40 shows the CHP arrangement compared with traditional energy generation.

[35] Natural England. JCA No. 43 – Lincolnshire Wolds. Available: http://www.naturalengland.org.uk/ourwork/farming/funding/ecs/sitings/areas/043.aspx

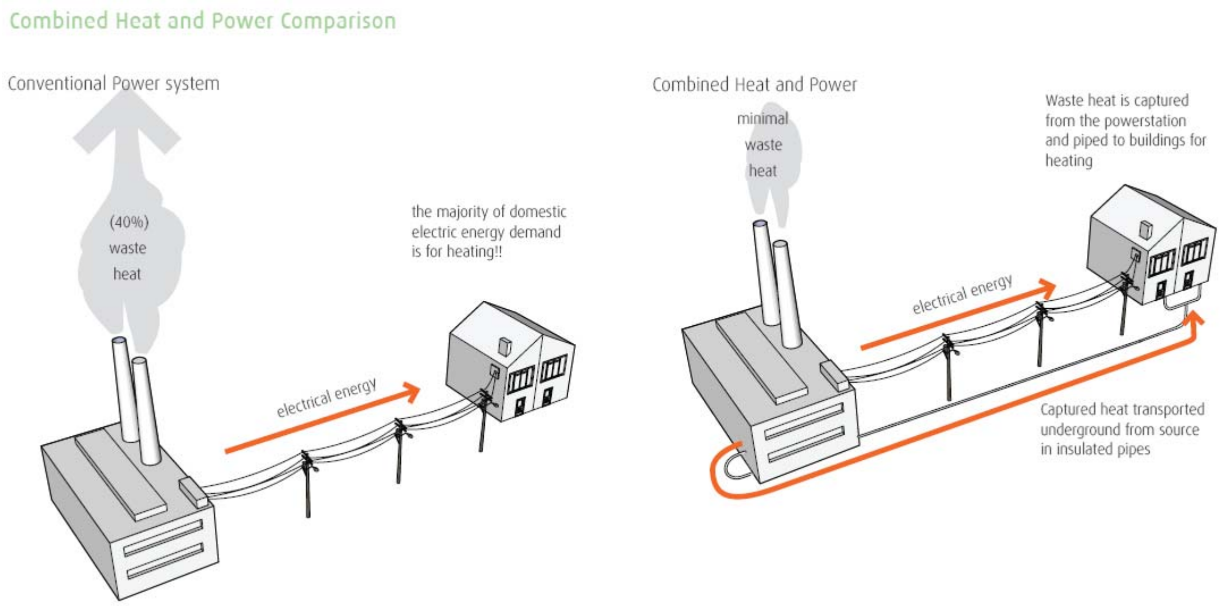


Figure 40: CHP comparison

Technical Potential

There appears to be very limited potential for district heating and CHP due to the predominantly rural nature of Central Lincolnshire. The EM Low Carbon Energy Study estimates that a 3% reduction in CO_2 may be achievable by 2031, typical of the rural HMAs. These estimates are based on the heat demand and heat density at a relatively coarse level and will therefore miss the opportunities for small scale district heating schemes. It is likely that any areas identified in the EM Low Carbon Energy Study, due to the mapping resolution, are in Sleaford, Gainsborough, and Lincoln.

Scale of potential

District heating networks allow the distribution of heat from a thermal generator to individual customers such as homes and businesses. District heating is generally only viable in areas which have a relatively high heat density. This means that sufficient heat can be sold over the network to provide an economic return. In low density areas where a large amount of district heating pipework is required for a relatively small heat demand, the high cost of the network combined with low heat sales means that, generally, the schemes are uneconomic.

Another factor to consider when developing heat networks is the type of customers. In general, a mixed customer base is beneficial because it provides a diverse heat load, allowing the CHP plant to operate for long periods. For example a mix of housing (heat demand in the early morning and evening) and business use (heat demand during the day) provides a relatively constant base load. The size of customers is also important, and in many heat network examples, an “anchor load” is important which provides a reliable heat demand and a degree of economic security. Hospitals and Universities are good examples of anchor loads due to their size, diversity, and usually public ownership.

The combination of district heating and CHP provides a method of low carbon heat and electricity generation in urban areas. For smaller scale schemes, the most common technology are gas engines, although larger schemes may be connected to biomass power stations, energy from waste plants, or even fossil power stations. Biomass CHP technology is still developing in the UK and most systems are at a pre-commercial stage. However it is expected that this technology will continue to mature and reach commercialisation. Hence, depending on delivery conditions it may be more suitable to implement gas-fired CHP in the interim and convert the fuel source to biomass or biogas as the technology and supply chain develops. However, the introduction of gas CHP is still beneficial as it contributes directly to CO2 reduction targets through efficient supply of electricity and heat.

Figure 41 highlights areas which have a heat demand intensity of greater than 20kWh/m2. These areas are expected to be commercially viable for the installation of a district heating or CHP system based on professional experience. The darker the red areas represent locations where more energy savings can be realised. As can be seen, these areas are focused around urban areas – Gainsborough, Lincoln, North Hykeham, Sleaford and Market Rasen. Figure 42 maps the Strategic Housing Land Availability Assessment (SHLAA)36 over the heat density map and suggests areas that might be capable of supporting heat networks based on future developments.

[36] The SHLAA identifies and assesses sites' potential for housing, and proposes when they are likely to be developed.

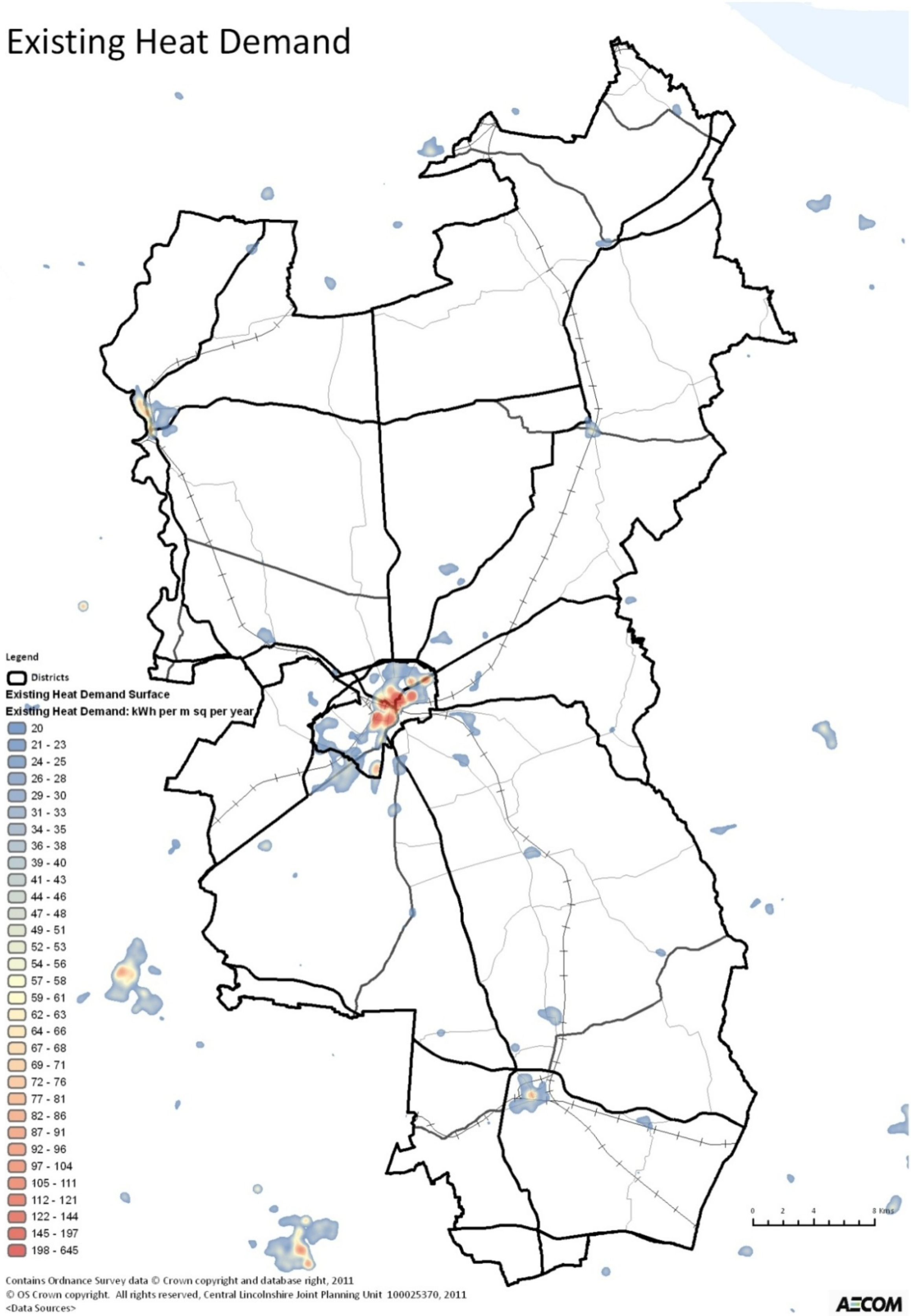


Figure 41: Current distribution of heat density

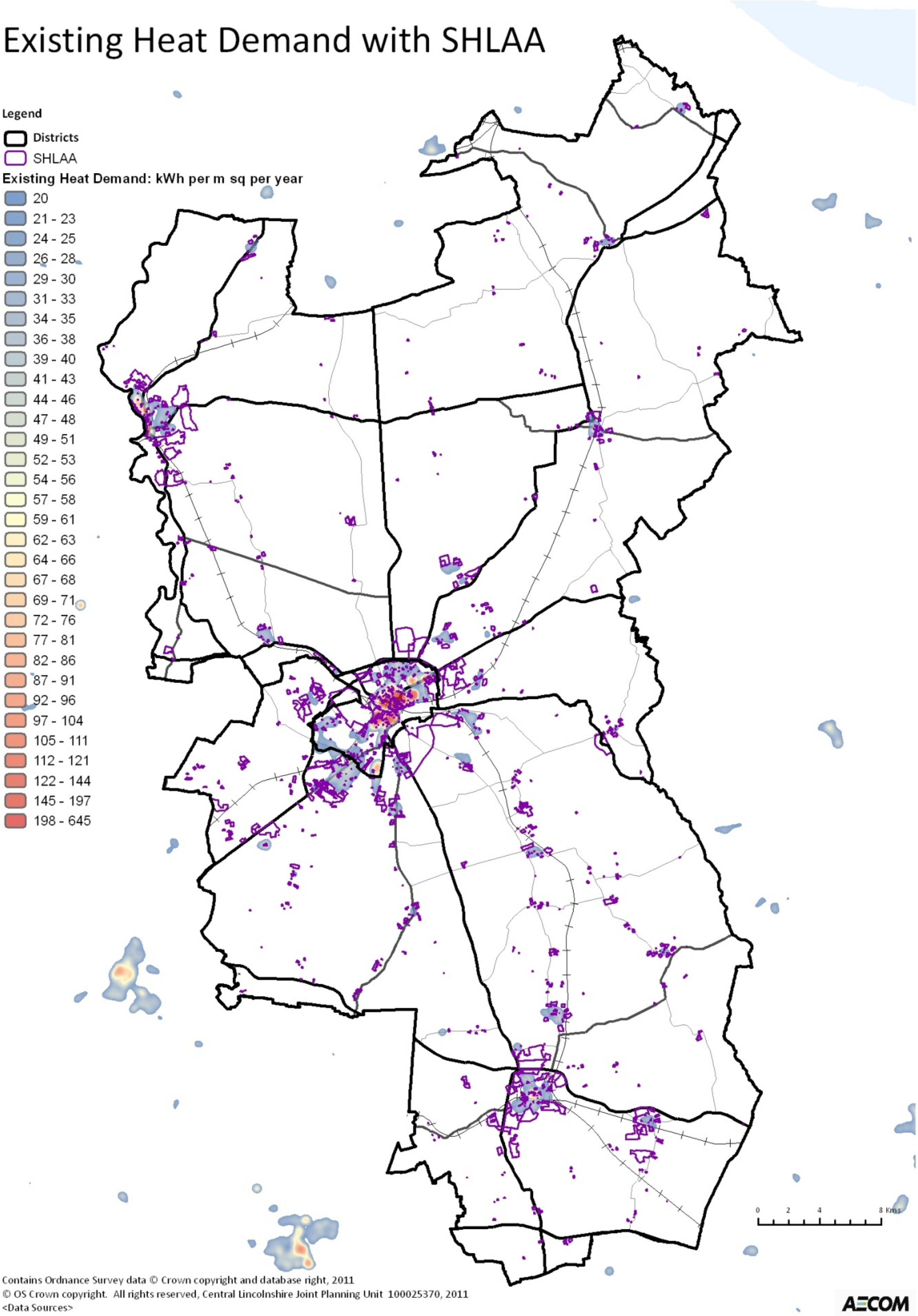
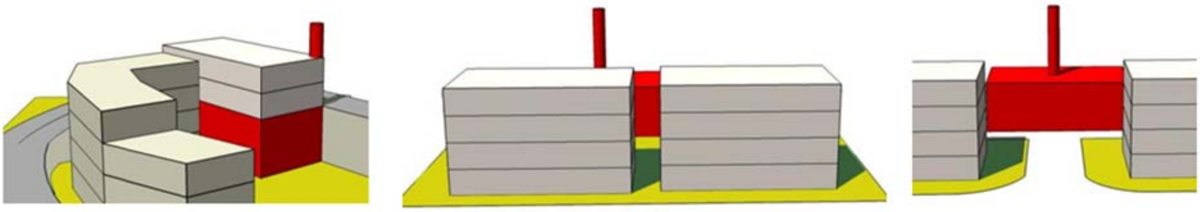


Figure 42: SHLAA in relation to current distribution of heat density

CHP linked to a neighbourhood via a district heating arrangement will be able to meet buildings space heating and hot water requirements. For residential developments, densities of typically at least 50 dwellings per hectare are preferable for commercial viability although this depends on each individual scheme. The size of the CHP plant will depend on the size of the heat network and the connected heat load and its demand profile. The energy centre size needs to be capable to house the CHP plant, back up boilers and thermal storage, and a size of circa 500 m^2 – 1000 m^2 footprint would be required for a development of around 2000 homes. When considering biomass CHP, the plant requires significantly more space, and additional space is required for biomass storage and delivery access. All CHP energy centres will need to accommodate a flue for the exhaust gases. These typically need to be a few metres higher than all the neighbouring buildings.

As CHP works best in higher density areas, such as Lincoln, Gainsborough and Sleaford, siting facilities can become a challenge. With sensitive and creative urban design, there is however, limited reason as to why they would not be able to be integrated into a townscape. With this in mind, the figure below highlights some potential options for urban design of CHP.



Bury it? Hide it? Celebrate it?

Figure 43: Design options for siting CHP

Traditionally CHP facilities have been designed to generate maximum revenue and rate of return. This has meant operating them in electrically led mode resulting in times when excess heat is produced. This can be inefficient in terms of energy demand and CO_2 emissions. To maximise CO_2 savings, CHP facilities should be designed in a heat led mode so that no or little excess heat is generated that cannot be used. "Good Quality" CHP has to meet certain efficiency criteria which enables access to incentives such as Climate Change Levy Exemption, reduced business rates and enhanced capital allowances. In general, Good Quality CHP will have very low or zero levels of waste heat. Where waste heat is generated by a CHP system, ways of using the heat should be identified, such as storage or use in absorption chillers. However the CO_2 benefits of these should be assessed because the alternative of not producing waste heat and using an alternative technology (such as electric chillers for cooling) could be more efficient.

Examining Delivery – case studies, opportunities and constraints

Case Studies

South Carlton Village – Burton Estates

South Carlton Village installed a district heating network, which supplies energy to multiple households from a biomass boiler. While district heating is normally only thought feasible in high density developments, and generally requires a key anchor load, this project suggests that when other factors, such as carbon reduction and fuel poverty, are the motivation, district heating networks can be feasible.

In response to a need to upgrade its heating scheme, Burton Estates converted the properties from oil and electric-based heating to a district heating network, which partially uses local woodchip supply as its fuel. Despite its low density nature and lack of anchor load, Burton Estates in South Carlton prove that district heating can be accomplished in a rural context. The system has also been designed to not disrupt the rural character of the area by housing the boiler in a redundant barn. When taking into account the potential Renewable Heat Incentive (RHI) to be introduced in 2012 (and applies retroactively to renewable heat projects from 2009), the payback period for installing the £350,000 system is 12 years (assuming income of 3p/kWh).

Lessons learned:

- District heating schemes should be evaluated through a cost-benefit analysis that considers a full range of benefits, including carbon reduction, energy security, fuel poverty and energy pricing assurance.
- In rural areas that are not served by the gas grid, biomass is often a favourable low carbon and economic alternative.
- Excellent opportunities for district heating can be delivered by partners that have a large concentration of property ownership in the same area, such as RSLs and local authorities.

Opportunities

Successfully delivering CHP requires the consideration of a number of factors including:

- **Anchor loads** – The location of such facilities is crucial as district heating schemes often need an 'anchor load' or consistent energy user to operate efficiently. Therefore, areas around these anchor loads are priorities for development. Anchor loads include larger buildings such as schools, hospitals, and retail clusters
- **Heat Generators** – These are facilities that generate substantially more heat than they consume, and could therefore be a supplier of heat. Large industrial sites are often heat generators. In Central Lincolnshire the proposed Energy from Waste plant at North Hykeham will be a heat generator and this heat should ideally be exported to a heat network[37].
- **Council property –** Retrofitting private properties can be a slow and time consuming process before the required critical mass for a district heating network is achieved. Therefore, an opportunity exists for council owned property to retrofit their properties first. In addition to council-owned properties, there might be potential for Community Energy Saving Program (CESP) funding to facilitate the development of an effective CHP network, provided the LPA is able to match CESP funding, as the programme requires.
- **New developments –** New developments of a large scale (300+ homes) or with a substantial mix of uses that will create a strong heat demand density may drive their own site-wide CHP and district heating systems. However, new developments are often built in phases. Each phase on its own is often small and makes district heating on a larger scale difficult. Where possible, new developments should be built in conjunction with large anchor loads, such as hospitals, schools, or community facilities that would make a

[37] A study is currently being conducted by Cofely examining the potential for using the heat from North Hykeham for a heat network.

larger CHP network feasible. Plans for the southern neighbourhood extension in Gainsborough include a CHP powered energy centre to provide low carbon energy to the 2,500 new homes. This should prove to be a catalyst for the surrounding area in Gainsborough.

Constraints

- **Heat network expense –** Because heat networks require connecting buildings via underground piping, retrofitting established neighbourhoods with heat networks can be expensive. For this reason, it is important to include heating pipes as part of the underground infrastructure whenever possible, such as when road maintenance makes it feasible.
- **Low density developments** – The lower density a development is, the less economical a heat network becomes. While developments that are not dense enough to support heat networks should be avoided, they are a reality (refer to the South Carlton case study). In these instances, individual biomass boilers are more feasible.
- **Existing infrastructure** – Connecting developments underground can encounter a number of infrastructure obstacles. Due to the expense and inconvenience of digging up railway lines, crossing railway tracks to connect a heat network is one of the most prevalent infrastructure constraints. With the move to place increasingly more infrastructure underground – including water, electricity and broadband – finding enough space to place heat piping can be another constraint.

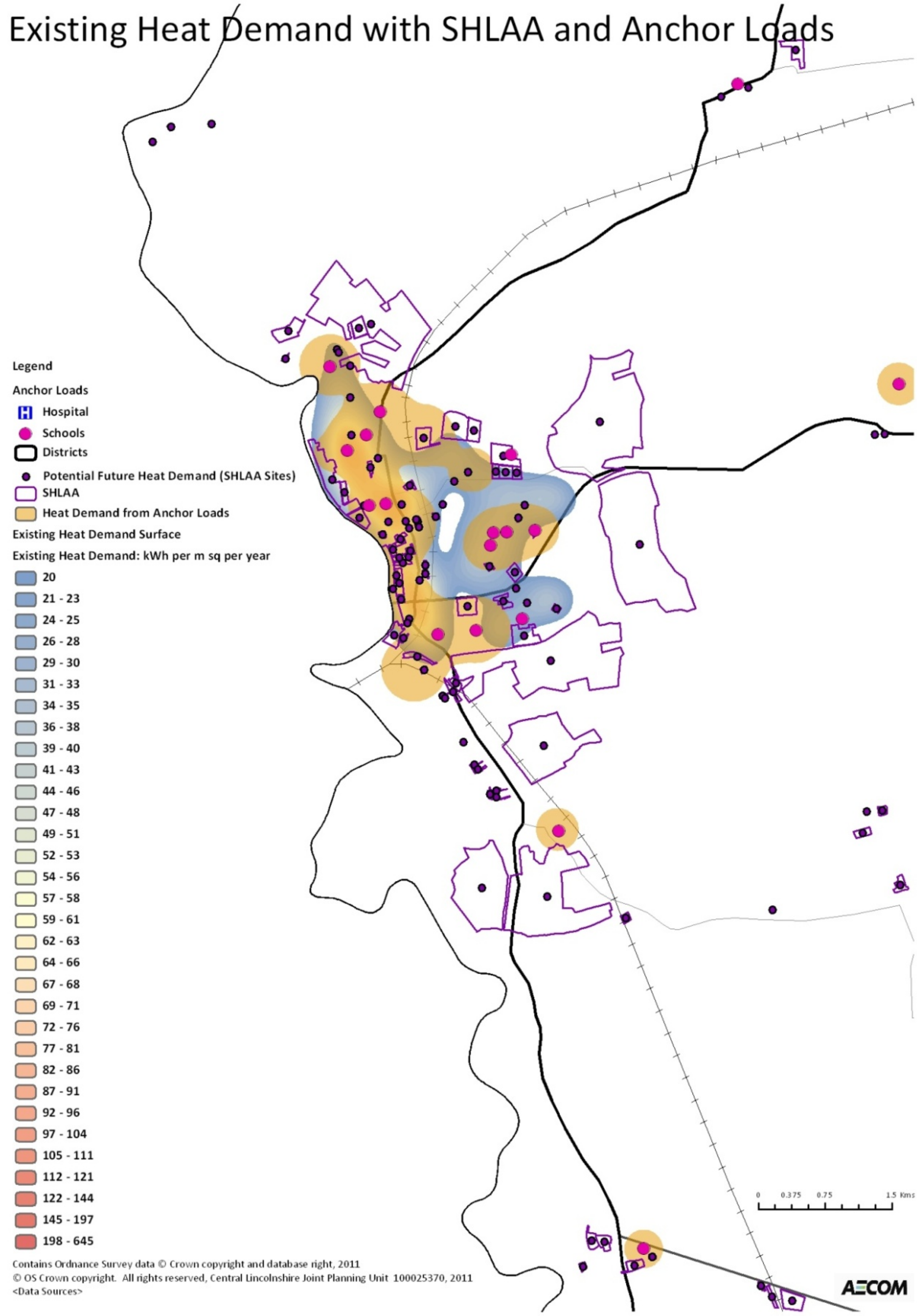


Figure 44: Key anchor loads in Gainsborough in relation to current distribution of heat density

The Figure 44 portrays the heat density in Gainsborough. As can be seen, there is strong potential for a heat network to be established throughout the town, particularly along its western edge where there are a number of schools and future potential development sites which could connect, helping them to meet future Building Regulations zero carbon targets. The development of Gainsborough's southern neighbourhood extension will provide additional heat demand helping to support the rational for heat networks further. As the extension is to include a CHP heat network, this should work to make other potential development sites in the area more desirable for development. It should be noted that existing infrastructure such as railway lines needs to be taken into account and that crossing these can incur significant costs.

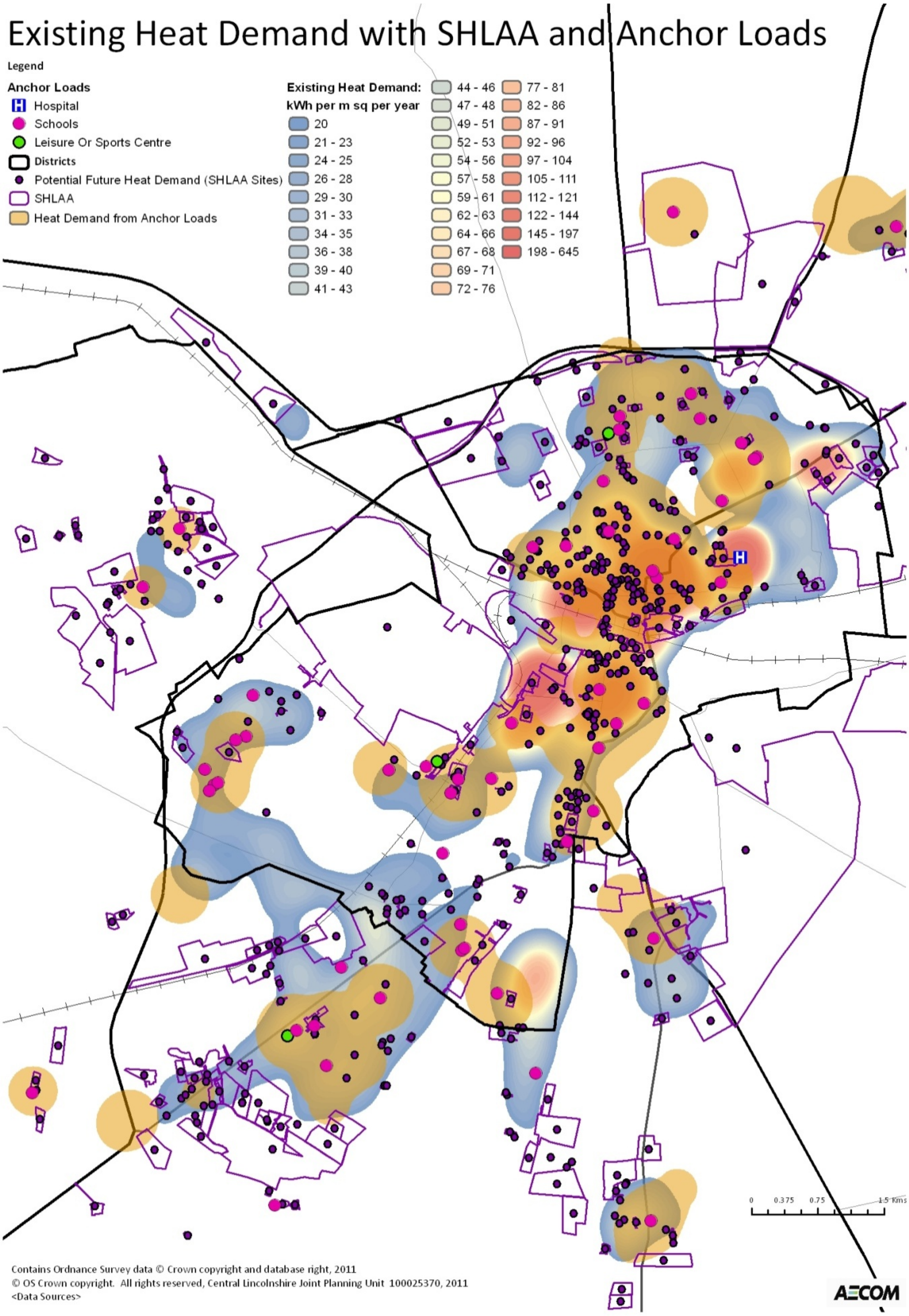


Figure 45: Key anchor loads in Lincoln in relation to current distribution of heat density

Figure 45 shows that that within Lincoln, there is a high heat density throughout the city. With a number of potential anchor loads in the area combined with areas of relatively high heat density, there are a number of potential opportunities for district heating networks.

The development of a heat network in this area presents the opportunity to require heat network infrastructure and connections to be incorporated for any site that comes forward for development into the area.

The nature of the city needs to be considered when assessing the potential for heat networks. Whilst the central parts of the city have the highest heat density, the historic nature of the centre and types of customers (mainly small shops and businesses) may make the installation and economic viability challenging. On the outskirts of the city, the heat density is generally lower. However these areas may facilitate lower cost installations and the nature of the customers, typically larger businesses and sites, could improve the financial and technical viability.

As with Gainsborough, the constraints posed by existing infrastructure, especially the railway, need to be considered in any viability work.

The development of the proposed Energy from Waste plant in North Hykeham provides an opportunity for the installation of district heating infrastructure in the surrounding area to utilise waste heat arising from the electricity generation process. A district heating network connected to the energy from waste plant could potentially provide heat to new development areas such as Teal Park and the proposed Western Growth Corridor as well as to existing industrial users in the area. Further discussion is presented in the section testing site options later in this report.

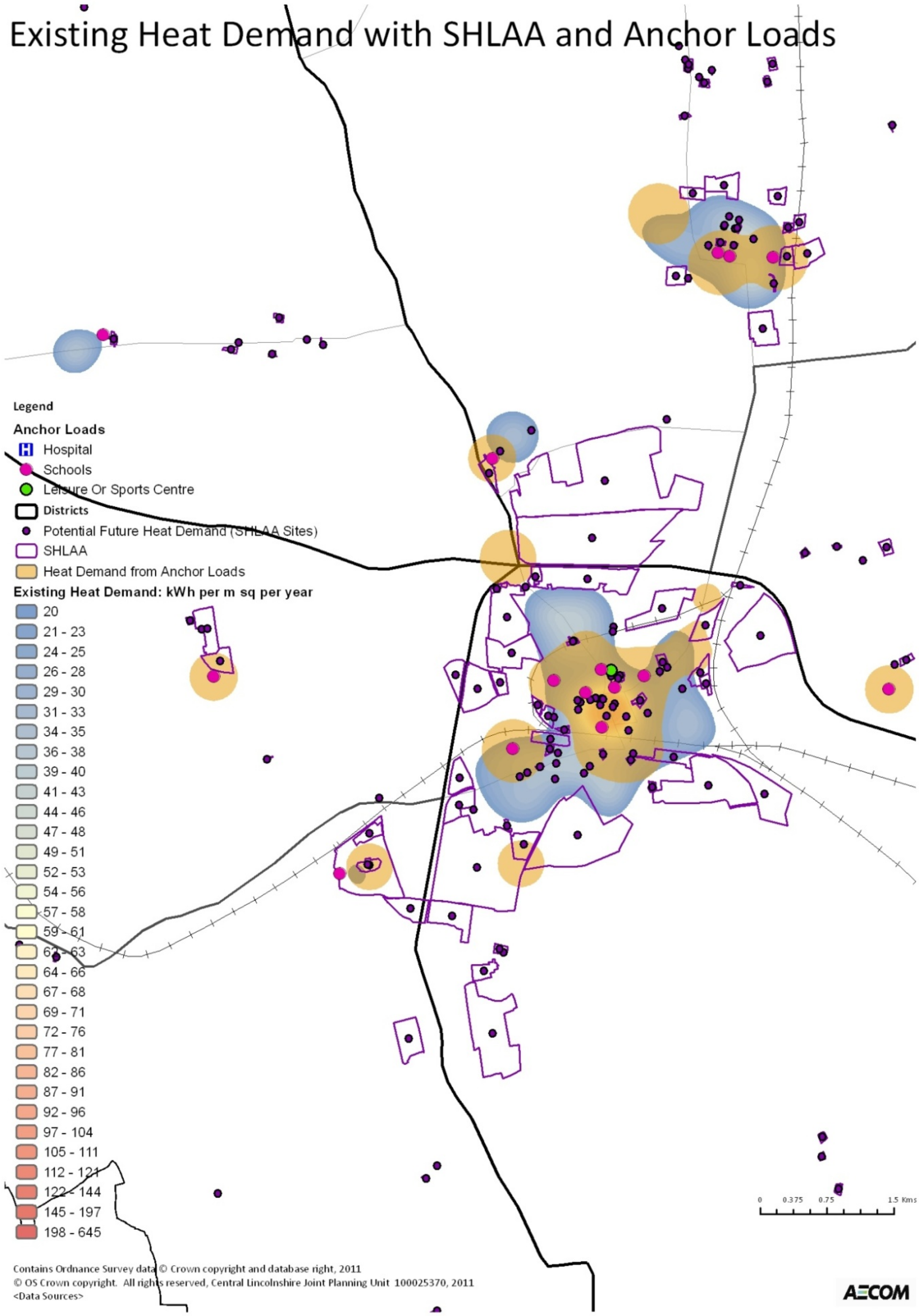


Figure 46: Key anchor loads in Sleaford in relation to current distribution of heat density

Figure 46 shows that Sleaford has potential for a heat network, not surprisingly particularly in the centre of the city. It will be important to determine if the Sleaford Leisure Centre has its own energy supply or if they connect to the main electricity network. Discussing a heat network with them could be the key to unlocking a district heating network in Sleaford as the Leisure Centre could be an effective anchor load. While railway tracks will also need to be considered in Sleaford, the heat density map does suggest that the majority of heat demand lies within the same railway 'borders'. Of course, should surrounding areas be developed, it would be prudent to consider additional heat networks in the future.

Influence of planning

The Central Lincolnshire planning authorities should look at developing and implementing planning policies that facilitate the development of and connection to a heating network. There are a number of strategies planners can employ to influence and encourage the development of district heating networks. Perhaps the most productive strategy would be for the authorities to set aside land for CHP plants and begin retrofitting their own properties, thereby becoming a catalyst in the drive to developing district heating networks for the area. The Woking case study, which follows, is a prime example of a council taking leadership and installing a CHP network throughout its authority area, saving over 40% of its energy consumption in the process. This could be buttressed by requiring key opportunity areas to undertake district heating feasibility studies, which can help ensure CHPs are located in the most effective areas to maximise financial and environmental benefits.

Planning can also require new developments in feasible district heating priority areas to install district heating systems (unless proved unviable). Large mixed use strategic sites can often prove financially attractive to independent Energy Services Companies, or ESCos, who will install CHP and a district heating network, serving customers in the development. CHP is often a cost-effective way of reducing carbon emissions to meet emerging Building Regulations or higher Code targets on large sites. Planning can drive the delivery of CHP on strategic sites by setting carbon reduction targets or requiring feasibility studies to be undertaken.

Within Central Lincolnshire, there are already a number of key sites that could be catalysts in the delivery of district heating networks. The Gainsborough neighbourhood extension and council owned properties represent future opportunities. Currently, however, with no district heating networks in Lincoln, Gainsborough or Sleaford, there is significant potential to reduce the amount of energy used in heating Central Lincolnshire's urban areas and should be a focus for the Central Lincolnshire authorities.

5.2.6 MICRO-GENERATION

The term micro-generation is used to describe small scale technologies (typically less than 50 kW electric and 100 kW thermal). These technologies are usually based in a building or on a small site, providing energy to one or more buildings. This section assesses the following micro-generation technologies:

- Photovoltaics (building mounted)
- Solar thermal
- Heat pumps (air source and ground source)
- Small scale wind
- Micro wind
- Micro CHP (domestic and commercial)

Micro-generation technical Potential

The Central Lincolnshire authorities perform averagely for heat pump technical potential with each authority area having a potential of between 150 and 300 MW. The DECC methodology uses overly optimistic assumptions on heat pumps and does not consider adequately the type and performance of buildings, and therefore the potential in Central Lincolnshire, as with across the rest of the region is likely to be much lower. Further work will be needed to assess the realistic potential based on a more detailed analysis of the building stock.

Central Lincolnshire again performs averagely in terms of solar potential (both PV and solar thermal). As with heat pumps, the DECC methodology is optimistic on assessing solar potential resulting in the outcome being closely linked to the overall number of buildings. Again, more detailed analysis is required.

Review and Testing of Technical Potential at a Local Scale

Assessing the potential for micro-generation technologies requires a different approach to most other schemes. Whereas the other energy generation technologies in this report are largely limited by resource availability, whether that is feedstock, land, or natural resource, micro-generation is generally not geography specific and suitability will depend on building type, operation, layout, and surrounding landscape. Hence the geographic location of Central Lincolnshire has little effect on the viability of these small-scale technologies.

The methodology for calculating the potential for micro-generation is based around the DECC methodology, using simple uptake fractions and defined capacities for different technologies and building types. The DECC methodology overestimates the capacity for some technologies and further constraints have been applied. One example is limiting heat pumps to post 1980 dwellings, which have higher levels of thermal efficiency.

Small scale wind generation is included as a micro-generation technology and is assessed using the above approach, rather than the wind mapping constraints approach, which is used for large scale wind generation. In general, the viability of small scale wind is dependent on micro factors (such as adjacency of buildings) and less dependent on the macro scale constraints such as wind speed, and therefore is more suitably assessed as a micro-generation technology.

Solar energy is a key type of micro-generation. There are two main solar technologies that are generally delivered alongside built development: photovoltaic panels and solar thermal panels. Photovoltaic panels produce renewable electricity and can be mounted on structures or used in stand-alone installations. Solar thermal panels, on the other hand, are commonly used to directly heat water in homes, but can also be used to assist heating. Photovoltaics have a high capital cost in comparison to other renewable energy options, but they are one of the few options available for renewable electricity production and are often one of the only on-site options to assist in CO_2 reduction associated with electricity use. Solar thermal panels are more space and cost effective and are well utilised technology for heating hot water.

Spatially, across the UK the relative benefit of the use of solar technologies varies. Central Lincolnshire's potential for solar energy is average when compared to the rest of the UK average. On a global scale, solar technologies do not perform at high efficiencies in the UK as compared to say, Colorado. Nonetheless, parts of England receive as much, or more solar irradiation as Germany, which has a large installed capacity of solar panels. Figure 47 shows the relative solar exposure of Central Lincolnshire compared with the rest of the UK. To ensure that solar technologies are effective, south facing roof space should be favoured in building design and masterplanning (through street orientation). In more open spaces, such as Central Lincolnshire's rural districts, there are opportunities to generate solar energy on a larger scale. With an abundance of rural land in the area, it is not surprising that the solar farm in Stow, West Lindsey is the first in Central Lincolnshire. The Stow solar farm could be viewed as a catalyst in the installation of additional PV installations in the area.

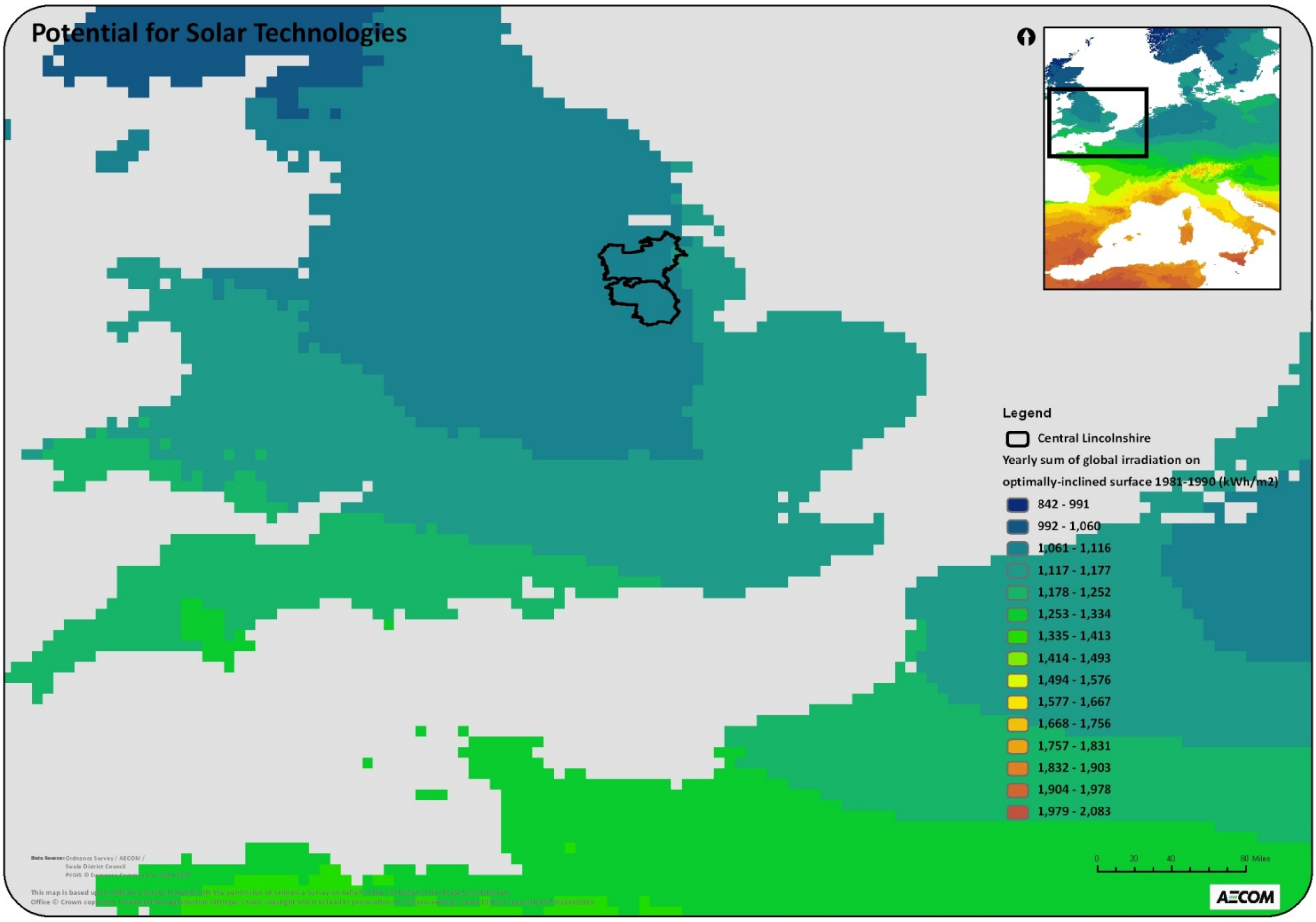


Figure 47: Potential for solar energy in Central Lincolnshire

Micro CHP is also considered in this section for domestic and commercial buildings. At the domestic scale, this technology is currently on the verge of becoming commercially available and could experience a measureable uptake over the next 10 years.

The potential for micro-generation is primarily dependent on the number of buildings to which the technologies can be linked. The constraints analysis therefore considers both the current building stock in Central Lincolnshire and potential growth to 2026.

The data in Figure 48 shows the total resource potential for micro-generation technologies by 2026, split by technology type. The total potential for renewable technologies is 332 MW with a further 109 MW from micro CHP (including thermal and electrical capacity). PV is has the largest single contribution with around 127 MW capacity potential – there are very few locational constraints to PV and through exporting electricity to the grid, it is independent of energy loads.

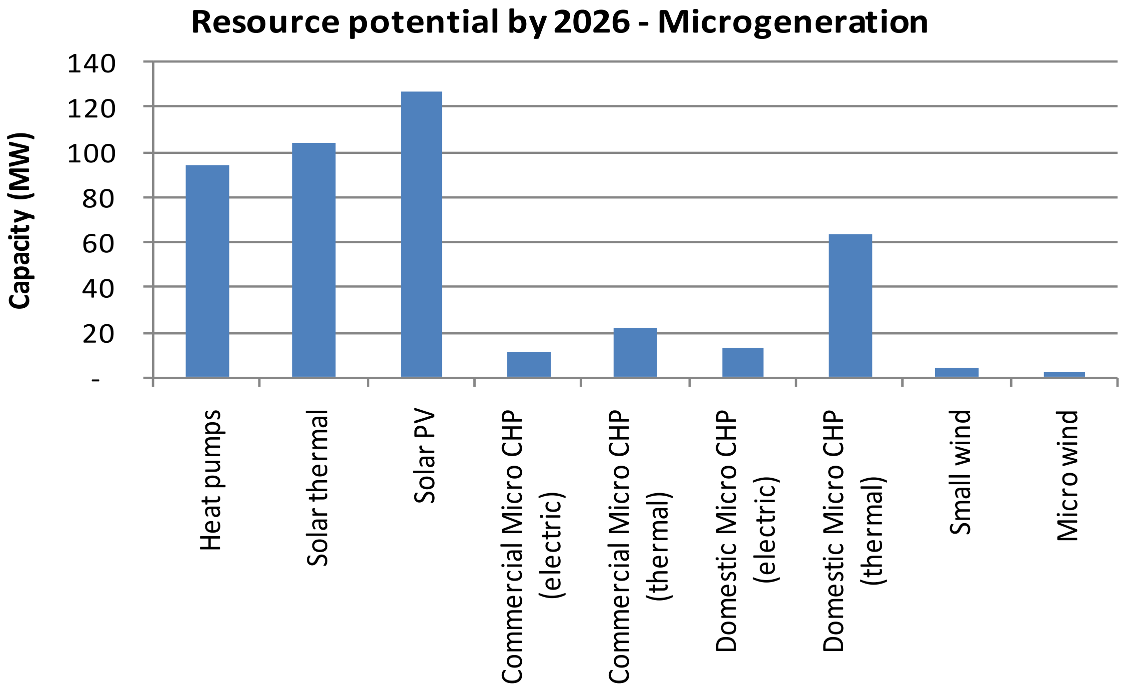


Figure 48: Resource potential by 2026 for a range of micro-generation technologies.

The total corresponding energy potential from the resource potential is 720 GWh in 2026, or around 17% of the Central Lincolnshire energy demand by 2026.

The uptake of most micro-generation technologies by 2026 is likely to be significantly lower than the identified resource potential. At present, most of the technologies are not economically feasible without grants or subsidies. Feed in Tariffs and the Renewable Heat Incentive can help provide a payback for many systems, but the significant capital expenditure can be a barrier to uptake. The introduction of the Green Deal may alleviate the upfront capital costs for qualifying projects. In addition, micro-generation technologies are often installed at a catalyst event, for example a heat pump may be installed when a boiler needs replacing or a PV system when a roof is refurbished. The uptake of technologies, therefore, is often dependent on other required upgrades.

It is important to note that there is a significant degree of uncertainty around micro-generation technology uptake, and therefore, the modelling in this report aims to establish a reasonable order of magnitude, rather than an accurate prediction.

The data in Figure 49 shows the total resource potential for micro-generation technologies by 2026 split by technology type and county. The total potential is around 134 MW (renewable) and 27 MW (micro CHP) with solar PV and heat pumps having the largest capacity potential.

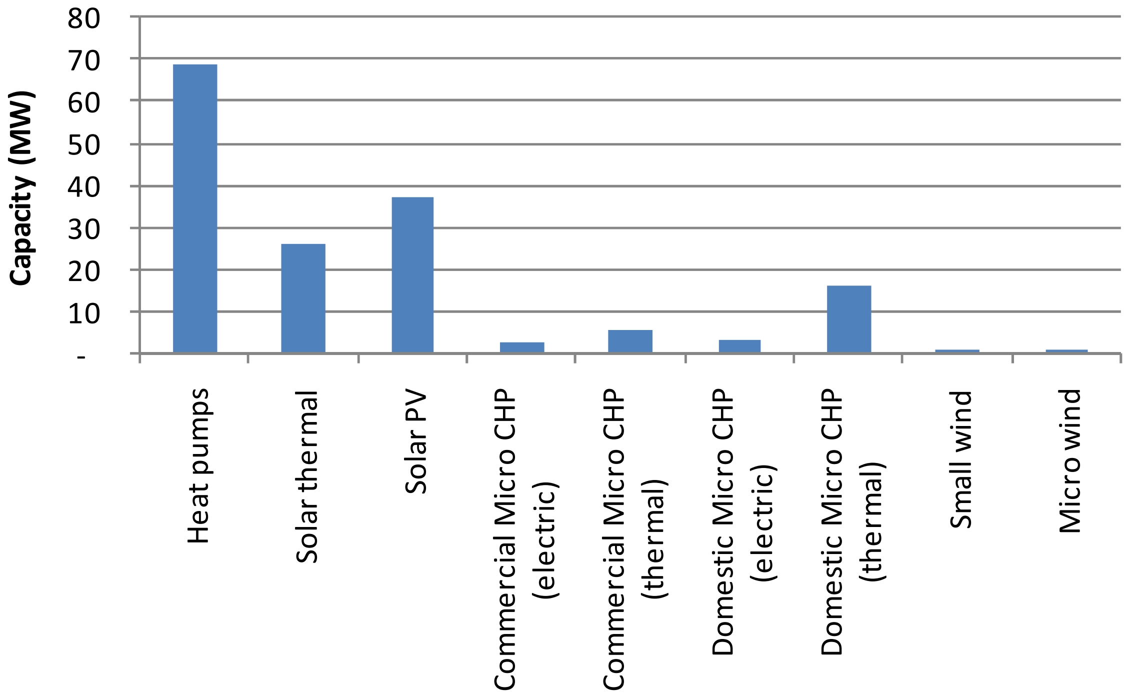


Figure 49: Potential uptake of different micro-generation technologies by 2026.

Under the uptake assumptions used, the annual energy production from micro-generation technologies is approximately 246 GWh which is around 6% of the projected 2026 Central Lincolnshire demand. The potential for micro-generation is partially determined by both the number and type of buildings, and so the potential will change over time as a result of further development. With this in mind, the estimated micro-generation potential will increase from 246 GWh to 441 GWh.

By 2026, it is estimated that the total resource potential will be around 441 MW. However, when the delivery potential is included, this reduces to a more realistic 161 MW, or around 6% of the projected energy demand. These uptakes are examined alongside the potential from other technologies and resources in Chapter 6, which examines future delivery scenarios and the potential impact of local action to support delivery.

Examining Delivery – case studies, opportunities and constraints

Case Studies

Lincoln City Hall – Solar Thermal

The City of Lincoln Council has recently launched a campaign called 'Lincoln Green' which aims to reduce carbon emissions in Lincoln, beginning with those the Council can influence through its buildings and services. Through an audit of its emissions, it was found that in 2010/11 the total greenhouse gas emissions from the City Council alone was 2,062 tonnes — an estimated 85% from buildings and 15% from transport.

One of the council's initiatives was to install solar thermal panels on the City Hall roof to heat hot water for the building. The installation is monitored and a live display unit showing the amount of energy produced has been installed in the City Hall foyer. Through this initiative the Council has shown leadership and also promoted renewable energy awareness with local communities.

Opportunities

- **Feed-in tariff** - Independent uptake of micro-renewables that generate electricity has been stimulated on a national scale through the introduction of the Feed-in Tariff, which has been in operation since April 2010. The Government has published planned Feed in Tariffs for the generation and export of renewable electricity for a range of micro generation renewables.
- **Permitted development** – As of April 6, 2008, changes to permitted development rights for renewable technologies no longer require planning permission for most domestic micro-generation technologies, including:
    - Roof-mounted solar PV and solar thermal
    - Stand-alone solar PV and solar
    - Wood burning boilers and stoves, and CHP
    - Ground source heat pumps
    - Air source heat pumps
- **Precedence** – Within the UK, the solar energy industry is starting to make a presence. In Truro, Cornwall, a 5,000 panel, 2.8 hectare solar farm, which will produce enough electricity for 300 homes, has been granted planning permission. Cornwall is currently considering 14 other approvals. Within Central Lincolnshire, the Stow Solar farm is already operational. Currently with an installed capacity of 1MW, it is looking to expand to 3.3MW. Fen Farm to the east of the HMA in East Lindsey is another solar farm installation of 1MW. To obtain planning permission a number of issues need to be considered.
- **Establish partnerships** – Micro-renewables can have an upfront expense that presents a barrier to installation. However, organising as a community to purchase large quantities can reduce the upfront costs and increase up-take.

Constraints

- **Feed-in tariff uncertainty** –While the new government has maintained the Feed-in Tariff, they have also announced that it will come under review in 2013. Perhaps an indication of a change in policy direction, in March 2011, the coalition government cut the incentive for larger scale solar installations (greater than 50kW) by more than 50%. This does not directly impact micro-generation installations; however, it does provide the impetus for those considering the use of micro-renewables to install them prior to 2013, thereby guarding against potential policy changes in the future.
- **Small wind and permitted development** – Installation of micro and small wind is currently not included as a permitted development due to legal technicalities with the current statutory instrument, though this should soon be resolved as revisions are currently in consultation.
- **Impact on landscape character** – These issues include how the solar farm impacts the general character of the surrounding area, the agricultural value of the land, and how the installation might impact wildlife habitats and general biodiversity. This is an industry that is in its infancy, and provided potential issues are mitigated, has the potential to become a major energy source in the future.
- **Delivery in conservation areas –** As per draft legislation[38], air source heat pumps are proposed as a permitted activity in a conservation area, while wind-turbines in conservation areas will require planning

[38] Permitted development rights for small scale renewable and low carbon energy technologies, and electric vehicle charging infrastructure' (consultation closed in February 2010)

permission where the wind turbine would be visible from any highway bordering the property. However, all types of micro-generation except ground and water source heat pumps would require planning permission for inclusion on non-domestic properties in a conservation area. The direction of future policy is likely to be more context-specific. For example, visually obstructive technologies may be unsuitable, but the scale and positioning of renewables should be considered in context to determine feasibility. Roof mounted technologies are likely to be the most concerning from a conservation perspective; however, roof-mounted objects such as TV aerials are allowable in conservation areas. Roof-mounted micro-generation technologies that may be of concern include photovoltaics (PV), solar thermal, flues associated with wood-burning stoves/boilers and CHP and micro-wind turbines. Notably the installation of roof-mounted (but not standalone) PV and solar thermal is currently permitted activity in conservation areas unless specific local guidance or policy is in place.

The consultation document provides an indication of the possible direction of future policy. Regarding the locating of micro-renewables, the document recommends considering the local context, stating:

'The impacts of renewable and low carbon energy technologies will vary on a case by case basis according to the type of the development, its location and setting. Development that is appropriate in one place may not be acceptable somewhere else and permitted development rights need to reflect this. This consultation therefore proposes that limits to what would be permitted would vary according to their site and location.'[39]

Further to this, the document states that

'More restrictive limits are proposed for sensitive areas where the Government considers they would be warranted:

- *Wind turbines, air source heat pumps and solar panels within World Heritage Sites would not be granted permitted development rights if they are visible from a highway adjoining the site. The same protection would be accorded to conservation areas, although there may be many such areas where they would be acceptable and could contribute to a low carbon footprint. The Government will be interested in views on how far this might be the case.'*[40]

While Central Lincolnshire is largely a rural in character, the urban areas do have many conservation areas. Areas such as the Lincoln Cathedral and City Centre, Lindum and Arboretum, and St Catherines are primary examples within Lincoln. As long as solar PV installations do not negatively impact on the visual appearance or overall character of these and other conservation areas, their inclusion should be considered. As an alternative to roof-mounted technologies, solar panels and wind turbines can be installed in private gardens out of view of the public realm. Similar issues are likely to be encountered in the case of listed buildings, and appropriate design measures will need to be taken to mitigate visual or structural impacts.

Influence of planning

To influence uptake of renewables outside residential areas, the Central Lincolnshire authorities can seek to encourage and support delivery of micro-generation by providing guidance, and working with communities and local industry. Some local industries, such as Branston Potatoes, have already shown they are open to environmental initiatives, and there is potential for the Central Lincolnshire planning authorities to incentivise swifter uptake of micro-generation in the area through a business information awareness campaign and through working with other partners to identify commercial/industrial businesses with larger areas of south facing roof, or flat roofs, who might either be interested in investing in solar technologies or who would be interested in linking up with an investment partner. Planning can take the opportunity to encourage the installation of micro-generation (along with other energy improvement measures) when a conversion or extension to an existing building is proposed. With the uncertainty around the future of the Feed-in Tariff, and the higher rates offered in

[39] See footnote 38
[40] See footnote 38

earlier years, speed is important when considering micro-generation installations. Specifically related to solar energy, the authorities should state their position for the installation of solar photovoltaic panels on buildings as well as in solar farm developments. As micro wind is not yet a Government permitted development, the authorities should also clarify their micro wind position.

Planning has more control over the introduction of on-site renewables on new development sites, though these are expected to lessen due to the proposals to tighten Building Regulations. High levels of on-site renewables can be driven through policies across Central Lincolnshire or for strategic sites where it is considered deliverable.

Case Study: Haringey Guidance on Renewable Energy in Conservation Areas

The London Borough of Haringey has developed guidance on renewable energy installations in conservation areas. The guidance discusses a range of technologies and diagrammatically demonstrates what areas and roof-tops can support renewable energy installations without impacting on conservation value.

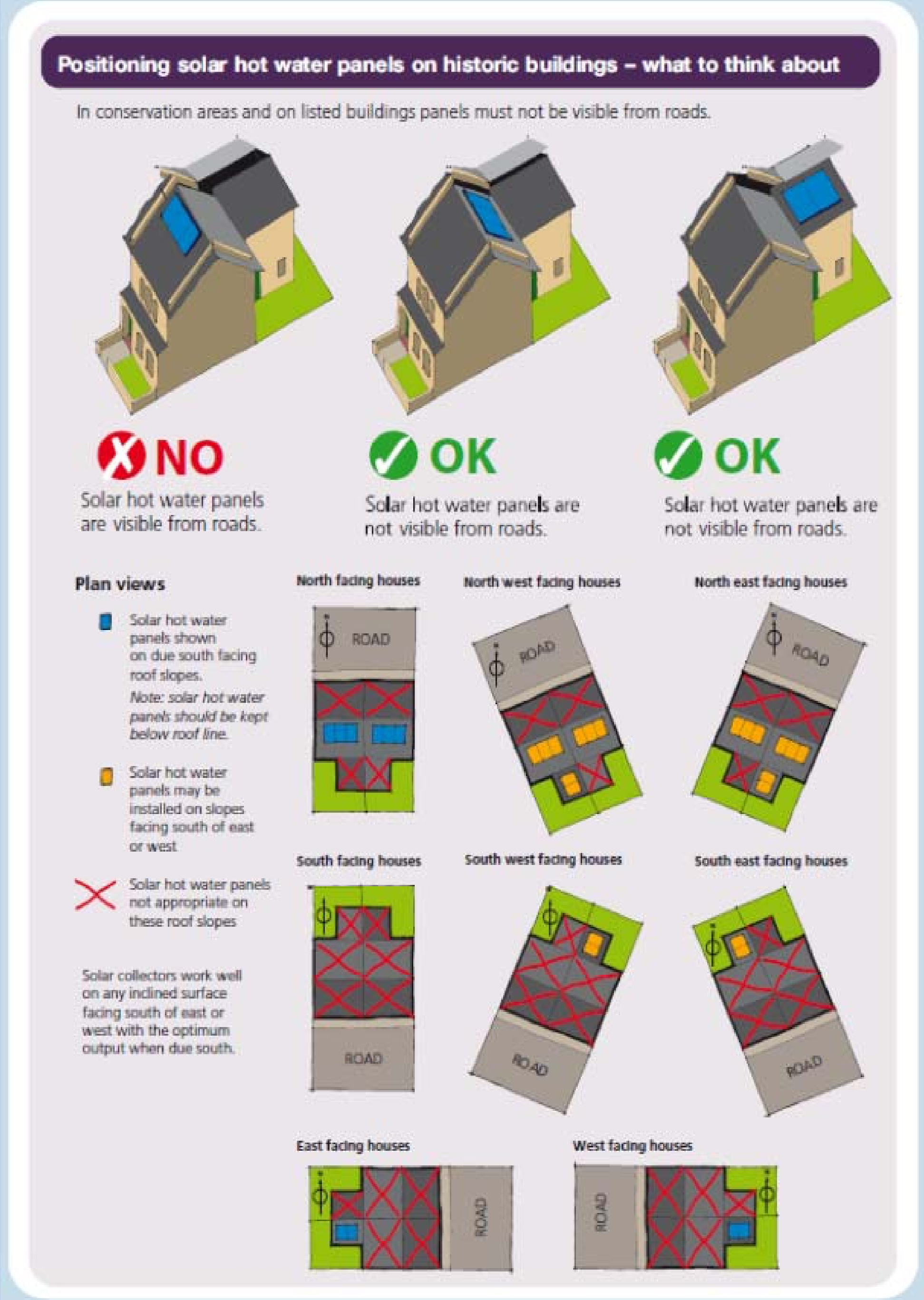


Figure 50: Guidance extract from Haringey Council's guidance on renewables for conservation areas[41]

[41] London Borough of Haringey. Use of Renewable Energy Systems: Historic Buildings and Conservation Areas. Available: http://www.haringey.gov.uk/renewable_energy_systems.pdf

5.3 CONSIDERING CENTRAL LINCOLNSHIRE RENEWABLE ENERGY TARGETS

From the above analysis, it is clear that there are substantial opportunities for renewable and low carbon energy in Central Lincolnshire. The area's biggest opportunity for renewable energy is the rural districts' potential for wind power. The more urban areas of Central Lincolnshire – including Lincoln, Gainsborough, and Sleaford – greatest potential is in the form of Combined Heat and Power (CHP) and district heating schemes. The prevalence of farms in the area also presents the opportunity to make use of agricultural arisings and biomass crops to fulfil Central Lincolnshire's energy needs.

The potential to integrate renewable technologies to supply electricity, however, varies for each form of renewable energy.

- **Wind** – The vast majority of rural areas of Central Lincolnshire have potential for wind energy development. While there are a large areas of land that are within the RAF sites and have potential to interfere with aerodrome radar, this Chapter has highlighted a number of ways to mitigate this issue. It is, however, incumbent upon the developer to fund radar mitigation techniques and prove they work.
- **Biomass** – Biomass suitable for combustion in boilers or CHP is a large opportunity. If 5% of the viable land was dedicated to growing fuel crops this would generate approximately 50,000 oven dried tonnes (odt). This would provide electricity for approximately 23,000 homes and heat for 31,000 homes if used in a biomass CHP or heat to 66,000 homes in a district heating system directly through using biomass boilers.
- **Micro-generation and solar farms** – If many of the commercial/industrial buildings install micro-generation technologies, such as solar photovoltaics, they could play a role in Central Lincolnshire's renewable energy mix. They also represent an opportunity to continue building community support for renewables in the area. There is potential for household retrofitting and buy-in to flow from this momentum. Solar farms might play a role into the future, as the Stow Solar Farm in West Lindsey has already demonstrated.

Central Lincolnshire's renewable potential is shown visually in the 'Energy Opportunity Map' in the next section.

Central Lincolnshire is similar to other parts of the country with respect to its ability to deliver renewable heat. As renewable heat is a similar delivery challenge for most areas across the UK, we recommend the delivery of its proportion of renewable heat based on the national target (around 12% of heat by 2020) should be adhered to. For greatest efficiency gains, this would ideally be delivered using district heating systems, but can also be delivered on a building-by-building basis.

In terms of electricity generation, targets should be challenging, but deliverable, based on the opportunities and constraints in Central Lincolnshire. National targets are aiming towards 30% of our electricity on a UK wide basis being supplied by renewables. Some of this target will be met by nationally-driven projects for off-shore wind, wind-farms, and tidal energy. The East Midlands Regional Plan set a target of 20% renewable electricity by 2020. The EM Low Carbon Energy Study notes that North Kesteven and West Lindsey are two districts with the greatest wind and biomass technical resource in the region. This evidence base has shown that Central Lincolnshire has considerable potential for the generation of renewable electricity from wind, biomass CHP and micro-generation, and a renewable electricity target would help to encourage delivery of these opportunities. A target of 60% of electricity from renewable sources by 2020 is therefore recommended to drive delivery of local opportunities.

5.4 ENERGY OPPORTUNITIES MAP

The analysis of renewable and low carbon energy opportunities discussed previously has been compiled to form an 'Energy Opportunities Map' (EOM) for Central Lincolnshire (see next page). EOMs can be used as a resource in policy and planning to guide key opportunities for consideration. This spatial map will help identify delivery opportunities now and into the future as new development opportunities come forward.

The map in Figure 51 should also be used to inform policy making in corporate strategies such as the Sustainable Community Strategy, neighbourhood plans, and climate change strategies. While these strategies are not required, their development is encouraged. The map should also be used to inform Central Lincolnshire planning authorities' investment decisions. The EOM could be incorporated into a planning guidance document and/or corporate strategies so that it can be readily updated to reflect new opportunities and changes in feasibility and viability.

The EOM includes the following:

- Spatial distribution of opportunities and constraints relating to renewable resources, including large wind, small wind, and biomass from woodland.
- Areas where the intensity of heat demand make the introduction of a district heating network a viable option.
- The identification of urban areas where improvements to existing buildings should be focussed including energy efficiency measures and the integration of micro-generation technologies.

Figure 51 shows that there are significant opportunities for wind energy, particularly on the eastern and western edges of Central Lincolnshire. Urban areas with higher population densities have more potential to support district heating networks. The inclusion of land availability for biomass energy crops renders the opportunities map illegible and is therefore omitted. However this information is available on the separate biomass maps in Figure 39. Overall, the make-up of Central Lincolnshire's potential suggests that it not only has a high potential to deliver substantial renewable energy projects, but also from a variety of sources.

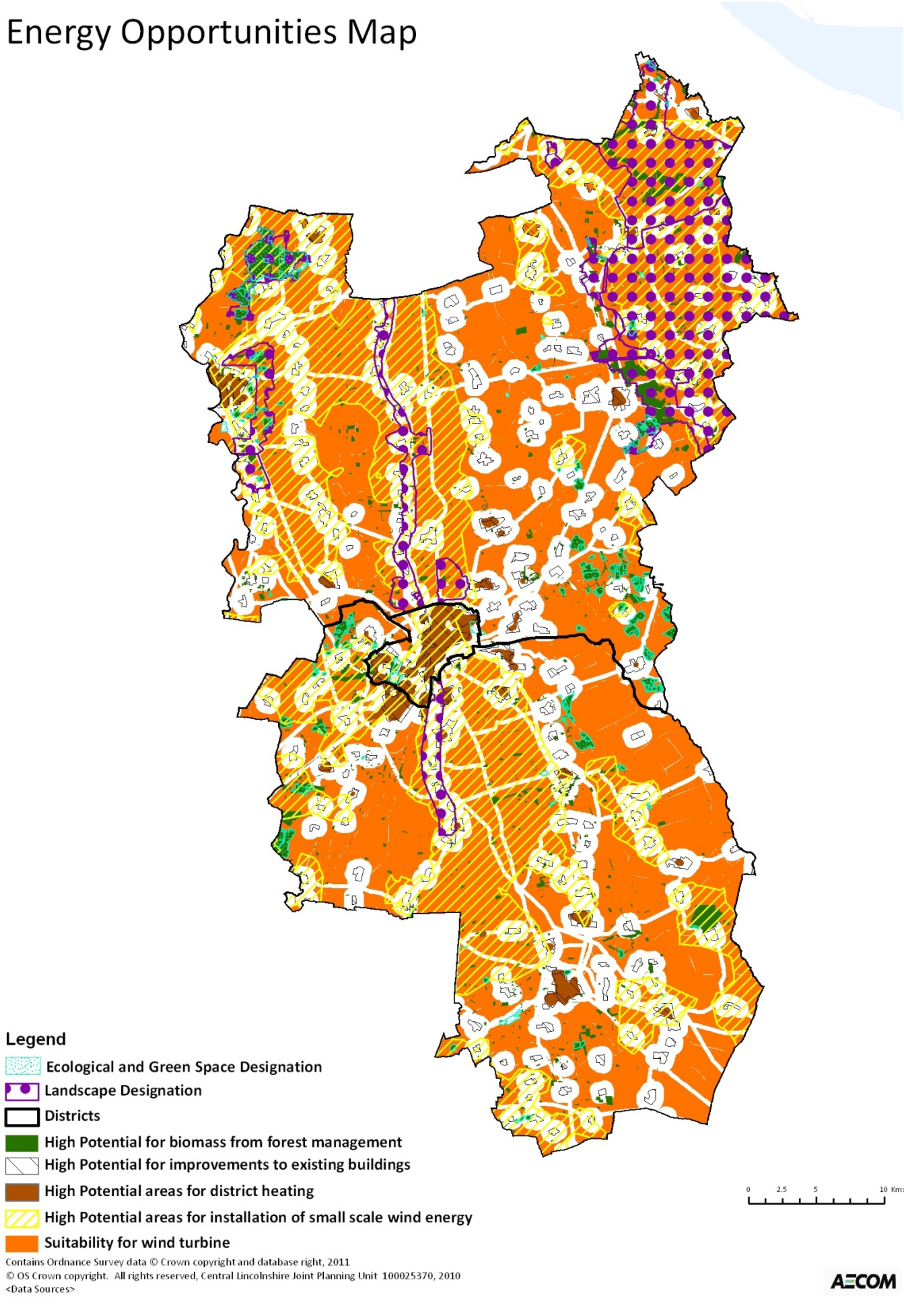


Figure 51: Energy Opportunities Map for Central Lincolnshire

SUMMARY TABLE

The EM Low Carbon Energy Study analysis of technical potential for Central Lincolnshire has been tested and qualitatively analysed in this section. The aim of this review is not to develop detailed numerical potentials or targets, but to understand the validity of the regional numbers, and how they may differ based on local conditions and delivery options. Table 22 summarises the key conclusions from our analysis. It should be remembered that the figures in the following tables for 2020 and 2030 are describing the technical potential, and should not be used for target setting.

Table 22: Summary of Central Lincolnshire EM Low Carbon Energy Study potentials and comments relating to local analysis (Pale green signifies heat producing technologies or resources).

Technology	Central Lincolnshire				
	2020 (MW)	2020 (GWh)	2030 (MW)	2030 (GWh)	Comments on the technical potential
Large Wind	2,528	3,986	2,528	3,986	The technical potential could be significantly higher if the buffer zones are revised to allow for community scale development. However landscape and visual impact, and cumulative impact will result in a potential which is much less than that provided by the mapping, but which is still significantly greater than any of the other renewable energy options.
Medium Wind	51	81	51	81	The EM report includes medium scale wind in the large scale analysis, selecting these turbines where there may be constraints to large scale. Medium scale wind may describe smaller turbines, or smaller wind farms (made up of 5 large turbines or less) to be delivered by communities, and therefore is highly dependent on delivery and community engagement.
Small Wind	1,333	2,102	1,333	2,102	The EM potential is extremely high based on land area, and in reality, small scale wind will be much less and based on delivery partner uptake, limiting the overall potential
Small Scale Wind <6kW	184	257	184	257	The uptake is likely to be much less than the EM predictions based on recent performance data and relative costs. The analysis in this report suggests a potential closer to 3 MW.
Managed Woodland (heat)	11	42	11	42	The woodland biomass resource could be higher if supply chains are developed which include landowners of woodland which is currently unmanaged.
Managed Woodland (elec)	2	13	2	13	(see above)
Energy Crops (heat) Medium	82	324	90	357	The EM report assumes that all abandoned land and pasture will be planted with biomass energy crops. In reality, the uptake is likely to be much lower.
Energy Crops (elec) Medium	14	107	16	117	(see above)

Agricultural Arisings	37	194	37	194	The EM potential is likely to be achieved with the construction of the Sleaford straw plant.
Waste Wood (heat)	1	7	2	8	The EM target appears low and agglomeration of waste wood could provide a larger resource.
Waste Wood (elec)	2	8	2	9	(see above)
Poultry Litter	7	37	7	37	The EM target appears reasonable and is similar to the existing chicken litter plants and catchment areas.
Wet Organic Waste	9	45	9	45	There are challenges to farm-scale animal waste AD which may reduce the potential. However investment in AD energy crop schemes could increase this.
Biomass Co-firing	0	0	0	0	Co firing is not included in this report. Whilst the biomass fraction can be considered renewable, this is a national scale technology and the local authorities have no control over either the amount or sourcing of the biomass.
Municipal Solid Waste (MSW)	10	51	11	56	The EM potential is reasonable and likely to be met with North Hykeham.
Commercial and Industrial	7	38	8	40	Refining the EM report potential would require significant research into the local waste streams, and appears a reasonable estimate. An EfW plant for commercial plant may be based on a waste agglomerater and so involve the import or export of waste.
Landfill Gas	3	13	1	4	This is a reasonable estimate based on recent data and unlikely to differ significantly
Sewage Gas	0	1	0	1	This is a reasonable estimate based on recent data and unlikely to differ significantly
Hydro	0	1	0	1	Hydro has an extremely limited potential which will be determined by the small number of schemes which may be bought forwards.
Solar PV	94	74	109	86	The EM potential is slightly lower than the analysis in this report (around 120 MW) but appears reasonable.
Solar Thermal	82	36	96	42	The EM projections are in line with this analysis and appear reasonable.
Heat Pumps	562	1,281	600	1,366	The EM report overestimates the heat pump potential and the potential is likely to be closer to 90 MW– 100 MW
Total (electricity)	**4,279**	**7,006**	**4,295**	**7,027**	
Total (heat)	**738**	**1,690**	**799**	**1,815**	

Table 23: Comparison of EM Low Carbon Energy Study technical potentials by local authority

	Lincoln				North Kesteven				West Lindsey (Outside AONB)			
Technology	**2020 (MW)**	**2020 (GWh)**	**2030 (MW)**	**2030 (GWh)**	**2020 (MW)**	**2020 (GWh)**	**2030 (MW)**	**2030 (GWh)**	**2020 (MW)**	**2020 (GWh)**	**2030 (MW)**	**2030 (GWh)**
Large Wind	4.36	6.87	4.36	6.87	1,215.21	1,916.15	1,215.21	1,916.15	1,308.04	2,062.52	1,308.04	2,062.52
Medium Wind	0.44	0.69	0.44	0.69	25.29	39.88	25.29	39.88	25.60	40.36	25.60	40.36
Small Wind	5.73	9.04	5.73	9.04	603.38	951.41	603.38	951.41	723.78	1,141.26	723.78	1,141.26
Small Scale Wind <6kW	0.00	0.00	0.00	0.00	81.33	113.99	81.33	113.99	95.24	133.49	95.24	133.49
Managed Woodland (heat)	0.18	0.71	0.18	0.71	4.25	16.75	4.25	16.75	5.52	21.76	5.52	21.76
Managed Woodland (elec)	0.03	0.23	0.03	0.23	0.70	5.27	0.70	5.27	0.91	6.86	0.91	6.86
Energy Crops (heat) Medium	7.78	30.67	8.56	33.74	41.86	165.01	46.05	181.53	29.26	115.34	32.18	126.85
Energy Crops (elec) Medium	1.34	10.10	1.47	11.07	7.20	54.24	7.92	59.67	5.03	37.89	5.53	41.66
Agricultural Arisings	0.04	0.24	0.04	0.24	17.37	91.28	17.37	91.28	19.45	102.24	19.45	102.24
Waste Wood (heat)	0.67	3.54	0.74	3.91	0.40	2.12	0.45	2.34	0.30	1.57	0.33	1.73
Waste Wood (elec)	0.79	4.14	0.87	4.57	0.47	2.47	0.52	2.73	0.35	1.83	0.38	2.02
Poultry Litter	0.00	0.00	0.00	0.00	3.83	20.11	3.83	20.11	3.21	16.88	3.21	16.88
Wet Organic Waste	0.29	1.52	0.29	1.52	2.59	13.62	2.59	13.62	5.69	29.90	5.69	29.90
Biomass Co-firing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Municipal Solid Waste (MSW)	2.95	15.51	3.25	17.06	3.81	20.02	4.19	22.02	2.87	15.07	3.15	16.58
Commercial and Industrial	3.53	18.56	3.71	19.51	2.11	11.10	2.22	11.67	1.56	8.22	1.64	8.64
Landfill Gas	0.00	0.00	0.00	0.00	2.28	12.01	0.62	3.27	0.24	1.27	0.07	0.35
Sewage Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.66	0.16	0.71
Hydro	0.00	0.00	0.00	0.00	0.04	0.21	0.04	0.21	0.10	0.52	0.10	0.52
Solar PV	35.00	27.59	43.48	34.28	31.69	24.98	35.60	28.07	25.86	20.39	28.16	22.20
Solar Thermal	30.57	13.39	39.04	17.10	27.84	12.19	31.75	13.91	22.22	9.73	24.52	10.74
Heat Pumps	173.39	394.91	194.58	443.18	213.42	486.09	223.21	508.38	169.69	386.49	175.43	399.56
Total (electricity)	54.50	94.49	63.67	105.08	1,997.30	3,276.75	2,000.81	3,279.35	2,218.08	3,619.35	2,221.12	3,626.17
Total (heat)	212.59	443.22	243.10	498.64	287.77	682.16	305.71	722.91	226.99	534.89	237.98	560.65

5.5 KEY CONSIDERATIONS EMERGING FROM THIS CHAPTER

The sections above have considered the resource potential of Central Lincolnshire. Key considerations emerging from this chapter are:

- There are considerable renewable and low carbon resource opportunities across Central Lincolnshire, with high carbon reduction opportunities linked to wind, biomass, CHP and micro-generation;
- While there are few renewable energy installations in Central Lincolnshire, there are many either awaiting construction, or in the planning process.
- The scale of potential and types of technologies that are likely to be viable varies across Central Lincolnshire.
- Lincoln, Gainsborough, Sleaford, North Hykeham, and a collection of villages on the outskirts of Lincoln all present good opportunities to generate and supply renewable and low carbon heat utilising district heating networks, and these opportunities should be supported through planning;
- Biomass is a strong resource for the area, but a biomass supply chain needs to be established to gather, process and supply biomass locally. Encouraging farmers to grow biomass on land not capable of supporting agricultural crops is an option that can provide biomass resource for the area and a second income stream for the farmer
- Significant parts of Central Lincolnshire are feasible for the production of wind energy, with the eastern and western areas of the land particularly suitable for large scale wind turbines
- All opportunities are delivery dependent – resource potential in itself does not contribute to targets, therefore focus should be on enabling delivery;
- The industrial and commercial sector will represent an important partner in the delivery of micro-renewables, and efforts should be made to cultivate these relationships;
- The extent of potential in Central Lincolnshire provides an evidence base that suggests the UK Government targets of 30% renewable electricity and 12% renewable heat by 2020 can be met and potentially exceeded technically; and
- An Energy Opportunity Map has been produced as a planning resource which will allow assessment and prioritisation of delivery opportunities.

6 Testing Delivery Potential for Renewable Energy

This chapter discusses stakeholders' perspectives on how best to drive delivery and uses case studies to illustrate how actions can drive delivery.

6.1 INTRODUCTION TO THIS CHAPTER

The previous chapter focused on the technical potential for renewable energy in Central Lincolnshire. Traditionally in renewable energy studies, the emphasis has been on understanding the theoretical potential for renewable and low carbon energy in order to set targets for delivery. While this approach gives an appreciation of the maximum potential and the relative scale of potential of each technology, it does not examine the local capacity to deliver that potential. The regional study of renewable energy conducted for the East Midlands which has been reviewed by this study, established this theoretical potential following the methodology set out by DECC. The regional analysis is useful as an initial basis, but a real understanding of the possibilities can only come from an understanding of the delivery context at a local scale.

Targets can be used as a mechanism to focus actions and set aspirations, but targets themselves do not deliver renewable and low carbon energy schemes. Without the development of robust actions and the coordination of a number of people and organisations, they will not be achieved. For many technologies, it is likely that the technical potential will never be achieved and the uptake is almost entirely dependent on actions and delivery partners.

The relationship between technical and delivery potential is illustrated in Figure 52. The technical potential derived by the DECC methodology can be refined to calculate a maximum potential for renewable energy from the 'top-down', while an analysis of delivery partners and their ambition can define what is realistically deliverable from the 'bottom-up'. A realistic target can only be set through an understanding of the relationship between technical and deliverable potential.

Figure 52: Finding the balance between technical and delivery potential

While this study makes use of information on technical potential to develop an understanding of the types and magnitude of the resource and technologies which may be suitable in Central Lincolnshire, the main emphasis is on the delivery of schemes – assessing the potential organisations and people who can deliver schemes and the actions required to support them. The eventual uptake of schemes will depend almost entirely on the actions of these delivery organisations, and the support locally and nationally which they receive. As a result, it is impossible to accurately predict the uptake of schemes. All of the following may impact on the eventual uptake:

- Consumer demand and behaviour
- Technical innovation and performance
- Government policy and incentives (e.g., the Feed in Tariff)
- Local initiatives
- Energy costs and energy security
- Local political ambition

While there are many stakeholders in Central Lincolnshire, they can be broadly grouped into four distinct categories based on their delivery drivers and perspectives:

1. public sector,
2. private sector,
3. communities and individuals, and
4. Energy developers.

For each of these partners, this chapter outlines their current delivery activity and project involvement, including case studies, as well as opportunities and constraints to their increased uptake of renewable energy.

Secondly, reflecting on this understanding of the local delivery context, a number of scenarios have been developed to test delivery potential. Two types of scenarios were used to test delivery: a base case and an 'all actions adopted' scenario. The base case assumes 'business as usual' where delivery rates are equivalent to a predicted level of delivery where no local action or focus is initiated, and delivery is reliant on national drivers and independent will. The 'all actions adopted' scenario assumes that local delivery is well supported through a proactive approach where a range of actions are taken to enable all stakeholders to increase uptake of renewable energy. Key actions that could be taken to increase delivery have been defined in the Action Plan in the final chapter of this report. A stakeholder workshop was used to inform these scenarios, and its conclusions are also discussed in this chapter.

6.2 EXAMINING DELIVERY PARTNERS: PUBLIC SECTOR

6.2.1 Delivery Activity

The public sector is a broad partner grouping that encapsulates all stakeholders which are owned or operated using public funds. The most prominent public sector stakeholders are local councils, schools, and registered social landlords (RSL). As beneficiaries of public funds, they operate for the public good, and therefore, are often not constrained to actions which are purely profitable. With respect to renewable and low carbon energy, this is critical. Sometimes programmes centred on renewable energy have a longer payback window and require a critical mass before it is financially profitable.

Public sector delivery partners tend have a strong influence on the delivery of micro-generation, energy from waste and district heating/CHP. As can be seen in Table 24, the public sector has been strong in delivering micro-generation schemes on public buildings and landfill gas schemes due to legislative responsibilities in the area. In the future, the public sector is seen to be a key delivery partner in driving and coordinating the delivery of district heating and CHP schemes in both new and existing developments. The public sector is a crucial partner in the delivery of these schemes, as due to the complexity and potential risk in delivering infrastructure across multiple property boundaries, independent energy developers may not necessarily explore opportunities. Public sector partners are more capable of coordinating and controlling delivery across a large spatial area and can also respond to a wider range of delivery drivers including fuel poverty, carbon reduction commitments and community benefit. The delivery of district heating has been demonstrated by an RSL in the village of South Carlton in West Lindsey, where energy security and community well-being were strong drivers for delivery for a scheme that may not have been viable based on a purely commercial rationale.

Table 24: Examples of public sector renewables projects delivered in Central Lincolnshire

Project Examples *Technology Type*	*Local Authority*
Micro-generation (various)	
• Lincoln City Council Building: solar thermal • North Kesteven Council Building: biomass • North Kesteven Council Houses: solar PV • Sports Pavilion: solar thermal • Hamilton House: solar thermal	Lincoln North Kesteven North Kesteven Lincoln Lincoln
Landfill gas	
• Lea Road, Gainsborough • Leadenham • Lincoln landfill	West Lindsey North Kesteven Lincoln
District Heating/CHP	
• South Carlton district heating network	West Lindsey

6.2.2 Examining Delivery – Case Studies, Opportunities and Constraints

What can we learn from delivery case studies?

The following set of case study examples examine how public sector partners have delivered renewable and low carbon energy schemes in Central Lincolnshire and elsewhere and what lessons can be drawn from those experiences about delivery opportunities and barriers. Five case studies have been examined:

1. **Woking District Heating Scheme**: Local Authority led retrofit of district heating
2. **Lincoln College Renewables Course**: Public funding to simulate local education initiatives
3. **Gainsborough Code 5 Pilot Project**: Publically funded demonstration buildings

4. **Luddington and Garthorpe Primary School Biomass Scheme:** School initiative to integrate renewables

Woking District Heating Scheme

Since 1990, Woking Borough Council has undertaken a series of sustainable energy projects, and become a pioneer in the process. Between 1991 and 2001, the council reduced its energy consumption by 40%. It established the UK's first local sustainable community energy system and the first public/private joint venture Energy Services Company (ESCO). This has resulted in £4.9 million in savings for the council, as well as other savings for local households and businesses. Woking is recognized as the UK's most energy efficient local authority, and is the only local authority to ever be awarded the Queen's Award for Enterprise for its work in sustainable development. In 2002, Woking's energy efficiency policy was replaced with by a more comprehensive Climate Change Strategy for the Borough as a whole, shifting its focus from savings in kWh to savings in tonnes of CO_2.

Lessons learned:

- Develop appropriate actions, timescales and monitoring
- Consult all partners and stakeholders, in both private and public sectors, as well as community members
- Maximise use of in-house and external technological expertise
- Political will cannot be underestimated
- Focus on both large and small scale renewable and low carbon projects
- Share knowledge widely
- Important to be bold and innovative
- Never miss external funding opportunities

Category	Savings over 11 years - Woking
Energy consumption savings	170,170,665 KWh (43.8% saving compared to conventional energy supply)
Carbon dioxide emissions savings	95,588 tonnes (71.5%)
Nitrogen oxides emissions savings	319.1 tonnes (68%)
Sulphur dioxide emissions savings	976.6 tonnes (73.4%)
Water consumption savings	340,011,000 litres (43.8%)
Savings in energy and water budgets	£4,889,501 (34.3%)

Source: http://www.climatespace.org/wp-content/uploads/2007/10/case_study_2-woking.pdf

Lincoln College Renewables Course

Understanding that with renewable energy becoming a greater need in the future, a regional network of colleges has initiated a number of courses around sustainable technologies. Lincoln College has started teaching a technical class in renewable energy technology repair and installations. Requiring only a relevant background (e.g., plumbing, electricity), students learn the technical details relevant specific to renewable energy.

To get the course started, Lincoln College received funding from Lincolnshire County Council. However, other colleges within the East Midlands, such as Boston College and Grantham have received similar funds from Pro Enviro, an organisation providing strategic and practical low carbon support to both public and private sector organisations.

Lessons learned:

- While the course has been offered, there has been little student interest in the course. This is likely the result of the private sector showing little interest in the program.
- More stringent requirements from local and national governments would push the private sector to have more interest in developing this sector. This would in turn have a positive influence on students enrolling in this course, and ones like it.

Gainsborough Code 5 Pilot Project

A site in Gainsborough has received planning permission to construct four new build homes to Code for Sustainable Homes Level 5. This will be the first scheme in the area to showcase that constructing homes to a high level of sustainability is possible. The scheme will regenerate a derelict site and use smart meters to track energy use.

Using Council-owned land, funding was received from the DCLG, as well as via Section 106 to get the project off the ground. The project also benefitted from a good working relationship with the delivery partner (Longhurst and Havelok Homes), who agreed to the standards set.

Lessons learned:

- While Code 5 developments can be expensive, funding mechanisms do exist to make them more feasible
- With the right expertise, Code 5 developments are not more difficult to build than conventional homes
- Council-owned land is an important asset that can be used to prove a concept
- The Council has noted that while the scheme was progressed well, improvements could have been made in organising the legal aspects of the project

Luddington and Garthorpe Primary School Biomass Scheme

When it came time to replace their aging oil fire boiler, Luddington and Garthorpe Primary School in North Lincolnshire saw it as an opportunity to switch to a more renewable source of energy. With a large supply of biomass in proximity, a wood chip heating system was installed, eliminating excessive transportation requirements. The new boiler provides the school with all its heating and hot water required. The additional benefit of biomass boiler is in educating students about the environment and sustainability.

However, the biomass boiler was not installed without trouble. The school found many difficulties in installing and operating the system. The silver lining is that others can learn from the issues the school experienced.

Lessons learned:

- While oil and gas boilers are capable of producing instant heat, wood chip boilers will reduce output to 30% when heat is not required. The implication is that it is important not to install a boiler that is too large, as a heat storage unit will be needed to absorb all excess heat.
- Important to consider a weather proof wood chip storage
- Need to consider how the wood chip is going to be delivered, as well as safe access and discharge of several cubic meters of wood chip.
- Siting and sizing of the new boiler will need planning permission, including vehicular access.
- Financial costs above and beyond the physical unit need to be considered.

What are the delivery opportunities for this partner?

- **Making the most of owned properties** – With a number of properties within Central Lincolnshire, local planning authorities and public bodies have the ability to play an important role in retrofitting properties. As Central Lincolnshire authorities have already undertaken an energy audit of their properties, the next step is to decide which energy efficiency measures would provide the most value.
- **Delivery of Strategic Opportunities** – Often with significant land and property ownership as well as an important role in coordinating new development, spatial planning and regeneration, the Public Sector has the ability to lead the delivery of strategic opportunities including district heating networks.
- **Pilot projects** – Initiating pilot projects within their own properties first could help prove technologies and demonstrate application, while at the same time foster the required local delivery infrastructure, supply chains and skills.
- **Promote and Educate** – Promoting and educating residents about the importance of energy efficiency and renewable energy should be considered as an important role for the Central Lincolnshire authorities. Schools play an important role, educating students about energy.
- **Leader and Coordinator Potential** – With the ability to set policy and local targets, and coordinate Allowable Solutions, the Central Lincolnshire planning authorities have a high level of influence. By taking a leadership role in facilitating communication with potential partners, the authorities have a real opportunity to influence the direction of renewable energy uptake in the area.
- **Planning Policy** – Setting planning policy which strongly supports renewable and low carbon energy will increase developer confidence in the authorities' direction on energy.
- **Longer term vision than other Stakeholders** – Public sector organisations, including RSLs, have the ability to think and plan for the long term and the ability to take advantage of long-term payoffs which might have a larger up-front capital cost. As profit is not always their prime motivator, the public sector can invest in projects that do not have a high rate of return.

What are the delivery constraints for this partner?

- **Political will –** Strong and consistent commitment is needed to drive forward local authority delivery of renewable and low carbon energy. Significant delivery is often the result of strong leadership.
- **Consistency** – Central Lincolnshire's authorities will need to represent a coordinated front across a large number of people in the area. Maintaining consistency in policy application across the authorities can be difficult, but equally, delivery potential will be greater where a consistent approach can be taken.
- **Agreement –** Members of the Councils will need to convince their constituents that renewable and low carbon energy is an important consideration. Improving public understanding of the importance of renewable and low carbon energy and dispelling myths is a major component of this.
- **Funding –** Funding is often the most prevalent issue for local authorities, particularly in the current economic climate. However, there are a number of funding mechanisms available to the Central Lincolnshire local authorities. These include:

- **Community Energy Saving Programme (CESP) –** This fund targets dwellings in areas of deprivation throughout the UK. CESP is funded by energy suppliers and generators
- **Eaga Partnership Charitable Trust –** This fund focuses on relieving fuel poverty and improving energy efficiency, particularly in homes which are difficult to heat and in rural areas.
- **Salix Finance –** Salix provides both grant funding to Local Authorities that manage to reduce CO_2 in a cost effective manner. Funding typically ranges from £250,000 to £500,000.
- **East Midlands Improvement and Efficiency Partnership (EM IEP) –** Following the success of the Department for Communities and Local Government's (DCLG) Regional Improvement and Efficiency Partnerships (RIEPs) programme, the EM IEP has budgeted for further funding support, including areas of climate change and efficiency.

EXAMINING DELIVERY PARTNERS: PRIVATE SECTOR

6.2.3 Delivery Activity

For the purposes of this report the private sector includes all stakeholders operating outside the energy sector, whose primary motivating factor for delivering renewable and low carbon energy is financial benefit and industry leadership. Examples of these types of stakeholders are local businesses, industry, housing developers, universities, land developers and land owners. These organisations generally undertake energy efficiency or renewable energy initiatives for financial rewards. Sometimes, an action is directly profitable, such as reducing energy use, or eliminating waste. Other times, the motivating factor might be indirectly financially beneficial – for example, a marketing exercise that will benefit the organisation in the longer term. Whether directly or indirectly profitable, actions taken by the private sector signal to others in industry that there is a financial benefit to be gained from energy efficiency or renewable and low carbon energy.

Private sector partners favour technologies including micro-generation, district heating/CHP, medium scale wind, biomass and anaerobic digestion. Table 25 includes examples of private sector projects in Central Lincolnshire.

Table 25: Examples of private sector renewables projects delivered in Central Lincolnshire

Project Examples *Technology Type*	*Local Authority*
Anaerobic Digestion	
• Branston Potatoes Factory	North Kesteven
Skills Development	
• University of Lincoln	Lincoln
CHP and District Heating	
• Doddington Hall	North Kesteven

6.2.4 Examining Delivery – Case Studies, Opportunities and Constraints

What can we learn from delivery case studies?

The following case study example examines how a private sector partner has delivered a renewable and low carbon energy scheme in Central Lincolnshire and what lessons can be drawn from that experience about delivery opportunities and barriers.

Branston Potatoes Factory

Branston Potatoes installed an anaerobic digestion plant, which uses potatoes unfit for consumption that would otherwise be sent to the landfill, to power its facility. While this case study was discussed in the case studies in section 5.2.4, it has specific relevance to private sector delivery partners. Private sector lessons learned from Branston Potatoes include:

- The Branston factory proves that not only can anaerobic digestion significantly reduce waste in the agricultural industry, but also save a substantial amount of money.
- For industry partners, renewable and low carbon energy schemes often make financial sense to reduce energy costs and manage resources on-site.
- If incentives are in place, industry can play a major role in contributing to the renewable energy in Central Lincolnshire.

What are the delivery opportunities for this partner?

- **Study land feedstock opportunities** – As Central Lincolnshire has a strong agricultural economy, there are substantial opportunities to be explored in the farming sector. Stakeholder consultation confirmed the significant interest of the farming community in opportunities for biomass, anaerobic digestion and wind energy deployment. Individual farmers have an opportunity to investigate how they can best use their land to contribute to renewable energy generation. Whether land can be used for wind power, or for planting biomass (on land not suitable for edible crops), farmers can add a secondary income stream to their farming operations.

- **Control –** Private industry is often operating on a property they own or have control over. For this reason, they have the ability to design renewable technologies into properties.

- **Economies of Scale –** Many private sector businesses either have a number of locations or operate large facilities. In either scenario, these organisations have the ability to purchase and install renewables at a more economical scale.

- **Exemplar Projects** – Should private industry decide to be bold in their adoption of renewable and low carbon energy, there is potential for them to receive marketing attention, and/or exemplar awards such as LEED, BREEAM or Code for Sustainable Homes.

- **Energy Cost Reduction –** Industry partners in particular can have the opportunity to harness waste heat and by-products from production processes to generate and recirculate energy. Options for CHP or anaerobic digestion will often make economic sense for large energy users in industry. These kinds of users could also drive the delivery of wider district heating schemes where those opportunities are coordinated with neighbouring land owners.

- **Waste Reduction –** Particularly for those operating in the agricultural industry, using agricultural waste to power their operations can reduce waste disposal fees as well as energy demand. The community also benefits from a reduction in greenhouse gas emissions.

- **Green Economy –** An increase in renewable and low carbon energy installations can play a role in the growth of a low carbon economy which will be mutually beneficial for local businesses and industry.
- **Harnessing 'Anchor Loads' –** Private sector businesses often own and operate large properties with a unique ability to contribute to a local authority driven renewable energy project. For example, these properties often represent key anchor loads for a district heating network. There is an opportunity to partner with the local authority or Energy Company to deliver a scheme that benefits both parties.
- **Strategic Sites –** Housing developers have an opportunity to deliver potentially large renewable or low carbon energy schemes in major new developments such as large urban extensions or major urban regeneration sites. Delivery of CHP and district heating networks on a large scale can benefit a developer by ensuring it is straightforward for individual units to gain Code for Sustainable Homes or BREEAM accreditation or to meet advancing Building Regulations. Where low-carbon infrastructure is delivered by new development there is an opportunity to extend infrastructure to also service local communities.

What are the delivery constraints for this partner?

- **Clarity from Government** – Understanding where the government stands on building regulations and funding incentives is an important motivator for the private sector. When government policy and regulations are unclear or not stringent, the private sector has one less reason to commit to energy efficiency and CO_2 reduction.
- **Expertise** – Installing renewables are not necessarily thought of as conventional. For this reason, private industry that lacks the expertise can see their adoption as risky.
- **Funding** – Particularly small businesses often lack the up-front capital required to install energy improvements. Education related to reduction in long-term operating costs can help.
- **Market Knowledge** – Private sector delivery partners can lack the market understanding to determine which renewable energy opportunities are likely to make the most economic sense. The farming community in Central Lincolnshire for example has expressed interest in delivery, but are lacking advice as to whether the market opportunities are viable for bio-crops and anaerobic digestion.

6.3 EXAMINING DELIVERY PARTNERS: COMMUNITY GROUPS AND INDIVIDUALS

6.3.1 Delivery Activity

Community groups represent the aspirations of what the community would like to achieve. These are often volunteer-based organisations that are motivated to improve the community's economic, social, and environmental resilience. These organisations are key to helping local authorities gather support for, and deliver renewable and low carbon energy. Central Lincolnshire is fortunate in that it has a number of active community organisations, and strong rural and urban community networks. This partner group also includes individuals who may decide to install renewable energy locally through their own environmental concerns or seeking financial benefit.

Community groups and individuals are capable of delivering small to medium scale projects. Micro-generation, medium scale wind, small hydro, medium scale solar arrays, and biomass heating are projects these partners often support. Table 26 references some of the community-supported projects currently delivered in Central Lincolnshire.

Table 26: Examples of community group renewables projects delivered in Central Lincolnshire

Project Examples *Technology Type*	*Local Authority*
Education	
• Transition Lincoln: Community education • Rauceby Little Footprint Initiative • Hill Holt Wood	North Kesteven
Retrofit	
• RLFI energy audit for 60 homes • RLFI smart meter trial for 50 homes	North Kesteven North Kesteven
Advocacy	
• Transition Town Lincoln • Transition Hemswell	Lincoln City West Lindsey

6.3.2 Examining Delivery – Case Studies, Opportunities and Constraints

What can we learn from delivery case studies?

The following set of case study examples examine how community partners have delivered renewable and low carbon energy schemes in Central Lincolnshire and elsewhere and what lessons can be drawn from those experiences about delivery opportunities and barriers. Three case studies have been examined:

1. **Hill Holt Wood Sustainable Forestry**: Individual initiatives to educate and develop forest management
2. **Rauceby Little Footprint**: Local retrofit and energy efficiency measures
3. **Transition Lincoln**: Local transition town movement and community workshops

Hill Holt Wood Sustainable Forestry

Hill Holt Wood founders, Nigel and Karen Lowthrop, began their search to purchase a woodland in 1993. By 1995 they had purchased the land with the vision of it becoming a community centre that sold timber as a by-product. While today it is a 34 acre woodland that practices sustainable forestry management, true to its vision it also works as a social enterprise. Hill Holt works with North Kesteven District Council as well as the wider community to provide many services, including:

- Helping to keep the local area clear from litter
- Providing gardening services for vulnerable council tenants
- Conferring with local experts to improve the organisation's carbon footprint
- Working with local schools and their students to maintain the school's green spaces
- Undertaken eco-tours focusing on retrofit and low energy new build in Nottinghamshire and Lincolnshire

- Hosting regular round table meetings to discuss important local issues in Lincolnshire and Nottinghamshire with local stakeholders

Lessons learned:

- Effective networking and partnerships have made Hill Holt Wood well known at both regional and national levels
- Social enterprises are important to rural development and diversification
- While planning policy can be a viewed as a barrier, determination and discussions with the local planning authority can uncover solutions
- Given the social and environmental benefits of these types of organisations for the greater community, they are important for Councils and private organisation to foster, fund, and support.

Rauceby Little Footprint Initiative

Beginning in 2008, the RLFI was started to undertake local initiatives the group felt were important. The RLFI's initial plans were modest, and included showing movies on climate change and an event to educate residents on micro-generation opportunities. As the group gained momentum, so did their initiatives. They worked with the Energy Savings Trust to offer insulation to all the community. In terms of energy initiatives, the group performed an energy audit of 60 households and a smart meter trial in 50 homes. Currently, in partnership with Freewatt, the RLFI are looking to sign up 30 people for solar PV and place solar panels on the village hall.

Lessons Learned

- People are drawn to successful projects and groups so it is important to start with easy wins.
- Trialling energy meters proved to be very successful. Any initiative that equates saving energy with saving money has great potential.
- David Hoare, the founder, found that when he could no longer lead the group for a short period, the group lacked leadership and stalled. There is a need for leaders to delegate responsibilities so that the group's success is not dependent upon them.

Transition Lincoln

Developing from the Lincoln Urban Permaculture Interest Group, Transition Lincoln is a community-led initiative focused on raising awareness of, and responding to, peak oil and climate change. This non-political, grass-roots organisation is affiliated with the national Transition Network movement which supports communities around the world adopt variations of the transition model to a more resilient, low carbon settlement.

With their active interest in moving towards a low carbon economy, Transition Lincoln has an important local insight in to the low carbon and renewable energy in the Central Lincolnshire context. As such they were invited to participate in the 'Renewable Energy and Low Carbon Development in Central Lincolnshire' workshops. In preparation for their involvement, and to obtain input from their wider network, Transition Lincoln proactively held their own 'Open Space – Future Energy Issues and Solutions' workshop. The output from this event was an informed set of cross-cutting issues and potential solutions for energy generation, buildings, transport and food.

Lessons learned:

- The growing transition movement is a proactive network of community organisations, including Transition Lincoln with an interest in reducing carbon and responding to climate change.

- As a local consultee, Transition Lincoln is an important source of localised knowledge and activity on opportunities and challenges for developing renewable and low carbon initiative.
- Furthermore, providing Transition Lincoln with detailed information will help them further develop and disseminate information.

What are the delivery opportunities for this partner?

- **Community ownership of renewable installations** – While some community members can be wary of large scale renewable energy schemes, they are likely to be more interested when they stand to personally benefit from the scheme. There are a number of cases where communities have partnered with energy providers to deliver a scheme, becoming partial owners in the process. A local East Midlands example of community ownership of a wind energy scheme exists in Hockerton.
- **Individual financial benefit** – National incentives such as the Feed-in Tariff, the Renewable Heat Incentive, and the Green Deal provide opportunities for individuals to install renewable technologies which will be economically beneficial in the long term.
- **Establish wider partnership** – When smaller communities partner with neighbouring settlements, they can increase their collective influence. Establishing a community group, which encompasses a number of communities, it is possible to unlock opportunities that did not previously exist. This could include cost savings through purchasing micro-generation in bulk, or increasing the community's share of potential partnerships with energy providers.
- **Potential for resident enthusiasm –** Community group membership is often a good indication of the willingness of residents to participate in their community. Central Lincolnshire has a couple of these groups, such as Transition Lincoln, Transition Hemswell and the Rauceby Little Footprint Initiative. There is potential for other community groups to organise local residents interested in renewable and low carbon energy.
- **Strong rural communities –** Central Lincolnshire has a potential delivery advantage in the community sector due to its already strong network of rural communities in particular. The strong identity of villages and hamlets in the area, and coordination through Parish Councils provides the base engagement networks for community initiatives to form.
- **Localism and neighbourhood planning** – Under the government's localism agenda, there is a stronger emphasis on ground-up initiatives and community involvement. This agenda could provide opportunities to stimulate community activity in the delivery of renewable and low carbon energy. Pilot areas for neighbourhood planning such as Caistor could demonstrate delivery for other communities to follow.
- **Fostering Uptake of Micro-generation** – the Central Lincolnshire authorities have the ability to make low carbon energy decisions easier for their residents. Below are a few strategies they can implement:
    - **Discount provision** – Available financing could be used to bulk buy technologies, thereby taking advantage of economies of scale, passing on the cost savings to households and businesses.
    - **Homeowner or business hire purchase** – Appropriate technologies could be leased to householders and businesses. Rental costs could be charged as a proportion of the generation income received by the beneficiary. After a period of time, ownership would transfer to the homeowner or business.

- o **Homeowner or business rental** – A third model could be for the authority or partnership to retain ownership of the technologies and rent roof or other suitable space. Rental costs would also be set as a proportion of generation income in this model. As with the hire purchase model, this flexibility will enable the authority, as the administrator, to fund energy infrastructure identified in the energy opportunities map (EOM).
- o **Property Assessed Clean Energy** – Currently in operation in California, the local authority offers a bond to investors, and then loan that money to businesses or homeowners to put towards energy retrofits. One of benefits of this model is that the loan is attached to the property rather than an individual. Property owners benefit as they can pay off their retrofits through increased council taxes over the bond payback period (e.g., 20 years), rather than through a large upfront capital expenditure.

What are the delivery constraints for this partner?

- **Other priorities –** As members join these groups on a voluntary basis, when time constraints present themselves, they are often the first commitments people drop. However, if the organisation can achieve quick wins and build momentum, participation is more likely to become more important to members.
- **Leadership –** Organising and starting community groups can be a time consuming process. Leaders can become overwhelmed if other members do not step forward to take on tasks.
- **Funding –** Small community organisations often have difficulty raising money to accomplish objectives. However, E.ON Sustainable Energy Fund and Big Lottery Fund are two funds that offer money for community groups.
- **Expertise –** Community groups are often concerned citizens, but feel their lack of expertise in a particular field precludes them from being effective. It is important for community groups to have access to advice.

6.4 EXAMINING DELIVERY PARTNERS: ENERGY DEVELOPERS

6.4.1 Delivery Activity

Energy developers and Energy Services Companies (ESCOs) are directly involved in the delivery of renewable and low carbon energy projects. While energy developers can be generally defined as for-profit companies, which focus on profit as their primary motivation, through public-private partnerships energy developers can work with local authorities and communities to deliver schemes that achieve wider aims. Central Lincolnshire has many energy developers operating or interested in delivering renewable energy.

Energy developers are traditionally interested in large scale projects, capable of delivering a return on investment. These projects include: large scale wind, energy from waste, large scale CHP, and large scale solar energy. As can be seen in Table 27, the majority of energy developer projects in Central Lincolnshire are in planning or awaiting construction.

Table 27: Examples of energy developer renewables projects delivered in Central Lincolnshire

Project Examples *Technology Type*	*Local Authority*
Onshore Wind	
• Browns Holt *(under consideration)* • Heckington Fen *(under consideration)* • Lodge Farm *(under consideration)*	West Lindsey North Kesteven North Kesteven
CHP	
• Sleaford Straw Plant: biomass *(granted planning permission)*	North Kesteven
Energy from waste	
• North Hykeham Energy from Waste *(under consideration)*	North Kesteven
Solar	
• Stow Solar Farm (*in operation*)	West Lindsey

6.4.2 Examining Delivery – Case Studies, Opportunities and Constraints

What can we learn from delivery case studies?

The following case study example examines how an energy developer partner has designed and proposed a renewable and low carbon energy scheme in Central Lincolnshire and what lessons can be drawn from that experience about delivery opportunities and barriers.

Sleaford Renewable Energy Plant

The Sleaford Renewable Energy Plant (SREP) is a straw-fired power plant that is set to be built in North Kesteven. The 40MW station will provide enough energy for 65,000 homes and save 250,000 tonnes of CO_2 per year. The plant will also recycle the ash and sell it as fertiliser.

The plant's location in North Kesteven is strategic. Due to the low energy value of straw, it is important that energy is not wasted in the transportation process – therefore, locating it in North Kesteven, near wheat farming is important.

SREP developers, ECO2, claim the plant will makes use of the Government estimated 3 million tonnes of surplus straw produced in the east of the country. The suggestion is that there is enough excess straw production in Lincolnshire to meet the 240,000 tonne demand of SREP without needing to grow additional wheat production. In fact, ECO2 asserts the furthest supplier is 41 miles away with the vast majority of its remaining sources will be within 30 miles of the plant.[42]

The project, however, has not been without its challenges. The community has voiced many concerns about the plant, including its location, size, pollution, and impact on the community. Other concerns are whether the plant will be able to source the amount of straw it needs locally. While

[42] http://www.sleafordrep.co.uk/

still in the planning phase, if the plant does get built, it will contribute significantly to Central Lincolnshire's renewable energy target.

Lessons learned

- It is important to involve the community in the early planning stages of a project
- Provide supply chain information as early as possible
- Partnering with the community groups to determine how the plant might benefit the community can help secure buy-in

What are the delivery opportunities for this partner?

- **Wind and heat potential** – With some of the strongest potential for wind in the East Midlands, there is substantial opportunity for energy developers to deliver wind energy projects in Central Lincolnshire. Similarly, the agricultural industry combined with the potential for district heating in the more urban areas, indicates that there is potential for both biomass and district heating networks.
- **Job opportunities –** There is opportunity for Central Lincolnshire to capitalise on the increased uptake in renewable energy installed in and around the area. With a technical college that is already training students in renewable technology installation and repairs, and a vast untapped potential to deliver renewables, the ingredients to develop green jobs are already in place. The creation of a renewable hub in the area may attract and support energy developers. This low carbon economy could be bolstered by the activity in the Humber region to the north of Central Lincolnshire.
- **Partnering with community –** Energy developers often face opposition from community members, either because residents don't want installations to interfere with their landscape and views of it (NIMBYism), or because they object to the financial profits not benefiting the community. Partnering with the community to ensure they receive some of the benefit can help mitigate negative reactions. Additionally, if community members are part owners in the project, they will likely be more vocal in their support.
- **Allowable solutions –** Additional funding through the Allowable Solutions mechanism (see page 34) is likely to be available to energy developers and ESCOs to deliver renewable energy projects.
- **Community driven ESCO –** As there is no ESCO currently operating in Central Lincolnshire, there is an opportunity for the community to form one or partner with an energy company, and drive the energy delivery they want to see and deliver smaller scale projects that may not attract commercial attention on a national scale.

What are the delivery constraints for this partner?

- **Planning process uncertainty** – If the local council's stance on renewable energy is not clear, energy developers will be more reticent to deliver renewable energy.
- **Infrastructure and grid connections** – Some areas of Central Lincolnshire lack capacity in electricity infrastructure to accommodate substantial renewable energy development. Without excess capacity and improved grid connections, energy developers' energy delivery will be constrained.
- **Local opposition –** Although largely considered a barrier due to local opposition being vocal, surveys have indicated that the UK public is actually largely in favour of renewable energy. In fact, Populus' 2005 survey suggests that 81% of UK residents are in favour of wind

development.[43] Better engagement with communities is needed to gain support for wind schemes in particular.

6.6 PARTNER PERSPECTIVES: SUMMARY OF THE STAKEHOLDER WORKSHOP

A stakeholder workshop was held as part of this study to test the ambition of local partners, and gather local insight into what could feasibly be achieved in the delivery of renewable and low carbon energy. Representatives from the partner groups– public sector, private sector, energy providers and communities – were included in the workshop. During a general conversation around achieving energy-related CO_2 reductions in Central Lincolnshire, two key opportunities arose: the vast technical potential of wind and biomass schemes, and the potential for communities to have an ownership stake in renewable and low carbon energy projects.

Figure 53: Stakeholder workshop held in July 2011

Each of the groups was then asked to discuss and share how ambitious they were with regard to their desire to deliver renewable energy. The level of ambition in Central Lincolnshire across all key partners was very high, demonstrating an ability to coordinate and accelerate delivery of renewable energy beyond the low current delivery rates.

[43] Populus (2005) *Energy Balance of Power Poll*. Available: http://www.populus.co.uk/uploads/download_pdf-060705-The-Times-Energy-balance-of-power.pdf

Figure 54: Results of the 'Ambition-O-Meter'

Understanding that delivery is not simply a matter of ambition, each delivery partner group then outlined what priority actions they could take to capitalise on opportunities and mitigate constraints. The groups' priority actions included items such as educating the community and establishing relevant partnerships.

In the final phase of the workshop, the four delivery partner focussed groups were asked to consider two scenarios for the delivery of renewable energy over the Core Strategy period for their partner, using a bespoke delivery 'game' (pictured below). In the first, none of their priority actions were achieved and delivery predictions were based on a 'business as usual' uptake. In the second, all of the priority actions were achieved and the delivery partner's achievement was optimised.

Figure 55: The renewable energy scenario 'game' completed by stakeholders for the two scenarios

After combining all four groups and totalling the amount of renewable energy they believed they could deliver, the two scenarios returned very different results. In the first scenario all the partners combined managed to deliver 31% of Central Lincolnshire's 2026 electricity demand in the form of renewable energy, but only 2% of the heat. In the second scenario, with all the priority actions achieved, the partners were able to deliver all of the area's future electricity demand, and 15% of heat demand. The completed exercises, with numbers of installations of different forms of renewable energy are shown in Table 28 and Table 29 below.

Table 28: Central Lincolnshire's ability to deliver renewable energy assuming "business as usual"

Resource / Technology	**Capacity (MW)**	**% of technical**[44]
Large scale wind	120	5%
Medium scale wind	8	16%
Large solar PV arrays / farms	17.5	***
Biomass heating	3.5	4%
Combined heat and power / district heating	2	***
Energy from waste	15	57%
Anaerobic digestion	6	70%
Hydro	0	0%
Micro-generation (building based)	27.5	1%
Straw	0	0%
Biomass electricity	0	0%
Percentage of Central Lincolnshire's electricity consumption[45]	31%	
Percentage of Central Lincolnshire's heat consumption[46]	2%	

*** No potential given in the EM Low Carbon Energy Study.

[44] Percentage of technical capacity. Technical capacity is taken as the theoretical maximum potential as listed in *Low Carbon Energy Opportunities and Heat Mapping for Local Planning Areas Across the East Midlands: Final Report* (East Midlands Councils, 2011)

[45] Based on AECOM modelling

[46] Based on AECOM modelling

Table 29: Central Lincolnshire's ability to deliver renewable energy assuming priority actions adopted[47]

Resource / Technology	Number of icons	% of technical[48]
Large scale wind	1267.5	50%
Medium scale wind	72	140%
Large solar PV arrays / farms	27.5	***
Biomass heating	10	11%
Combined heat and power / district heating	9	***
Energy from waste	15	57%
Anaerobic digestion	30	350%
Hydro	0	0%
Micro-generation (building based)	530	24%
Straw	0	0%
Biomass electricity	0	0%
Percentage of Central Lincolnshire's electricity consumption[49]	237%	
Percentage of Central Lincolnshire's heat consumption[50]	15%	

***: No potential given in the EM Low Carbon Energy Study

These delivery predictions demonstrate that a large proportion of electricity demand is thought to be deliverable through renewable energy. However, the delivery of renewable heat seems more challenging.

[47] This is the opinion of those who attended the workshop and therefore may not be a realistic representation of what is likely to come forward in Central Lincolnshire

[48] Percentage of technical capacity. Technical capacity is taken as the theoretical maximum potential as listed in *Low Carbon Energy Opportunities and Heat Mapping for Local Planning Areas Across the East Midlands: Final Report* (East Midlands Councils, 2011)

[49] Based on AECOM modelling

[50] Based on AECOM modelling

6.7 DELIVERY SCENARIOS

The insights provided in the stakeholder workshop along with the analysis of delivery partner opportunities and barriers have been used to develop two delivery scenarios – 'business as usual' (baseline) and 'all actions adopted' (optimised). To reason and test the validity of the scenarios, the delivery capability of each partner was tested against what has been observed in other areas of the UK, providing an additional layer of analysis for a more robust idea of which types of technologies and resources show the most significant potential, and which delivery mechanisms are best placed to deliver them. This section presents some simple analysis of uptake scenarios for Central Lincolnshire, enabling future actions to focus on the schemes with the best potential and on supporting the correct types of organisations and people for delivering them.

6.7.1 Methodology

The methodology used in this section aims to assess potential uptake scenarios using simple assumptions. **The results are necessarily high level and should not be used to imply a degree of accuracy that does not, and cannot exist.**

The assessment is based on taking delivery partners, examining the types of schemes and technologies which each of these is likely to bring forward, and then the potential uptake for each. The delivery partners include those described in the preceding sections:

- Public sector. This includes local and county council buildings, social housing, and publicly developed stand-alone projects.
- Private sector. This includes housing developers, non-domestic developers, land owners, universities, and commercial and industrial businesses.
- Communities and individuals. These are non-commercial partners including community organisations and individual house owners.
- Energy developers. These are commercial organisations that develop commercially viable energy generation schemes. Wind farm developers are one example.

The list of delivery partners is not exhaustive, but is designed to represent the vast majority of options. For each partner, a number of likely renewable technologies and schemes are identified. These may be linked to existing buildings (for example micro-generation), or be stand-alone energy schemes, such as an energy from waste plant.

For each scheme, two sets of uptake by 2026 are selected to represent the business as usual case and an All Actions Adopted (AAA) case, representing what may happen if each partner takes the actions suggested in the final chapter of this report.

By summing the energy output and CO_2 savings across different delivery partners and resources or technologies, it is possible to gain an understanding of:

- The relative impact of intervention and actions from different sectors. This can be used to highlight where further support is needed and where incentives may be most effective;
- The relative importance of different technologies and resource streams; and
- Approximately how much low and zero carbon energy can contribute and reduce emissions across Central Lincolnshire by 2026 under these scenarios.

6.7.2 Results from scenario development

The following results show the outputs from the scenario development in terms of CO_2 savings and energy capacity and generation. The baseline energy and CO_2 emissions include all fuel and electricity in buildings and commercial uses, but exclude transportation.

The potential CO_2 savings are shown in Figure 56 split into the delivery partners. The uptakes represent the lead delivery partner, although in reality more than one partner will be involved in many of the schemes. This means that whilst the outcome may be shown under one sector, other partners will be required to take actions to support this sector, but it prevents the double counting of resources.

The public sector is shown to provide savings of in the region of 5% for both scenarios. This relatively low uptake is unsurprising considering that the public sector is unlikely to commence large scale energy generation development in the same scale as commercial suppliers. Whilst the public sector may encourage and become part of some community energy scheme, this will probably be in partnership with other sectors and of a limited scale. The majority of public sector investment is on building and site related technologies and this is fundamentally limited by the public sector building stock. Local Authorities could substantially increase their delivery of renewable and low carbon energy by becoming and energy company themselves following the example of Working Borough Council; however the ambition to follow such a path is uncertain at this stage. The All Actions Adopted scenario assumes the public sector delivers district heating to 2500 homes.

The private sector shows a large increase from the baseline to the All Actions Adopted (AAA) scenario, although the maximum potential is still less than 10%. The change in uptake can be partially attributed to economic conditions. Where suitable incentives are provided, there is likely to be a strong uptake if a business case existing. The proliferation of large scale PV planning applications is one example of this following the Feed in Tariff introduction. However the subsequent collapse of interest following the review of tariffs (rendering large scale PV uneconomic) shows the high degree of sensitivity and the future uncertainty.

The smallest uptake is in the community and individuals sector. In general this sector is not interested in economic return and is capitally constrained. Most investment is likely to be in relatively small installations (for example solar thermal systems on houses), and whilst the uptake in terms of installations could run into many thousands, the scale means that the overall impact will be small. For example, to save the same CO_2 as one large wind turbine, many 1000s of domestic PV installations would be required.

The most significant potential is shown by the commercial energy developers, with between 20% and 50% CO_2 reduction potential. Energy developers being the leading sector is not surprising – they are the most suitable organisation for delivering large scale energy schemes, and by virtue of the scale, any partner delivering these schemes will be an energy developer. The savings in this sector are mainly derived from large scale biomass power generation and onshore wind development as shown in the figures below.

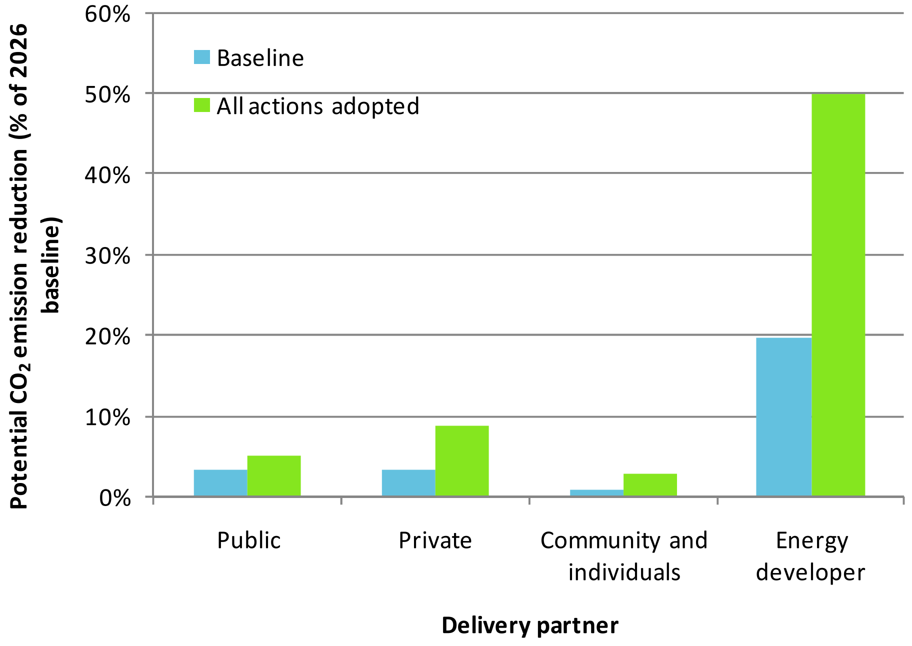


Figure 56: Potential CO_2 savings as a percentage of the 2026 baseline emissions.

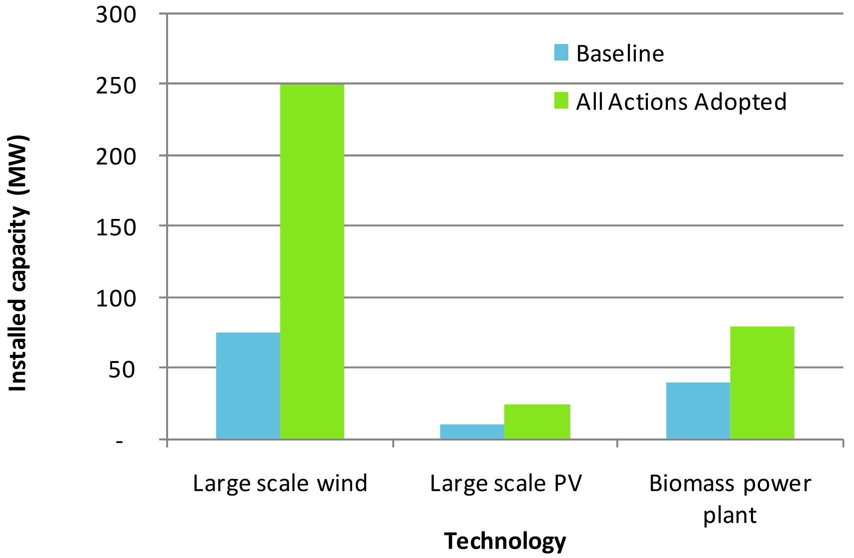


Figure 57: Delivery of schemes by commercial energy developers. In total, these are predicted to save between 20% and 50% of the 2026 baseline CO_2 emissions.

The following points can be drawn from Figure 57:

- Onshore wind has the largest capacity potential with 250MW in the AAA scenario, representing an assumed 10 wind farms each consisting of 10 turbines. This is only 10% of the technical potential identified in the EM Low Carbon Energy Study, and so in reality under the correct conditions, the uptake of wind could be much greater.
- The biomass capacity represents between 1 and 2 plants of circa 40 MW, typical of the current plants being developed including the Sleaford straw burning plant. The upper value

is less than that identified in the EM Low Carbon Energy Study (which is circa 3 plants of 40 MW) and so could be higher if the resource can all be accessed. The capacity could be increased if biomass is imported to Central Lincolnshire, but this will depend on market conditions and does not represent a local resource.

- Large scale PV makes a small contribution although the uptake of this will be heavily dependent on future incentive schemes.

An alternative view of the scenarios is shown in Figure 58 with a breakdown of the annual energy generation (GWh) by technology. This chart clearly illustrates the dominance of the commercially delivered schemes by energy companies with onshore wind and biomass power being significantly greater than any of the other options. Even though the capacity of the biomass power installations is smaller than that of the large scale wind, the annual generation is higher due to the larger load factor.

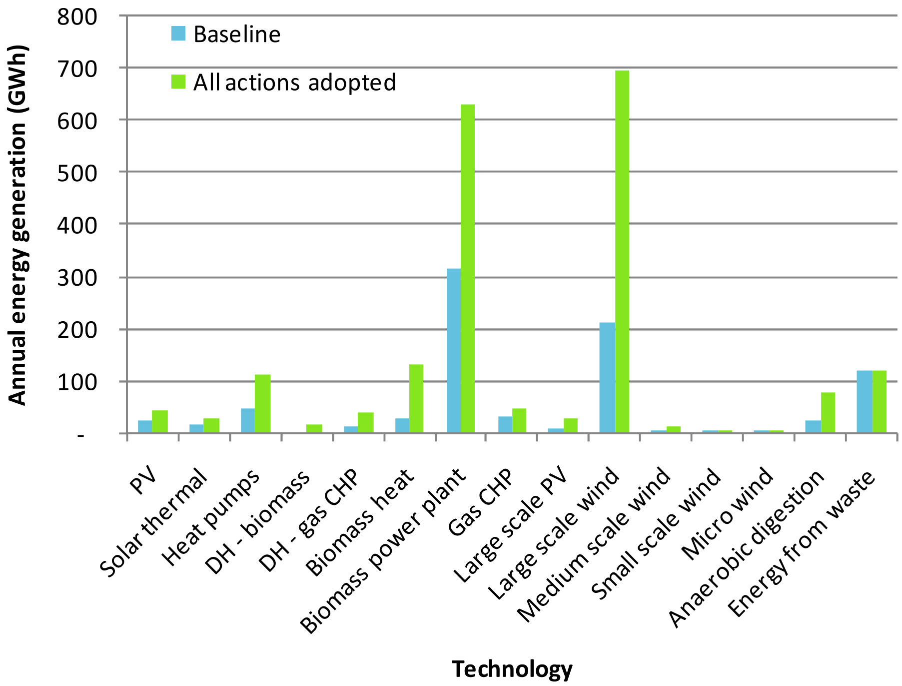


Figure 58: Scenarios for energy generation by technology

It is important to note that the outputs presented in Figure 58 in general represent a large uptake of the technologies. In particular the energy from waste and biomass power figures represent the technical capacity using local resource. The large scale onshore wind output is only 10% of the potential identified in the EM Low Carbon Energy Study, and so once more, the importance of onshore wind in the future low carbon energy mix for Central Lincolnshire, and more widely for contribution to regional and national energy generation, cannot be understated.

The location of the capacity across Central Lincolnshire will depend on the technology. For the smaller scale systems connected with buildings, the installed capacity is likely to be evenly spread in proportion to population and the number of buildings. The wind capacity may be split evenly between North Kesteven and West Lindsey based on the similar technical potentials. However given that the scenarios only represent 10% or less of the technical potential, it is possible that either of the rural authorities could deliver the capacity. The biomass power plants will draw resource from across the three authorities (although mostly from the rural areas, with waste wood being the main resource from Lincoln). The location of these is therefore resource independent and they could be located in any of the authorities.

6.7.3 Developing targets for renewable energy

The UK Government target for renewable energy of 15% by 2020 will require a greater contribution from parts of the country with increased resources. The target can be broken down into 12% for heat and over 30% for electricity, selected because of the maturity of the electricity generating renewables and the relative ease of the two markets over the next 10 years.

The technical potential section of this report demonstrates that Central Lincolnshire has a significant resource for renewable and low carbon energy, and for some technologies such as wind, this resource is important regionally if not nationally. In the same way that some authorities have to contribute more than others to general electricity generation by hosting power stations which generate more electricity than the authority requires, some authorities with important renewables resources will have to produce excess electricity to support less resourceful areas.

Table 30 shows the outputs of renewable heat and electricity from the two scenarios expressed as a percentage of the estimated 2026 electricity and heat demands.

Table 30: Projected outputs of heat and electricity under each scenario

	Baseline	All Actions Adopted
Heat	4%	12%
Electricity	48%	109%

The data shows that under the baseline scenario, Central Lincolnshire will not meet the national target of 12% renewable heat, but with all actions adopted this may be achievable (note that the scenarios are based on 2026 and not 2020). A target based on the national target of 12% would seem reasonable for Central Lincolnshire because the potential for heat is heavily linked to heat loads as well as resource, and therefore relatively uniform across the county.

The electricity scenarios illustrate the relative importance of Central Lincolnshire for renewable electricity, and it is reasonable to suggest that Central Lincolnshire should produce excess electricity to support other more resource constrained areas. The figures of 48% and 109% may appear high, but still only represent a small fraction of the potential for onshore wind. We therefore propose that Central Lincolnshire should adopt a target for electricity production which is higher than the national average. Given the analysis on uptakes in this report, a target of 60% by 2026 would appear achievable. We would expect this to increase further post 2026 in line with national targets.

6.8 KEY CONSIDERATIONS EMERGING FROM THIS CHAPTER

The sections above have considered the delivery potential of partners in Central Lincolnshire, namely the primary four partner types; public sector, private sector, communities and energy developers. A number of lessons have emerged:

- While technical potential analysis provides us with a theoretical maximum for renewable energy deployment, the real situation can only be understood through an understanding of the delivery partners, their drivers and their capacity to deliver.
- There is strong ambition and opportunities associated with all of the four delivery partner types in Central Lincolnshire, but some experience significant barriers to delivery. While the barriers are sometimes numerous, none are insurmountable, and a lot of these barriers are to do with lack of coordination, expertise and leadership – all factors that can be influenced through a proactive and focussed action plan.
- A stakeholder workshop that was conducted as part of this study confirmed local ambition and highlighted the need for greater support and communication.
- Two scenarios were modelled to examine how much renewable and low carbon energy could be delivered by the four delivery partner types over the Core Strategy period. All of the delivery partners and technologies make an important contribution and all have actions which can improve the uptake for themselves and support other partners.
- Energy developers will be the most important delivery partner, primarily through the construction of wind farms and biomass power schemes under the options assumed. These may be purely commercial projects, or delivered with the involvement with other partners, such as community partnerships. Energy developers are in the prime position for delivery with funding and governance structures created for this purpose. Many of the actions to support their delivery actually lie with the other partners in the form of de-risking through a long term strategic framework (primarily the public sector) and gaining public support and understanding (the community and individuals sector). Hence partners play an important role in not only delivering schemes, but supporting other partners in that process.
- Onshore wind and biomass show the largest potential in the scenarios, and whilst the levels of biomass are around the local resource limits, large scale wind has a significantly larger potential post 2026. Central Lincolnshire has an important wind resource at a regional (and to a smaller extent, national) scale, and developing robust but supportive policy alongside engaging with communities is vital to achieving this potential.
- A target of 60% of electricity and 12% of heat from renewable energy by 2026 is believed to be deliverable in Central Lincolnshire.

7 Testing Delivery through Growth

This chapter assesses the viability of incorporating low and zero carbon forms of energy on new development in the Central Lincolnshire area, taking into account the local opportunities and constraints in combination with technical viability. This information can be used to help inform local planning policy development and decision making on planning applications.

7.1 INTRODUCTION

Planning can have a direct influence on carbon reductions in new development through specific policies and targets. Historically, the enforcement of on-site renewable targets and carbon emission reduction targets has seen significant success. Beginning with the introduction of 'Merton-rule' style policies (which set a percentage target for use of renewable energy in relation to overall energy use), planning has become a direct driver in directing the energy strategy for new development sites. Over time however, proposals for changes to Building Regulations have taken the emphasis away from planning targets with minimum standards being directed through national scale requirements. However, planning can still be used to set targets that exceed those proposed through Building Regulations. Currently, Building Regulations are expected to dramatically increase carbon reductions required in new developments, with step reductions combing into force in 2013 and 2016. Hence, on an area-wide basis, setting planning policy targets for additional CO_2 savings or a minimum contribution from renewable or low carbon technologies could be seen add to the complexity of the planning and development control process, with potentially little impact on resultant CO_2 emissions or generating capacity. Furthermore, planning policy targets of this nature would only have a short term impact, as they would effectively be superseded by the Building Regulations zero carbon requirement from 2016 onwards for homes and 2019 for other types of building.

However, planning can have an important influence on sites which have the potential to achieve large carbon reductions in a cost and carbon effective manner. Planning can also coordinate more strategic interventions across an area through the spatial planning process. New developments are often an important trigger for the delivery of new infrastructure, and hence it is important to understand what scale and type of development can drive energy solutions.

This chapter examines four 'typologies' of typical development in Central Lincolnshire to demonstrate what level of carbon reduction is achievable, and the associated cost implications of those reductions. This analysis can be used as a resource for planning officers to inform their expectations from development proposals, but also to help the Central Lincolnshire authorities develop policies for strategic sites. Carbon reduction targets can be set that exceed Building Regulations for strategic sites where greater carbon reductions are believed to be deliverable. These can be set out through site allocation policies and Area Action Plans.

The Central Lincolnshire authorities are not yet at a stage where specific development sites have been allocated and hence no strategic sites have been tested for their ability to exceed emissions targets associated with Building Regulations. The authorities should use these typologies, along with the Energy Opportunities Map to identify sites where higher targets could be investigated.

7.1.1 Supporting and Facilitating Carbon Reduction Opportunities

Post 2016, Allowable Solutions will place emphasis on local authorities to identify and support delivery of community scale solutions. It may therefore be more productive for planning to begin to focus on identifying and delivering community scale energy opportunities which go beyond site boundaries, and obtaining an appropriate financial or delivery contribution from developers towards this. These opportunities do not need to be delivered in association with new development, although the two are not mutually exclusive. Large cost savings can often be made by planning in low carbon and renewable infrastructure at the start of the design process.

This approach could also reduce the burden on developers at a later date, when the zero carbon requirement is introduced, since coordination of community and large-scale renewable and low carbon energy opportunities would enable them to access a broader range of Allowable Solutions for Building Regulations compliance.

The level of funding that will arise from Allowable Solutions is unknown but it is possible to calculate the approximate level of Allowable Solutions which may be raised in Central Lincolnshire through future development. If the average new build home is assumed to be a semi detached house of 80 square metres with baseline emissions of 1.6 tonnes, then achieving a carbon compliance level of 56% post 2016 will mean that Allowable Solutions will be required to offset the remaining 44% or 0.7 tonnes. Assuming a value of £100 per tonne over 20 years, this is an income of around £2100 per dwelling.

The projected housing growth for Central Lincolnshire is around 40,600 homes by 2026 or 2,700 homes per year. Post 2016, the total income from Allowable Solutions is estimated at around £5.7 million per year, or £57 million by 2026 cumulatively.

7.1.2 Driving Wider Sustainability Standards through Planning

Taking a wider approach to sustainable design and construction than just carbon and energy, Central Lincolnshire local authorities can also utilise the Code for Sustainable Homes and BREEAM targets on either an area-wide or site specific basis to uphold a high standard of building in their area. The following sections discuss the application and cost implications of the Code for Sustainable Homes and BREEAM standards, and the current direction from Government on the need for local targets.

Code for Sustainable Homes

The Code for Sustainable Homes (The Code), developed by BRE and supported by the Department of Communities and Local Government (DCLG), sets out a national rating system to assess the sustainability of new residential development, replacing the previous system 'Ecohomes'. The Code consists of a number of mandatory elements which can be combined with a range of voluntary credits to achieve a credit level rating of between 1 and 6 covering nine sustainability criteria including CO_2 reduction, water, ecology, waste, materials, management and pollution. If the mandatory elements for a particular level are not reached, irrespective of the number of voluntary credits, then that code level cannot be achieved. This means that to achieve a full code rating, a range of sustainability issues will have to be incorporated into the building and site design.

Table 31 outlines specific requirements to achieve different levels of the Code. Further details of the requirements are discussed in Section 2.1 starting on page 26. November 2010 brought updates to the Code that included minimal changes. One of the major changes compares Code levels 4 through 6 to Part L of 2010 Building Regulations as opposed to Part L from 2006's Building Regulations. The resulting improvement over Target Emission Rate (TER) is the same – 44% improvement above Part L 2006, or 25% above Part L 2010.

Table 31: Performance required to meet Code levels.

Code Levels	Minimum entry requirements		Total points score out of 100
	Energy Improvement over TER	Water litres/person/day	
Level 1 (★)	10%	120	36
Level 2 (★★)	18%	120	48
Level 3 (★★★)	25%	105	57
Level 4 (★★★★)	44%	105	68
Level 5 (★★★★★)	100%	80	84
Level 6 (★★★★★★)	Zero Carbon	80	90

The PPS1 Supplement and the draft NPPF states that planning authorities should specify requirements for sustainable buildings in terms of achievement of nationally described sustainable buildings standards (such as the Code for Sustainable Homes). Where such local requirements go beyond national requirements including the Building Regulations, the evidence base must justify this is based on local circumstances. The draft NPPF further emphasises the importance of sustainable buildings, and is only restricted in designated areas (e.g., conservation areas), "when not outweighed by the proposal's wider social, economic and environmental benefits."

Since May 2008 it has been compulsory for new homes to have a Code rating. There is currently no national minimum requirement for the rating that they achieve; however, proposed changes to the Building Regulations are expected to reflect the requirements of the Code for energy.

Cost Implications of the Code for Sustainable Homes

An industry report on the costs of building homes to full Code levels has been used to show the financial implications of achieving Code targets.[51] The costs were predicted and the development industry does not fully support them yet. Only a handful of real Code assessments have been completed so there is not yet sufficient final cost data to establish robust cost benchmarks. An initial study was undertaken in 2008, and updated in 2010 as knowledge has progressed, but nevertheless cost estimates are still evolving.

Predicted costs show that costs associated with meeting advanced Code for Sustainable Homes levels are relatively modest for most elements. A significant proportion of the costs of delivering Code levels is in meeting the standards for CO_2 emissions, which after 2010 will become necessary for meeting Building Regulations. The percentage uplift in build costs associated with Code requirements not related to the energy and CO_2 requirement is around 3% for flats and around 6% for houses for Code Level 4. This relates to achieving **all** additional Code credits – homes must actually achieve 57% of available credits to achieve Code Level 3 and 68% of available credits to achieve Code Level 4.

There is a significant jump in cost when moving from Code Level 4 to Code Level 5 due to the need for water re-use and recycling systems in order to meet the mandatory water requirements for Code Level 5 and above. [52] The percentage increase in build costs for Code Level 5 (excluding the mandatory energy criteria) is around 4.5% for flats and nearly 12% for houses. As a broader and more cost-effective strategy it is suggested that Code 3 or 4 are used as standards for new development, and funding instead should be focussed on retrofitting existing properties.

[51] Code for Sustainable Homes: A Cost Review (produced for department for Communities Local Government by Davis Langdon , March 2010)
[52] See footnote 51

Figure 59 to Figure 63 show the predicted cost to deliver Code targets 3, 4, 5 and 6, broken down by the assessment category areas for a flat and a house. Energy standards make up the majority of the costs, but will over time be enforced through Building Regulations. The costs associated with energy standards and building regulations for the types of development expected in Central Lincolnshire are tested in the following sections.

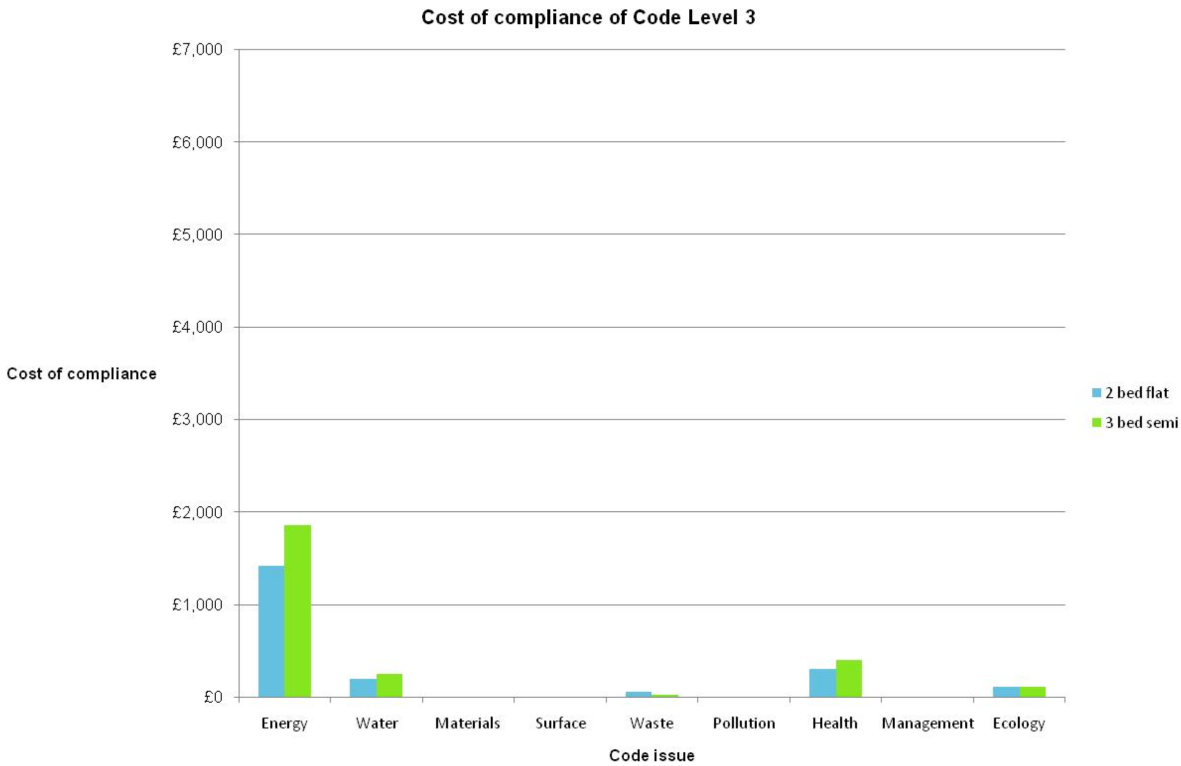


Figure 59: Costs (over base construction cost) for delivering Code Level 3 categories for a flat or house

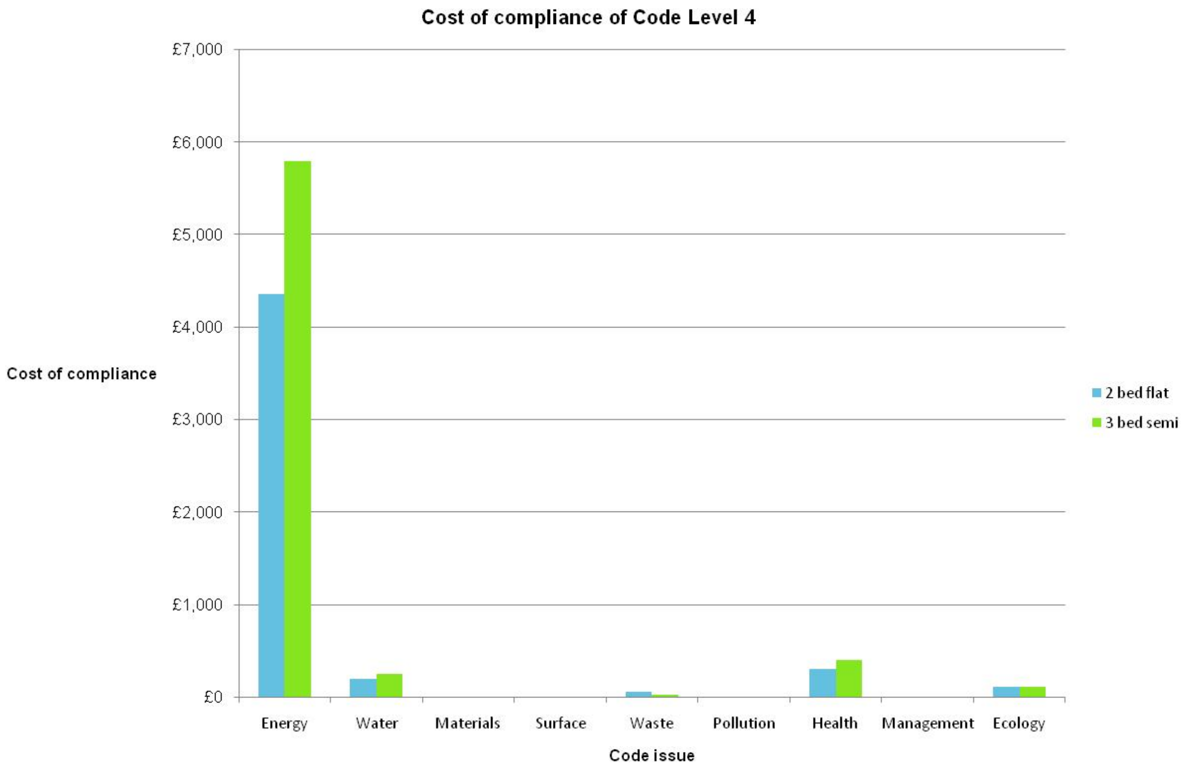


Figure 60: Costs (over base construction cost) for delivering Code Level 4 categories for a flat or house

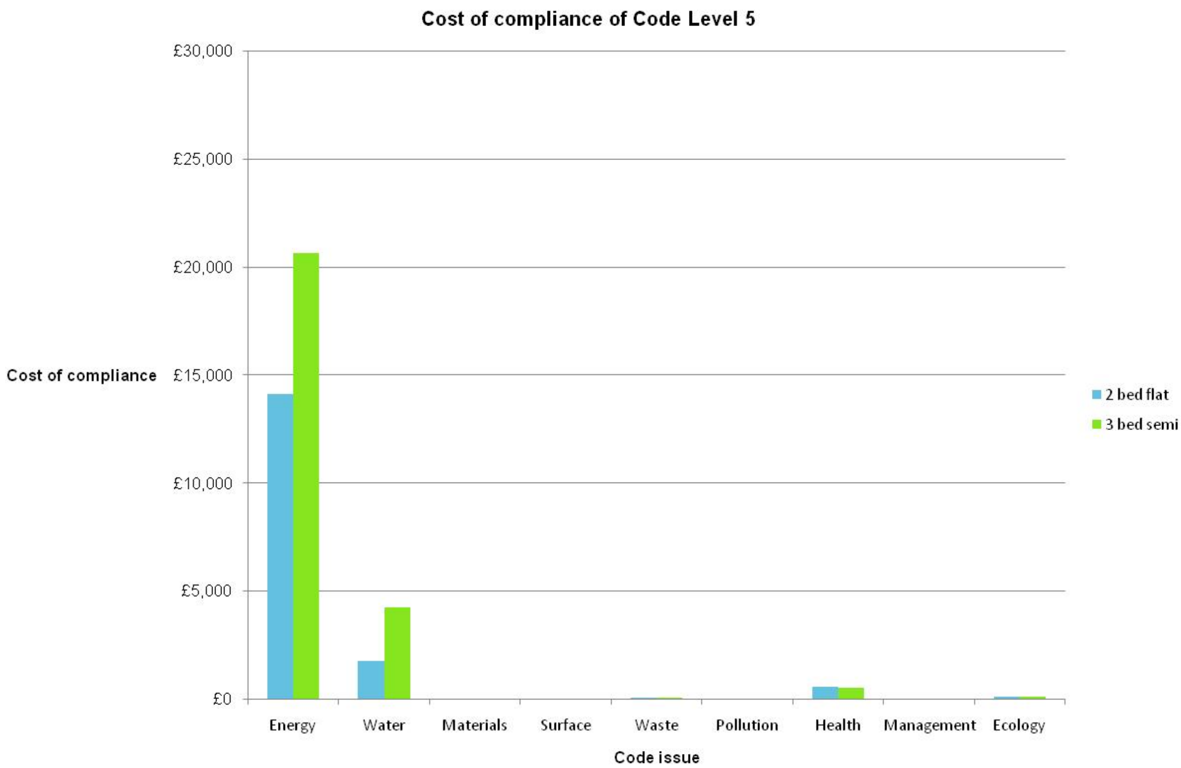


Figure 61: Costs (over base construction cost) for delivering Code Level 5 categories for a flat or house

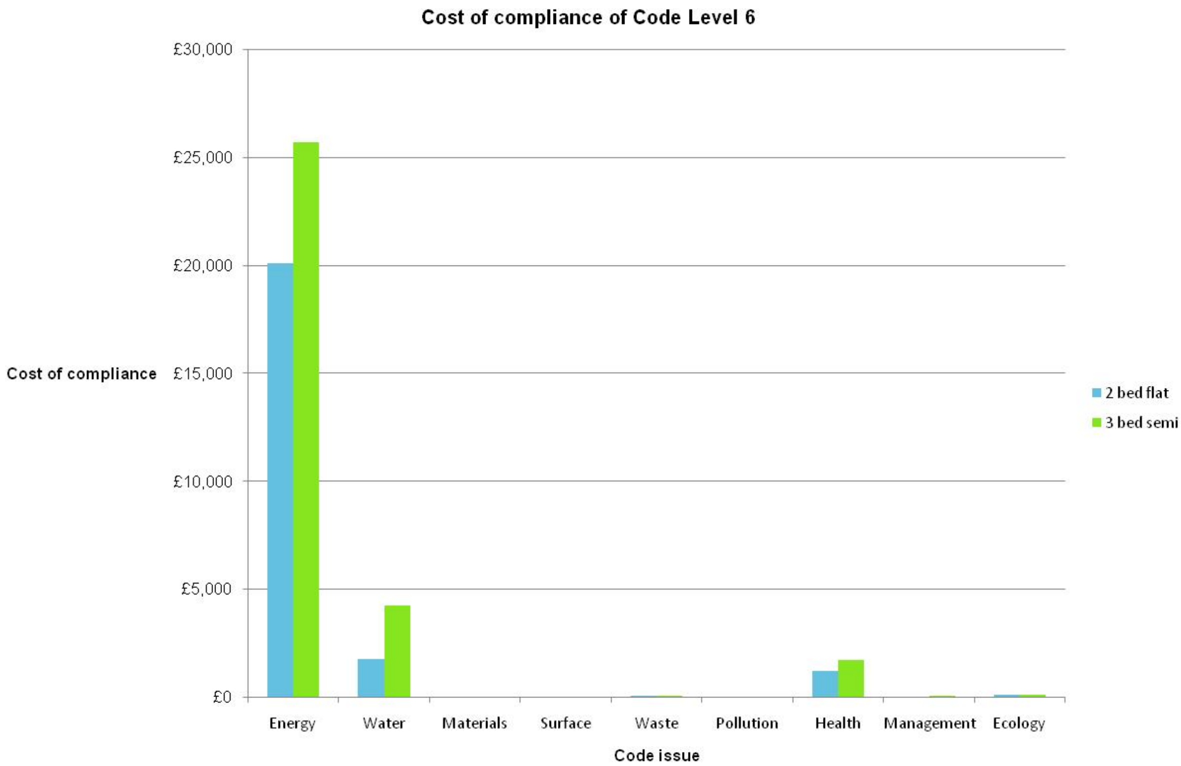


Figure 62: Costs (over base construction cost) for delivering Code Level 6 categories for a flat or house

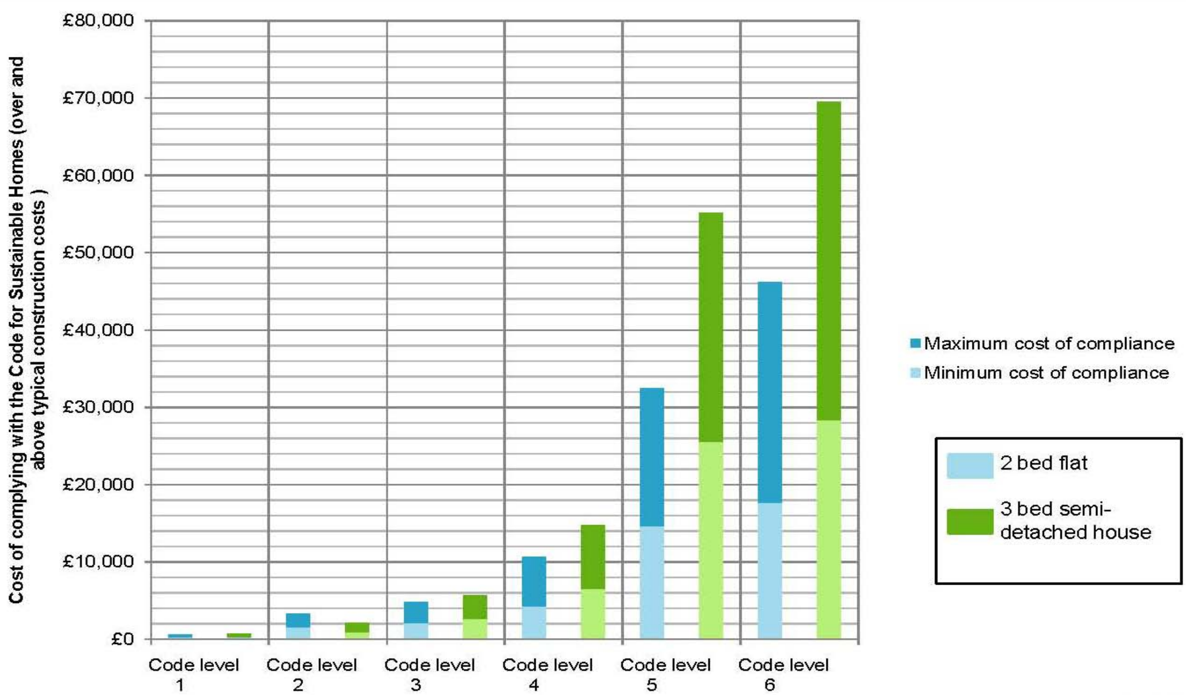


Figure 63: Costs associated with complying with the Code for Sustainable Homes

BREEAM

BREEAM (Building Research Establishment Environmental Assessment Method) is a voluntary assessment scheme which aims to help developers reduce the environmental impact of new non-residential buildings. Like the Code for Sustainable Homes, BREEAM allows independent assessors to appraise the environmental implications of a new building both at the design stage and post construction. This assessment can then be used to compare with other similar buildings. Therefore, it provides a consistent and independent assessment tool, which can be used in planning. An overall rating of the building's performance is given using the terms Pass, Good, Very Good, Excellent, or Outstanding. The rating is determined from the total number of BREEAM criteria met, multiplied by their respective environmental weighting. A properly conducted BREEAM assessment can influence design – both in terms of the masterplanning process and detailed architectural, mechanical and electrical specifications.

BREEAM was initially launched in 1990 as an environmental assessment methodology aimed specifically at office buildings (BREEAM Offices). Since then BREEAM assessments have been made more flexible and capable of assessing a range of other building types, including schools, industrial, retail, healthcare, and mixed use buildings. In the latest BREEAM 2010 methodology, all of the assessment types are combined under a standard scheme which is tailored to suite the type of building being assessed. Credits are grouped in to the following categories:

- Management
- Health and Well Being
- Energy
- Transport
- Water
- Materials
- Waste
- Land Use and Ecology
- Pollution

In policy terms BREEAM is useful as it provides a single assessment method which covers a number of key topics relating to sustainable construction. However it should be remembered that whilst it is the most common scheme in the UK, BREEAM is a commercial organisation (unlike the Code for Sustainable Homes) and there are alternative methods and schemes which can also be used.

Cost Implications of BREEAM Standards

While build cost estimates for BREEAM 2011 are not yet available, Figure 64 shows the percentage increase on the base build cost to deliver Very Good, Excellent, and Outstanding ratings under BREEAM Offices (2008). Target Zero led the costing exercise, supported by a host of private sector organisations, including AECOM.[53] The same consortium of organisations has completed a similar analysis for schools[54].

In order to help in the achievement of certain BREEAM standards, companies can claim both Enhanced Capital Allowances (ECA) and Carbon Trust grants to help them invest in Combined Heat and Power (CHP), renewables and other low and zero carbon technologies.

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[53] Target Zero (2011) *Guidance on the Design and Construction of Sustainable Low Carbon Office Buildings*
[54] Target Zero (2011) *Guidance on the Design and Construction of Sustainable Low Carbon School Buildings*

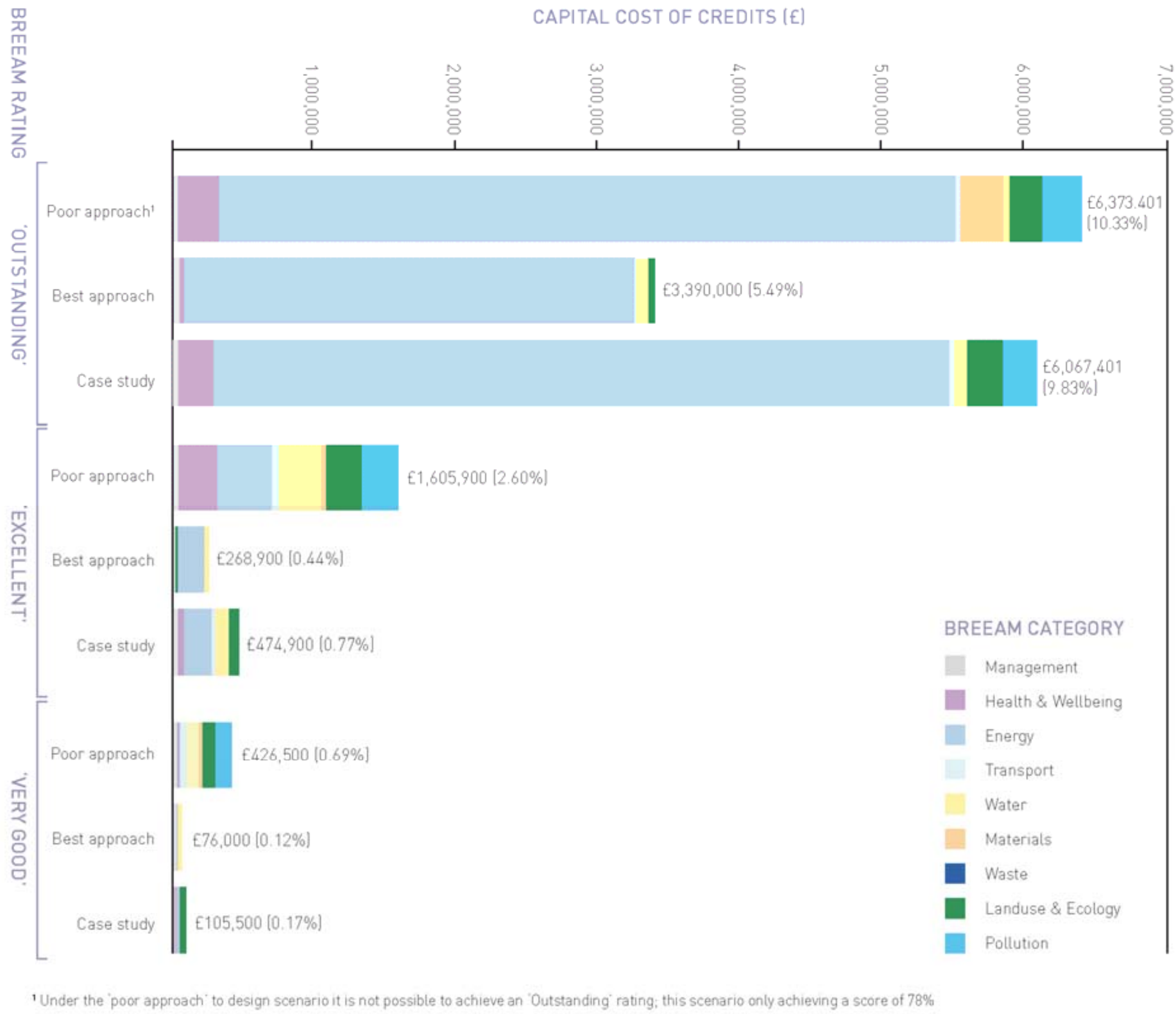

Figure 64: Costs (over base construction cost) for delivering BREEAM Offices (2008) under different approaches[55]

The cost analysis above shows that the 'Very Good' level of BREEAM is achievable with minimal increase to build costs, while the costs associated with BREEAM 'excellent' are only slightly more. BREEAM 'outstanding', on the other hand, has substantial cost implications. These costs can vary significantly depending on the approach taken, with a marginal increase of 5.5% given the 'best approach' for offices. For schools, BREEAM costs vary depending on development context (urban versus rural). Achieving BREEAM 'Outstanding' schools in a greenfield development carries the heaviest costs increase of 7.2%; however, attaining lower BREEAM levels are substantially less expensive. It should also be noted that BREEAM standards are not static, and are updated over time to ensure that the higher levels are still challenging. With this in mind, planning requirements that use higher levels of BREEAM should be treated with caution.

55 Target Zero (2011) *Guidance on the Design and Construction of Sustainable Low Carbon Office Buildings*

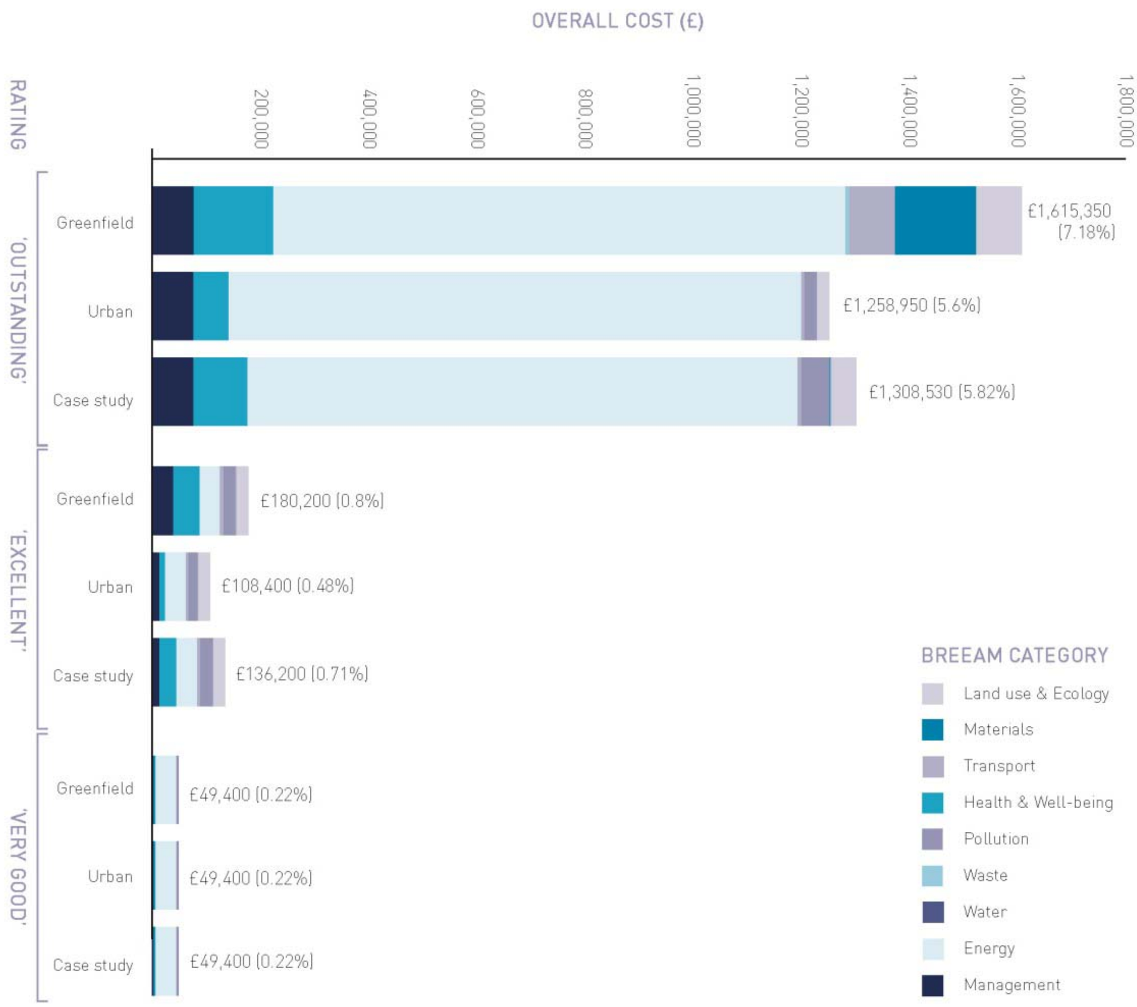

Figure 65: Costs (over base construction cost) for delivering BREEAM Schools (2008) under different development contexts[56]

7.2 DELIVERING CARBON REDUCTIONS IN NEW DEVELOPMENT IN CENTRAL LINCOLNSHIRE

Carbon efficient new development will be delivered through a combination of energy efficiency measures and development driven renewable and low carbon energy infrastructure, in-line with the Government's commitment to 'zero carbon' development in 2016. This will require a significant reduction beyond the Target Emissions Rate (TER) to achieve carbon compliance with the remaining emissions potentially picked up through a range of 'allowable solutions' to offset the remaining energy requirements. Consequently, new development will deliver a proportion of renewable and low carbon energy which can contribute to the local renewable energy targets.

The selection of technologies included in new development will depend on the level of CO_2 reduction which can be achieved through energy efficiency, and the most cost effective energy generating technologies available for inclusion on-site to reach the required CO_2 reduction. The general range of technologies available for use in new development and their constraints is shown in Figure 66.

[56] Target Zero (2011) *Guidance on the Design and Construction of Sustainable Low Carbon School Buildings*

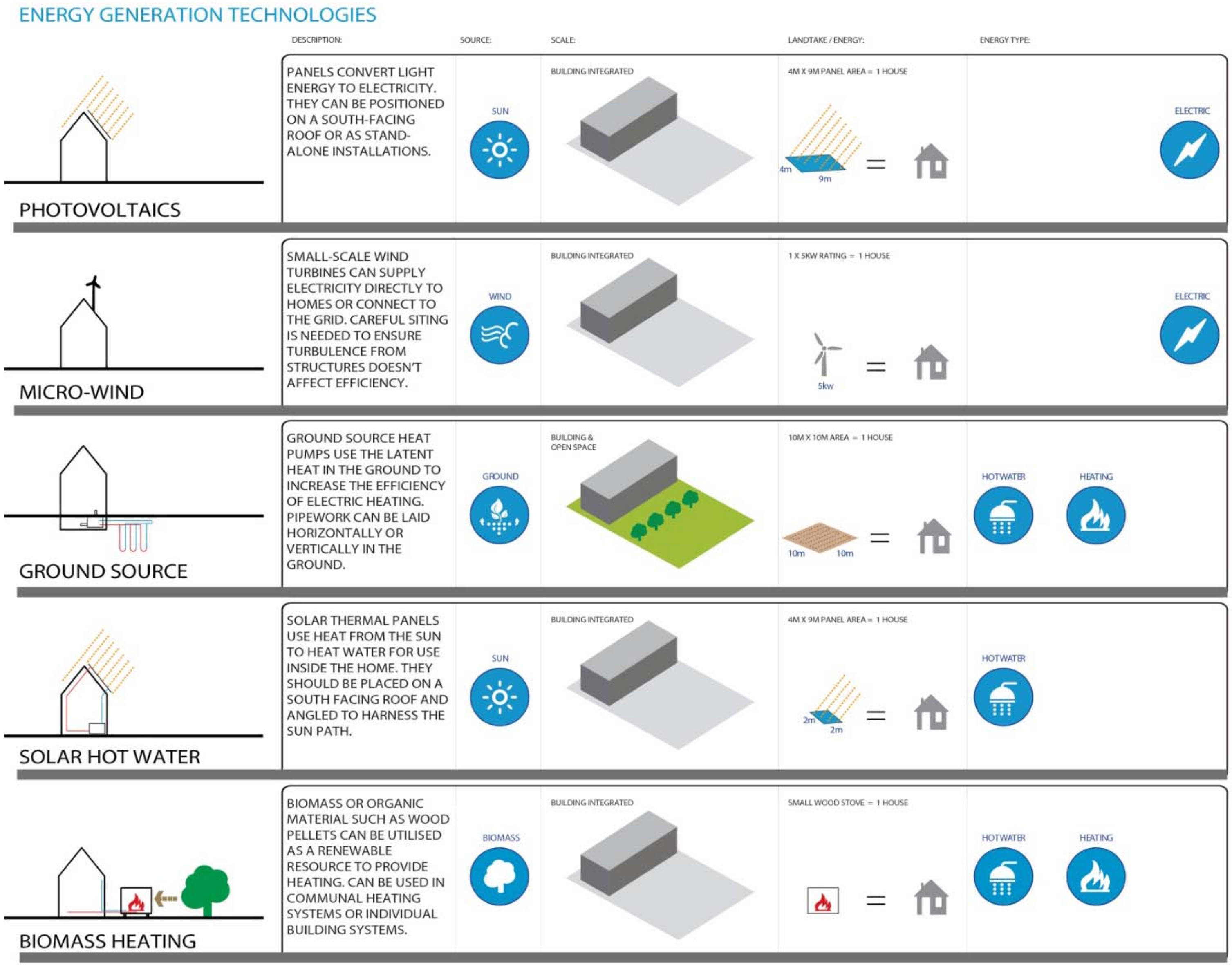

Figure 66a: Range of renewable and low carbon technologies available for use in new development

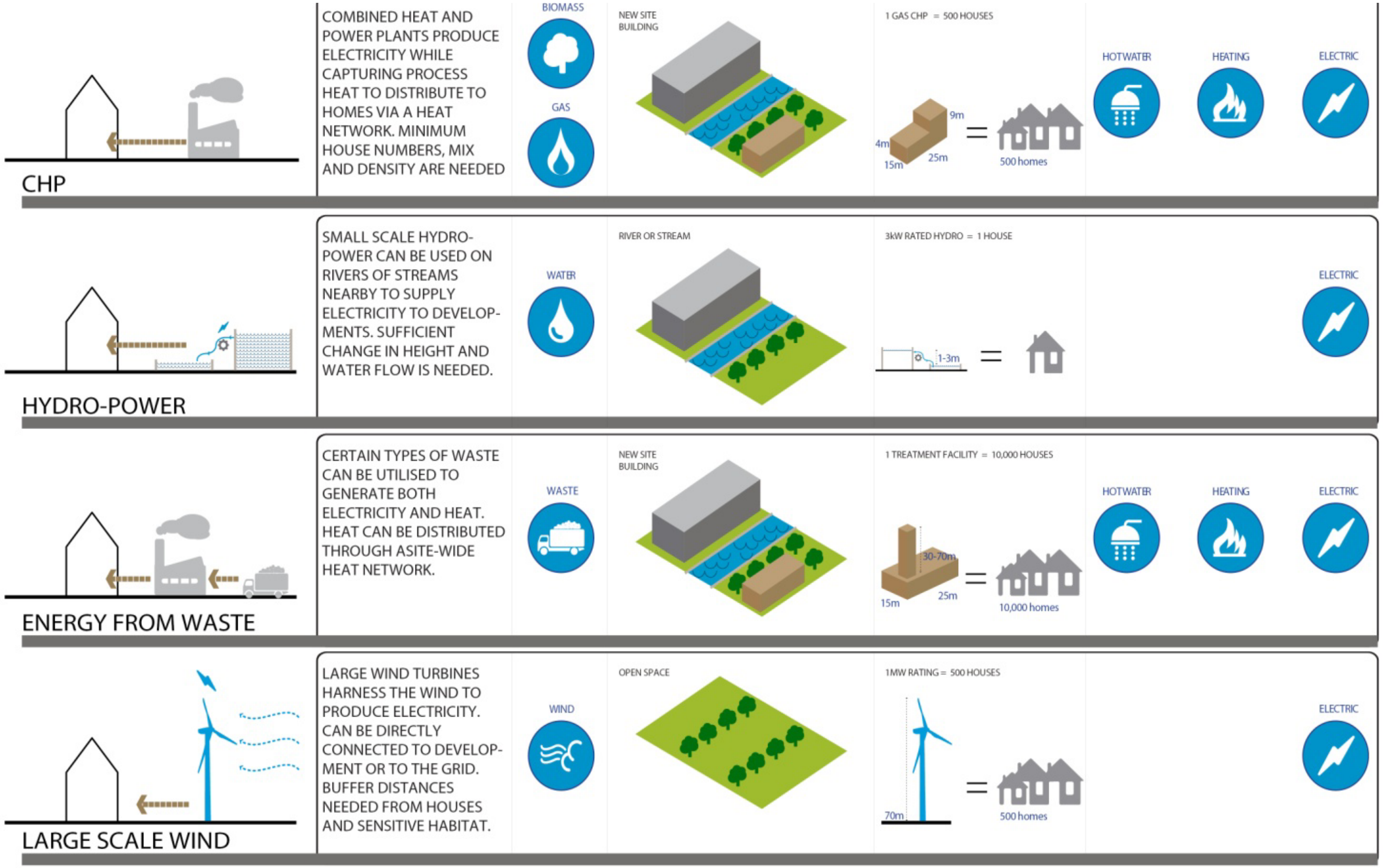

Figure 66b: Range of renewable and low carbon technologies available for use in new development

Renewable and Low Carbon Technologies Considered

Expanding on Figure 66, the following sections discuss the design considerations associated with each technology relating to their technical and financial viability that determined whether they could be applied to the strategic sites.

Enhanced energy efficiency

There are no site specific opportunities or constraints associated with this issue as enhancing energy efficiency does not have a spatial implication at a masterplan scale, and only affects the internal layout of buildings. There is, however, likely to be a financial constraint as, beyond a certain standard, energy efficiency measures progressively become an expensive way of achieving CO_2 reductions. The advantage of enhancing energy efficiency is that the need for onsite renewables and low carbon technologies to deliver carbon compliance levels will be reduced.

For non-residential buildings the improvements are likely to focus on the specification of more efficient services more than on building fabric changes as the CO_2 savings achievable with building fabric improvements are relatively limited. Careful specification of services within the building, such as lighting and ventilation, can achieve significant savings, which outweigh those achievable by low carbon technologies. Unfortunately, the extent of these savings is difficult to estimate at an early stage due to the variation possible in non-residential building types and designs.

Gas fired Combined Heat and Power (CHP)

CHP is most cost effective at a large scale, connected to a district heating network and serving a mix of building types with relatively consistent electricity and heating demands. CHP systems are generally coupled with district heating networks; however, these are typically only cost effective on developments of high density as the length of pipes required is low relative to the energy being distributed.

Solar water heating (SWH)

Solar water heating has been successfully implemented in various building types but has little CO_2 reduction potential in commercial building uses where demand for hot water is low relative to the overall building energy demand. SWH is more attractive for use in homes, where it is well proven, and can contribute up to 13% CO_2 savings. After 2013, new homes will be required to deliver a greater level of CO_2 saving than can be delivered using only SWH and the technology may be less favoured in future as it competes for demand with other technologies, such as biomass heating and natural gas or renewable-fired CHP, all of which can contribute much higher levels of CO_2 saving. These technologies also meet energy demands for space heating and - in the case of CHP – with the added advantage of electricity generation.

Wind turbines

Micro (building mounted) wind turbines have not been considered for this assessment as feedback from field trials (by BRE, Carbon Trust and EST) has shown limited energy outputs from small turbines installed in urban and sub-urban locations where wind conditions are turbulent. The potential for wind at a larger scale is discussed separately in Chapter 5. It is worth noting, however, that due to site constraints, large scale turbines are unlikely to help meet Code for Sustainable Homes or BREEAM targets for any of the strategic sites.

Solar Photovoltaics (PV)

Other than wind turbines, photovoltaics (PV) are the only renewable energy technology delivering electricity. PV is likely to play a major role in delivering future targets for onsite CO_2 reduction, as replacing electricity has higher CO_2 saving potential than replacing heat. This is due to the fact that fossil fuel powered electricity generation and distribution is a carbon intensive process. The amount of suitable area for accommodating panels and their cost are the only factors limiting PV energy output. Good design should be able to maximise the area which can be used for mounting PV panels. To operate effectively, panels need to face South at a 30^{o} pitch. Valley roofs or flat roofs can be used where conventional pitched roofs cannot be orientated to face south. PV is well suited both to residential and non-residential installations as all building types require electricity and generation and demand profiles are not an issue as excess electricity can be sold to the national grid.

PV have a high capital cost; however, they are becoming more competitive with other low carbon technologies and has only improved since the introduction of Feed in Tariffs in April 2010.

Ground Source Heat Pumps (GSHP)

The technical viability of ground source heat pumps for any of the strategic sites has not been considered in detail at this stage as this would require a detailed ground condition survey and the potential CO_2 savings from this technology are relatively low compared to other low carbon options to make this worthwhile doing at this stage. For all three sites it has been assumed that ground conditions are suitable for installing the ground loops required for GSHPs.

In terms of spatial implications GSHPs have limited impact on masterplans as the ground loop can be buried in a vertical borehole and the heat pump would only require a small space within the building. Where more space is available, for example where there are houses, the ground loop can be laid horizontally by burying it in the garden, which reduces installation costs. For flats it may be necessary to use vertical boreholes, which do not require large outdoor areas to be kept free from buildings.

GSHP have particularly high potential in commercial buildings as they can meet both heating and cooling loads; however, they do compete with other low carbon technologies that are more effective at saving CO_2 such as CHP. In terms of financial viability, the capital cost of GSHPs is high, particularly if a vertical borehole is required. For this reason we have assumed that GSHP would only be viable for commercial buildings and houses but not flats.

Energy benchmarks used to calculate energy demands for non-residential buildings do not provide a breakdown of the electricity consumption. Therefore, it was not possible at this stage to define the cooling demand of buildings. This means that the calculated CO_2 savings associated with GSHPs only show the savings from ground source heating but not ground source cooling. The extent of these additional savings can only be assessed once more detailed information on building types and their energy demand becomes available.

GSHPs can deliver Code Level 3 energy requirements (or Level 4 when combined with other technologies). However, much of the benefit from GSHPs is due to the technology taking advantage of the 'fuel factor' for electricity. This means that the calculated target emission rate s higher than if the base case were gas heating, making it easier to meet the Code target improvements. The use of this fuel factor for heat pumps is being reviewed for future versions of Building Regulations[57], meaning that in future GSHPs may not be as advantageous as under current regulations.

Biomass heating and CHP

Biomass heating is well suited for low density housing as this type of development has relatively high heating demands and most likely will have sufficient space to accommodate solid fuel storage. This technology can generally achieve Code Level 4 on its own without need for additional renewable technologies.

Biomass CHP, as gas CHP, is best suited for large, dense, mixed developments and is the low carbon technology discussed here with the highest potential for on-site CO_2 savings. It can meet the energy requirements of Code for Sustainable Homes Level 5 (100% reduction on regulated emissions) and can deliver greater savings if sized to meet the development's electrical demand. However, this does mean that some of the heat generated may be wasted, if no suitable end uses for it can be found. This is due to the heat to power ratio associated with CHP engines.

[57] Energy efficiency requirements for new dwellings, A forward look at what standards may be in 2010 and 2013 http://www.communities.gov.uk/documents/planningandbuilding/pdf/Energyefficiencyrequirements.pdf

7.3 ANALYSIS OF LOCAL DEVELOPMENT TYPOLOGIES

The results of modelling for four development typologies, representative of those expected to be typical in Central Lincolnshire, are described in this section. A range of solutions has been presented to comply with expected changes in Building Regulations standards between 2010 and 2013, with the planned implementation of zero carbon homes in 2016. The achievement of the various Code for Sustainable Homes and BREEAM levels (for energy only) has also been considered.

All sites are fictitious, but are designed to be representative of possible future development situations in Central Lincolnshire (this does not mean that such development scenarios will be pursued in the LDF, nor does it mean that scenarios that are not identified below will not be pursued in the LDF). This will allow planners and stakeholders to understand the carbon reduction possibilities associated with different types and locations of development.

How should these results be used?

The results included in this section show the overall CO_2 reductions and site wide costs for the development typologies. Additional information is provided in Appendix B showing the results for individual building types on each of the sites.

All figures on technology costs, construction costs are based on benchmark figures and in reality will vary with the individual requirements for each development. They should therefore only be used as a guide and may differ from those provided by developers. Standard performance factors and carbon emissions factors, both for use in Part L calculations, are used where available to calculate the energy performance and CO_2 reductions from individual measures. Again the performance of a technology or measure will depend on the individual building design and plant design, and these are likely to vary in reality. The information presented here therefore provides an important component of the evidence base when testing the viability of measures and standards on new development, but a degree of flexibility is required to allow for variation in detailed proposals.

It is important to note that the results presented are referenced to Part L 2006 as a baseline. Most analysis of future standards, and the resultant future standards, can be referenced to Part L 2006, and therefore this provides a relatively simple way of assessing performance. However the approach for the domestic and non-domestic sector differs slightly:

- **Domestic.** Part L 2010 requires a reduction in CO_2 emissions of 25% over Part L 2006. It is therefore possible to adjust the baseline to provide an assessment over Part L 2010.
- **Non domestic.** The cost effectiveness of achieving CO_2 savings in different building types depends on the use of the building. Therefore Part L 2010 requires an aggregate reduction of 25% over Part L 2006 across the new non-domestic stock, but the actual improvement varies by type as given in Table 32 below. The use of an aggregate approach means that the actual level of reduction on a site containing non-domestic buildings will depend on the mix of the site.

Table 32: Reductions in CO_2 emissions over Part L 2006 for different building types

Shallow plan (heated)	Shallow plan (Aircon)	Deep plan (Aircon)	Warehouse (no rooflights)	Warehouse (with rooflights)	Hotel	School	Retail	Supermarket
27%	33%	19%	22%	36%	25%	23%	33%	11%

As the Building Regulations become increasingly stringent in the future, requiring larger CO_2 reductions, the economic viability of meeting these reductions in different building types will become more variable. For domestic buildings, future revisions to the building regulations will increase this improvement to 44% over Part L 2006 (or around 25% improvement over Part L 2010) for the 2013 revisions, and 100% improvement of regulated loads by 2016. The "zero carbon" standard for 2016 includes a level of carbon compliance for on-site reductions which is currently proposed to be 44% (over Part L 2006) for flats, 56% for terraced and semi-detached houses, and 60% for detached houses, allowing for the viability variation. In the non-domestic sector, the level of variation is more pronounced, and recent research by AECOM and Europe Economics for the UK Government has proposed a range of values for viable levels of reduction[58]. These are provided in Table 33 below.

Table 33: Potential Carbon compliance levels for non-domestic buildings at future revisions of the building regulations

Building type	2013	2016	2019
Deep Plan Office Air Con	21%	26%	33%
Shallow Plan Office Air Con	27%	32%	40%
Shallow Plan Office Heated	30%	43%	62%
High Street Retail	12%	12%	12%
5 Star Hotel	20%	26%	33%
Out-of-town Supermarket	12%	12%	19%
Retail Warehouse	44%	54%	60%
Distribution Warehouse	55%	66%	72%
Acute Hospital	31%	40%	55%
Cultural	21%	24%	29%
Defence	42%	48%	56%
Prison	65%	72%	82%
Secondary School	30%	36%	47%
Primary School	23%	57%	60%
3 Star Hotel	27%	34%	53%
Country Hotel	34%	56%	72%
Mini Supermarket	12%	12%	17%
Aggregate reduction	33%	41%	49%

The future approaches for assessing reduction in both the domestic and non-domestic sectors means that there is a high degree of variability and the information used in this report can only be used for high level guidance and not detailed assessment of individual sites.

[58] Zero Carbon Non-Domestic Buildings: Phase 3 Final Report. AECOM and Europe Economics for DCLG.

7.3.1 Characteristic development types

Table 34: Site analysis typologies

Typologies	Housing	Commercial	Other	Assumed Housing Density	Detached %	Semi %	Terrace %	Flats %	Site Constraints	Site opportunities
• Large urban extension / eco-town	2000 homes	30,000 m2 of B1 10,000m2 of B8	1 primary school, 1 local centre (retail, community, leisure, health care, library, crèche, church)	55 dwellings/ ha	25	30	30	15	• Phasing • Landscape character • Multiple developers	• Retrofit heat systems to adjoining development • Allowable solutions • Site-wide systems • Nearby industrial areas • Masterplanning
• Small rural development in village	10 homes	none	none	20 dwellings/ ha	60	40	0	0	• Landscape character • Residential amenity	• Wind opportunity area • Solar PV
• Medium urban infill development	100 homes	none	All residential	50 dwellings/ ha	15	40	35	10	• Tight urban environment	• Retrofit heat systems to adjoining development • Allowable solutions • Nearby town centre
• Business Park development	none	43,000 m2 B1, 35,000 m2 B2, 17,000 m2 B8, 4,645 m2 C1, 7,154 m2 D2	Includes hotel, public house	-	-	-	-	-	• Variable/unpredictable uses	• Symbiotic industries • Waste heat • Masterplanning • Large roof areas

7.3.2 Site 1: Large urban extension / eco-town

The large urban extension considered includes 2000 homes and a range of mixed use non-domestic buildings typical of such a site. The housing is split between all forms (including flats) and has an average density of around 55 dwellings per hectare. For a large mixed site like this, unless there are significant energy users present, for example a data centre, many of the issues and options are identical to similar large sites ranging from a few 100s of homes to many 1000s of homes.

The mix and scale of the site opens up opportunities for the following types of systems:

- Site wide district heating networks, connected to Combined Heat and Power (CHP) generators. The economic viability of district heating will depend on the overall heat density of the site to allow maximum heat sales over a given network. The heat density is likely to vary across the site (detached houses will be much less dense than flats) and therefore a heat network may only be preferable in certain areas. Careful site layout can be used to maximise these opportunities (see below).
- Linking to existing neighbouring energy network systems (for example a neighbouring heat network). A large extension could present an attractive additional heat load for existing CHP and DH schemes, if and when constructed.
- Locations are often on the outside of towns near industrial areas, opening opportunities for linking to these, and making use of waste heat where available. The longevity risk of the heat source needs to be establishes, as do the CO_2 implications – the extract of "waste" heat can impact on the efficiency of plant.
- Developing the masterplan to improve energy efficiency, through orientation, co-location of complementary buildings (for example taking the waste heat from one to heat another), and site layout which is supportive of district heating networks.

Many of the opportunities presented are due to the scale of the site, but this can also introduce constraints to the development of energy schemes. These can include:

- **Phasing of construction**. Large sites will be developed over a number of years, but a secure energy supply is required from year one. A long term strategy (such as a site wide scheme) may not be viable for earlier phases due to the site size, and so these need an alternative option which may be an interim or permanent solution. This has the effect of reducing the remaining site size and therefore may impact further on the long term viability.
- **Technology development**. Some solutions which have been discussed for large scale schemes are potentially not yet commercially viable (an example being biomass CHP). Whilst these may be mature and commercially viable by the time the site is completed, an interim solution may be required.
- **Changes to building regulations and national policy**. It is likely that both of these will change during the build out of a site. The requirements of policy and regulation can drive certain solutions and therefore a scheme may need to change solutions during its lifetime. An example is the influence of the electricity grid CO_2 intensity. In the short term, gas CHP may deliver larger CO_2 reductions than heat pumps, but as the grid CO_2 intensity is reduced over time through the increased integration of low carbon electricity generation including potentially renewables, nuclear power, and Carbon Capture and Storage (CCS), the opposite may become true.
- **Multiple developers**. Most large schemes are split into a number of sub-sites for developers. It is possible to set design guidelines and codes which include requirements for low and zero

carbon energy standards and infrastructure, but these need to be flexible to allow each developer to select the most viable technical solution for each site. It is possible that one scheme may have the highest viability overall, and leadership is needed over the entire scheme to encourage developers to work together to accept this solution. The procurement process for each developer may also need to be adjusted to ensure that maximising land value for each plot separately does not preclude site wide schemes.

- **Landscape character**. For out of town developments including new towns, landscape character needs to be considered. It is possible that more rural schemes, and particularly larger schemes where the layout permits large areas of open space, could accommodate technologies such as wind turbines. The impact that these have on neighbouring areas and landscape character needs to be considered.

The results of the cost and CO_2 modelling for each of the building type are shown in Appendix B. For a given CO_2 reduction target (either tied to future building regulations or code levels), the solution with the minimum cost which meets or exceeds the specific target can be identified. The exact solution will depend on the building type, and so the use of a site wide scheme may be sub-optimal for certain types, but provide an optimal solution over the entire site. For domestic buildings, the Part L 2010 level is indicated by a dashed line. For the non-domestic options, the range of potentially viable CO_2 compliance levels is indicated by the shaded area.

The results for the dwellings show the change in suitability for site wide solutions vs. building level solutions. For all dwellings, the DH options are generally comparable in terms of cost with stand alone options suggesting that for each house type, DH may present a viable option for certain CO_2 reduction targets. In all the dwelling options, the ground source heat pumps (GSHP) appear to be expensive compared with other options. This is partially because the CO_2 reductions can be relatively small (as demonstrated also in recent field trials by the Energy Saving Trust) and therefore they appear early in the chart.

The charts for non-domestic buildings demonstrate the significant level of variability between building types. The shaded overlay on the charts shows the range

The level of reduction is limited in Air Conditioned (AC) offices to around 30 – 40% beyond Part L 2006. A Part L 2010 compliance AC office may already have between 19% (deep plan) and 33% (shallow plan) reductions and so further reductions are limited. This is due to the dominance of cooling and electricity use for services in AC offices. These can obviously not be offset by heating technologies, and providing renewable or low carbon electricity and further efficiency savings is challenging.

The workshop and primary school have proportionally higher heating loads than AC offices. The range of CO_2 savings is therefore wider, with a higher potential form the more expensive options. With a Part L 2010 improvement of 23% for schools, and between 22% (workshop – no rooflights) and 36% (workshop – with rooflights), there remains scope for further improvement as indicated by the shaded potential carbon compliance bands.

7.3.3 Site 2: Small rural development in village

The development has been assumed to be a small rural development of 10 homes or less. The density is relatively low at 20 dwellings per hectare, and mostly made up of semi detached, and detached homes.

The size of the site means that community schemes are unlikely to be viable unless there are additional drivers, for example the reduction in fuel poverty in social housing, or a demonstration project. It is therefore likely that any CO_2 reductions will be achieved at an individual dwelling scale, with potentially some additional site scale electricity generation.

The main opportunities provided by a low density rural development are:

- **Space.** The nature of the development will provide more space in the form of land and roof area. This means that the dwellings may be slightly larger with gardens, opening up opportunities for ground source heat pumps, biomass boilers and biomass storage, and PV on large roof areas.
- **Increased wind potential.** It may be possible to include small or medium scale wind turbines on a rural development. These would typically be mounted on a mast and have a hub height of circa 15 m or more (representing turbines of around 6 kW or more).

The developments are likely to be small in area and so the inclusion of systems such as wind turbines needs to be considered from an amenity and landscape perspective.

The results demonstrate that most options rely on some degree of PV to achieve a CO_2 reduction and achieving a carbon compliance level of between 56% and 60% will require at least half of the roof to be covered in PV. It will therefore be important to consider roof orientation on developments without access to community solutions. As with the large mixed development, ground source heat pumps are one of the most expensive ways of reducing CO_2, due to their capital cost and relatively inefficiency performance (resulting in minimal CO_2 reduction with the current grid CO_2 intensity). It is also likely that, based on current development layouts and practice, the ground area, even including gardens, will be limited and potentially too little for surface collector systems. Likewise, air source heat pumps are also generally relatively cost inefficient. Whilst they have a lower capital cost than ground source systems, the coefficient of performance, and therefore CO_2 reduction is also likely to be lower.

The modelling demonstrates that biomass boilers provide one of the most cost efficient means to reducing CO_2, and with the addition of PV, this is the only option that can significantly exceed the carbon compliance level, and meet the current Code 5 definition of 100% reduction in regulated emissions onsite. The decision for biomass boilers in individual new dwellings however needs careful considerations. There are implications in terms of space for the boiler and biomass storage (requiring usually a separate boiler room) and there are increased requirements for maintenance and operation for homeowners. Most importantly, the high heat output and slow response may not be well suited to modern thermally efficient dwellings where a large proportion of the heat load (and all in the summer months) is for DHW only.

7.3.4 Site 3: Medium urban infill development

The medium urban infill development represents a site which sits between the large urban extension and the small rural development. The intermediate scale of development is at a size where there is unlikely to be sufficient heat load for a site wide DH scheme with CHP, and the high density nature of infill development (at around 50 dwellings per hectare in this case, and comprising mostly semi detached and terraced housing) means that space is limited for technologies such as wind (which is also precluded due to an urban location) and ground source systems (which have already been shown to be relatively expensive in any case). The baseline position for an infill site is therefore the use of stand-alone systems for each dwelling or block. However there may be some opportunities available to these sites for alternative options:

- The sites are likely to be close to neighbouring existing development, both residential and commercial. There may be opportunities to link into neighbouring DH and CHP schemes so that a viable scale of scheme is achieved. Neighbouring uses may include leisure centres, hotels, and public buildings (council offices, schools, hospitals etc), all of which could help form an anchor load for CHP.
- Urban infill sites may be close to industrial areas where there is a potential source of waste heat. Infill sites may also be located in areas with larger scale regeneration and redevelopment, enabling them to join a more strategic energy scheme.

The opportunities for infill development lie not in specific technical options, but in the potential to be linked to, and to be part of something much larger. It is therefore important for developers of these schemes, and planning officers involved in these schemes, to map out neighbouring activities, both current, and future plans, and assess whether there are any opportunities for synergies to be made. The issue of phasing will often be problematic, and developers will not be able to wait a number of years until neighbouring schemes commence. However ways of overcoming the phasing issues should be developed, including the use of temporary strategies which have the opportunity to be upgraded at a later date (for example making a site CHP ready). This may require some flexibility from planners in the form of what can practically be achieved in year one, and also a commitment from the developer to upgrade as and when viable.

7.3.5 Site 4: Business Park development

The fourth case study site of a business park represents a typical development which may occur on the outskirts of a town or city, comprising a mix of employment classes, and including amenities such as a public house and hotel. The results presented here are based on one mix of development, but as seen already, the range of energy consumption and the resulting potential for making CO_2 reductions is very sensitive to the use types present.

Business parks can present a number of opportunities for reducing CO_2 emissions:

- Business parks often contain low rise buildings with large footprints. These provide a large roof area which can be used to support large PV arrays.
- There may be symbiotic building uses present which can support diversity on district heating schemes, and potentially make use of each other's waste energy. One example could be a hotel making use of waste heat from a neighbouring industrial building.
- Business parks may be located close to out of town waste management facilities, such as the Energy from Waste plant at North Hykeham. This offers the opportunity for making use of the heat generated at the plant through a DH network.
- Business parks are usually built from a large scale masterplan, often as part of wider re-development proposals. This allows for strategic planning of energy schemes, allowing the

coordination of a number of organisations and people from the early conceptual stages of design.

There are, however, also a number of potential issues with business parks which can restrict the options available:

- **Types of use**. Many uses on business parks can be low in energy demand. Warehouses and factories are often unheated, or have minimal heating, which reduces the potential for DH and CHP schemes, and reduces the potential for making CO_2 reductions using heating technologies. It is often more cost effective to provide heating at a building level.
- **Speculative development**. Buildings on a business park are often speculative. This means firstly that the developed building may have no, or limited servicing, (for example heated office space, but unserviced factory space) which limits the potential for reductions in CO_2 using heating technologies. Secondly, the speculative nature means that often the type of business is not known until the development is complete and the units let or sold. It is therefore difficult to predict the level of energy demand and using a building scale solution can be less risky. Depending on use, two identical buildings could have energy consumption varying by a factor of 10, with one used for distribution and unheated, and the other used for energy intensive industrial processes.

The charts in Appendix B show the range of CO_2 reduction achievable in the modelled building types. As for site 1, the charts also indicate the potential carbon compliance ranges developed by AECOM for the UK Government. These represent the maximum predicted (from a low to high level) CO_2 savings which are deemed economically viable for future building regulations. It is therefore not recommended that local policy requires CO_2 savings which exceed these levels unless it can be demonstrated that specific circumstances exist.

It is clear from the data that for all building types apart from the warehouses, the actual range of potential CO_2 savings is relatively limited. This can be attributed to two simple reasons:

- Space heating is in general a relatively small component of overall CO_2 emissions in most modern non-domestic buildings. Therefore the CO_2 reduction potential from any heating technologies (excluding process loads which are not included in the regulations) will be limited, resulting in a limited range.
- PV is one of the main technologies but limited by roof area. The roof area therefore provides an overall cap on reduction potential.

The information contained within the charts, and for non-domestic buildings in particular, should be used with caution. The CO_2 savings and costs are based on specific assumptions relating to building type, use, and form and therefore may not be representative of another building of the same class. The width of the carbon compliance bands highlights both the degree of uncertainty over the economics and performance of measures, but also over the actual baseline energy consumption due to variation in building type. In some cases the band is around 30% or more of the regulated emissions.

For all the non-domestic building types assessed apart from warehouses (which have a high degree of variability), the Part L 2010 compliance levels are approaching or exceeding the lower carbon compliance band. This means that under current Building Regulations, some buildings may struggle to meet or exceed the regulated standards in a viable manner. Therefore there is limited scope for increasing the reduction targets without allowing off-site solutions, potentially in the form of Allowable Solutions.

The modelling therefore suggests that CO_2 reduction targets for non-domestic sites should be based around Part L limits unless a special case economically viable solution exists. One example of a site is Teal Park which is located near to the North Hykeham Energy from Waste plant, and could have the potential to link into the site. Discussions with Cofely, the consultant and DH scheme operator, who have conducted analysis of a DH scheme from North Hykeham to Teal Park and surrounding areas have found that it may be possible to develop a viable DH network to Teal Park transporting heat from North Hykeham, but the economics are marginal (which will make finding a commercial investor challenging) and there is a high degree of risk due to the lack of a significant anchor load, and the requirement to sign up commercial customers in an open market. Therefore whilst these options may exist, and should be identified using the mapping in this report, and promoted by planners for new development sites, it may still be challenging to develop such schemes without the support (and potentially finance) of the public sector.

7.4 KEY CONSIDERATIONS EMERGING FROM THIS CHAPTER

- Expected changes in Building Regulations will significantly decrease CO_2 emissions from new development, making further additional CO_2 reduction more challenging technically, and less economically viable. This therefore removes some emphasis in this role from planning authorities;
- The changes to Building Regulations are likely to create demand for 'Allowable Solutions' which involve the development of solutions outside of the site boundary that can further reduce CO_2 emissions associated with new development. The Central Lincolnshire authorities are likely to need to play a role in coordinating and delivering Allowable Solutions, especially if this investment is to be used for local projects;
- The Code for Sustainable Homes is a national and independent assessment tool which can be used to appraise sustainable design and construction in new homes. Any additional CO_2 reductions beyond national standards (the prevailing Building Regulations) making use of the evidence in this report supported by the charts in Appendix B, should be aligned with the Code CO_2 mandatory levels to ensure consistency.
- BREEAM is also a common assessment method used in direct design of non-residential development. The energy sections of BREEAM can be used as a policy target (with the allowance for developers to use alternative recognised tools from BREEAM if they prefer). The Code and BREEAM also require other sustainability aspects to be addressed. The costs associated with other aspects are considered reasonable in relation to the overall build cost for levels up to and including Code for Sustainable Homes Level 4 and BREEAM 'Very Good'.
- Development typologies have been developed that demonstrate the potential and cost of implementing carbon reduction opportunities in new development in Central Lincolnshire. This evidence base data should be used to explore options and set higher targets, where possible, for strategic sites.

Growth plans for the area should consider where new development can deliver the greatest carbon reduction opportunities, using the Energy Opportunity Map.

8 Policy and Planning Recommendations

This chapter outlines how sound planning policy and long-term strategic vision can be developed in a viable manner to promote low carbon development in Central Lincolnshire

8.1 THE DEVELOPMENT OF POLICY AND PLANNING RECOMMENDATIONS FOR CENTRAL LINCOLNSHIRE

Planning policy can potentially influence three distinct scales of energy opportunity:

1. **Existing Development**: Policy can encourage improvement of existing buildings and influence the design and delivery of renewable energy associated with existing homes and buildings.

2. **New Development**: Planning policy has a direct influence on new development and can set design and carbon reduction requirements for new buildings.

3. **Strategic Interventions:** The spatial planning process and a strategic planning vision also offer opportunities to coordinate bigger opportunities across sites and areas.

The various policy options have been considered, and a set of policy recommendations and broader planning suggestions have been made for each of the three scales of energy opportunity. Table 35 below outlines the recommendations.

Table 35: Recommendations for policy options and wider planning recommendations

Energy Opportunity Type	Policy Option	Planning Recommendation
Existing Development		Guidance and encouragement for consequential improvements
New Development	Efficient design of new development Sustainable Design and Construction Targets Design for climate change adaptation Strategic sites targets	Prioritisation of carbon-efficient growth locations through spatial planning
Strategic Interventions	Renewable energy vision Delivery of the energy opportunities map District heating priority areas Wind energy development Allowable Solutions Strategic adaptation interventions	Guidance on considerations for wind energy applications Working with the Lincolnshire Wolds AONB Local Adaptation Strategy

8.2 EXISTING DEVELOPMENT

The scope of planning policies to directly influence existing development is fairly limited. For this reason, it is important that non-policy delivery opportunities are developed further in order to improve the energy performance and resilience of the existing building stock.

In Central Lincolnshire, the existing stock – particularly existing commercial and industrial buildings – makes up a significant portion of energy demand (and thus energy related carbon emissions) over the Core Strategy period. This means working to retrofit and improve existing stock is a priority. This evidence base gives an overview of current stock and possible improvement scenarios for the future.

8.2.1 Policy options: Consequential Improvements to Existing Homes

Policy Options Development Context

The purpose of these recommendations is to reduce CO_2 emissions from existing buildings, including both residential housing and industrial and commercial buildings, thereby creating more resilient existing buildings. The approach aims to make the most of any easily attainable opportunities for improvements to existing buildings. These might include loft and cavity wall insulation, draught proofing, natural cooling, improved heating controls, installation of small-scale renewables and replacement boilers.

When owners submit an application for an extension to their building is an opportune time to encourage owners to also consider improving the energy efficiency of their buildings. It is not, however, advisable to set blanket requirements to improve existing buildings when a planning application is triggered through a proposal for an extension. We recommend that policy mechanisms and planning processes are promoted and that information is available to building owners that outlines the possibilities and associated costs. Information could be outlined in an SPD or targeted brochure.

Precedent examples exist for these types of policies and supporting guidance for existing development within the Uttlesford District Council Energy Efficiency and Renewable SPD (2007). This SPD includes details of policies relating to extensions and replacement dwellings. These precedent policies are listed below:

Uttlesford Guidance 2 - In relation to extensions, where a property is proposed to be extended the Council will expect cost effective energy efficiency measures to be carried out on the existing house. Applicants are asked to complete and submit a home energy assessment form and are notified of energy savings measures that the Council will require as part of the conditions of granting planning permission for the extension

Uttlesford Guidance 3 - In the case of replacement dwellings if the replacement is bigger than the existing house then the Council will seek an "as built" dwelling emission rate 10% lower than the target emissions rate calculated to comply with Part L1A of the Building Regulations

Uttlesford District Council has been successful in implementing these policies and over the past three years, which have also been well received by households. While the results stemming from this policy have never been empirically verified, they have reportedly influenced approximately 1,400 extensions so far, and the total projected savings from measures required as a result are £72,600 and 398,000kg of CO_2 per year.

The Central Lincolnshire authorities can also ensure that micro-generation is delivered throughout Central Lincolnshire, including conservation areas, by providing design guidance as to how technologies can be incorporated on difficult buildings or on sites in conservation areas. The guidance can demonstrate which technologies are most suitable for designated areas. Any guidance can also be strengthened with information on water efficiency initiatives.

Planning Recommendation:

We recommend that the Central Lincolnshire authorities develop supporting guidance in an SPD, or targeted brochure, that encourage improvement of existing buildings and apply these where the planning process is triggered in extension or conversion applications. Currently, requiring improvements to existing homes through policy could be seen as outside the role of planning, and policies that do exist are yet to be tested. However, the Central Lincolnshire authorities, especially Development Management officers, can play an active role by working with building owners and developers to prompt the opportunity to retrofit carbon reduction and adaptation measures.

The installation of micro-generation technologies in conservation areas should also be supported by guidance that shows how selection and placement of micro-generation technologies should be undertaken to ensure conservation priorities are not harmed.

8.3 NEW DEVELOPMENT

There are many different planning approaches that can be directed towards new development. The starting point has been to focus on policies that the Central Lincolnshire Development Management teams can easily implement and potential applicants can easily understand; do not have an adverse impact on the scheme's viability; and maximise CO_2 reduction and decentralised renewable and low carbon energy installations.

It is important that new buildings are designed with energy efficiency in mind, and include renewable energy, where feasible. When possible this should be included on-site, but off-site solutions could be considered provided benefits can be shown - for example, where a critical mass can be established community scale infrastructure could deliver economies of scale that meet requirements more efficiently, where the needs of more than one development can be met or where benefits could extend into existing communities. Often the most cost-effective options for carbon reduction are realised through considering the wider context of a development's relationship to its surrounding area. In these situations, it is likely in the interest of the developer, partner authorities and community to deliver wider opportunities.

While the Central Lincolnshire JPU are still in the process of defining its planned level of growth, based on current aspirations, a large amount of commercial, retail, and housing stock is expected to be planned for and built over the Core Strategy period. As such, there is an opportunity to influence where much of the new growth is located and to identify possible strategic sites where specific climate change policies should apply.

8.3.1 Policy options: achieving a reduction in CO_2 Emissions through new development

Policy Options Development Context

The role of planning in setting carbon reduction targets for new developments is declining in scope due to the proposed changes to Building Regulations nationally. Previously stand-alone policies for CO_2 reduction, such as 'Merton-style rules' for inclusion of certain percentages of renewable energy supply, have been used for new development, but such policies are likely to be superseded by proposals for changes to Building Regulations.

The draft NPPF states that 'when setting any local requirement for a building's sustainability, do so in a way consistent with the Government's zero carbon buildings policy and adopt nationally described standards'. Changes to the Building Regulations for residential buildings, in 2010 and expected in 2013 and 2016, will bring in tighter standards for CO2 emissions. From 2016 it will be necessary for all new residential buildings to be built to zero carbon standards, with the equivalent standard for non-residential buildings due to be introduced in 2019.

Former guidance on the application of the PPS1 Supplement on Climate Change suggested additional carbon reductions could be required by policy in the interim before the zero carbon policy came into effect nationally through building regulations. By applying carbon reductions beyond required Building Regulations, policy can be used to accelerate a move toward zero carbon developments. However, this is not recommended on an HMA-wide basis for a number of reasons, including:

- Carbon reduction policies that are too challenging could to be counterproductive considering the development aspirations in the area;
- The PPS1 guidance advises that additional targets should only be used in the interim before 2013 when more stringent Building Regulations come into place;
- The Core Strategy is unlikely to come into application until 2012 or later;
- The resource and training required to implement such a policy for such a short period of time is considered burdensome; and
- Viability testing should be applied to test local delivery of additional targets.

Considering the proposed changes to Building Regulations, blanket CO2 reduction policies alone will be limited in effect, but the spatial planning process can add value by considering location, type and phasing of new development. Planning can also require higher targets for strategic sites where unique opportunities for low carbon energy exist (as discussed in the strategic sites section below). The draft NPPF encourages local planning to 'plan for new development in locations and ways which reduce greenhouse gas emissions'. The Energy Opportunities Map identifies opportunities for decentralised energy systems and district heating networks. These maps and other analysis conducted in this study for low carbon opportunities should be key criteria used in determining how Central Lincolnshire will grow.

Precedent examples exist for these types of policies for new development within the draft Manchester City Council Core Strategy. The Core Strategy includes details of a policy relating to reducing CO_2 emissions through new development. This precedent policy is listed below;

Policy Approach En1 – Achieving a Reduction in CO_2 *Emissions through New Development*
The City Council will seek to decouple growth in the economy and growth in CO_2 *emissions, through the following actions;*

- *All development must follow the principle of the Energy Hierarchy*
- *Wherever possible new development must be located and designed in a manner that allows advantage to be taken of opportunities for decentralised, low and zero carbon energy.*
- *Where possible new development will be used as a mechanism to help improve energy efficiency and increase decentralised, low carbon energy supplies to existing buildings.*
- *Where appropriate new development will be required to connect to existing or planned/potential decentralised heat and/or power schemes.*

Planning Recommendation:

Through the spatial planning process, opportunities for growth and development should be prioritised where they are likely to drive low carbon solutions; by being in an opportunity area near a viable district heating network, where development sites are of a size to drive their own decentralised systems, or where clear opportunities exist to implement wind energy or support other renewable energy developments.

Policy Option:

Efficient Design and Integration of New Development

All new development and redevelopments of existing buildings should, where possible, be located and designed in a way in which advantage can be taken of opportunities for decentralised, low and zero carbon energy.

All new development should catalyse improvements for energy efficiency and increase supplies of decentralised, low-carbon energy in existing buildings.

All new development should, where appropriate, be required to connect to existing or planned decentralised heat and/or power schemes.

Design, Layout and Location

Development proposals should respond to opportunities identified in the Energy Opportunities Map.

All new developments should ensure buildings are designed to be warmed by the sun, orientating buildings to maximise sunlight and daylight and using natural lighting and ventilation to reduce carbon emissions.

The Central Lincolnshire authorities should support the design or location of buildings to enable people to get access to amenities with fewer or shorter car journeys. In addition the authorities should support development which makes efficient use of land with good access to public transport to reduce travel and therefore carbon emissions.

Approach to Policy Implementation

Developments that have an opportunity to install or connect to decentralised energy should be identified using the Energy Opportunities Map (EOM). On larger sites, an energy strategy should be required, outlining the ways in which development will achieve carbon reductions and investigation of a range of opportunities.

In encouraging energy efficient buildings that use the minimum amount of energy and meet the needs of the people using them, the context of the site and its surroundings buildings should be taken into account to make sure the building is designed to take advantage of passive energy. This can be achieved in a number of ways, such as: ensuring principal rooms face south to benefit from solar gain; buildings are laid out on the site to account for the wind direction; and tree and shrub planting are designed to act as windbreaks, which will ensure wind chill factor is reduced. These goals will help to ensure policy options can be met.

In addition, the Central Lincolnshire authorities should consider the orientation of new residential developments to prioritise energy efficiency. For example, the use of the cul-de-sac in building design is inefficient as the heating circuit is incomplete. Arranging the location of buildings in block form allows heat to flow constantly around the system. Mixed use buildings also offer good opportunities for energy efficiency as a range of uses provides a variety of heat loads.

Policy implementation can also be achieved by considering how existing areas that are to be re-developed or enhanced can assist in meeting energy efficiency goals. The Gainsborough Town Centre regeneration plans to achieve Code for Sustainable Homes level 5 has the potential to act as a catalyst for surrounding developments, as the installation of a district heating network, or CHP plant might encourage others to join the scheme.

8.3.2 Policy options: Wider Sustainable Construction Targets for New Development

Policy Options Development Context

The PPS1 Supplement on Climate Change allows local authorities to set sustainability standards where local circumstances warrant them. The East Midlands will be affected by climate change, with increased flood risk, possible heat waves, changes in the landscape as well as changes in habitats and species composition, habitat fragmentation and changes in soils, recreation and tourism and cultural heritage. This means that actions must not only be taken to reduce the impacts of climate change by reducing CO_2 emissions, but also to adapt proposed development to the effects of climate change and other environmental damage.

The wider evidence base developed in the *Delivering a Sustainable Future for Central Lincolnshire: Portrait of Place* study established that there are a number of sustainability issues to be addressed in Central Lincolnshire, including water scarcity, waste recycling (in West Lindsey in particular), building quality, surface water run-off management and ecology. The Code for Sustainable Homes is the voluntary Government-backed building assessment tool that covers a full range of sustainability issues including, but not restricted to, energy and CO_2 emissions. The draft NPPF encourages the use of nationally approved standards. It should be noted that BREEAM for non-residential buildings is not a nationally approved standard (but an independent rating system).

As the Code for Sustainable Homes requires mandatory credits for energy and water, these are the most inflexible areas within each Code level specified. Other areas of the Code are more flexible and account for site-specific conditions as to whether or not they can be achieved.

In practice, determining whether achieving Code levels 5 or 6 would be viable across sites in Central Lincolnshire would require scenario and typology testing. However, the additional cost associated with achieving water credits, likely makes them unfeasible. As Delivering a Sustainable Lincolnshire: Portrait of Place Report outlined, the HMA is a water sensitive area and needs to be a focus for policy development. While water is a key issue for the area, building to Code 3 and 4 still provides very high levels of water efficiency. The proposed policy Code targets could be reviewed in response to any future changes in Code water criteria for Code Levels 5/6.

For non-residential development, there is no nationally endorsed standard, though BREEAM is the most commonly used. Policy can be based around the use of BREEAM or an equivalent as long as it gives flexibility on the system used. Based on previously established cost information, it is likely that BREEAM ‘very good’ or equivalent will be the highest standard suitable for application on a HMA-wide scale. Higher BREEAM standards can be unachievable on some buildings due to their location or inherent design restrictions. Strategic sites can aspire to higher standards where achievable.

Dover District Council has adopted Core Strategy policies that require delivery of district-wide Code and BREEAM levels. These policies are supported by a sustainable construction evidence base that shows that that the Dover area is very resource constrained and is likely to be seriously affected by climate change. Dover District Council's policies include a provision to fund off-site reductions in carbon or water use where targets cannot be met on-site. The Dover policies are as follows:

New residential development permitted after the adoption of the Strategy should meet Code for Sustainable Homes level 3 (or any future national equivalent), at least Code level 4 from 1 April 2013 and at least Code level 5 from 1 April 2016.

New non-residential development over 1,000 square metres gross floorspace permitted after adoption of the Strategy should meet BREEAM very good standard (or any future national equivalent).

Where it can be demonstrated that a development is unable to meet these standards, permission will only be granted if the applicant makes provision for compensatory energy and water savings elsewhere in the District.

Climate change needs particular attention in Central Lincolnshire, as much like many areas of the country, the HMA is prone to flooding, water scarcity and heat wave risks. A policy option has been included that requires new development applications to demonstrate how they have created resilient places and buildings. This policy should be linked to other policies around design quality and development location. Flood resilience will be particularly important in current and future flood risk areas – particularly in high population density area of Lincoln and Gainsborough.

The draft Manchester City Council Core Strategy includes a policy on climate change adaptation as follows (it includes a separate policy on managing flood risk):

'All new development will be expected to be adaptable to climate change in terms of the design and layout of both buildings and associated external spaces. In achieving developments which are adaptable to climate change developers should have regard to the following, although this is not an exhaustive list:

- *Appropriate treatment of all surface areas to ensure rain water permeability*
- *Measures to reduce the urban heat island effect*
- *Increase in tree cover*
- *Building orientation to reduce solar heat gain*
- *Incorporation of green roofs where appropriate'*

Policy Options:

Sustainable Design and Construction

New residential developments (10 units or greater) in Central Lincolnshire are required to meet 'Code for Sustainable Homes' standards or equivalent. These requirements will not come into effect until successive updates to Part L of the Building Regulations become mandatory:

Code level 3 or above, will be the current required for all new homes as part of Part L Building Regulations.

Code level 4 or above, will be required for all new homes once updates to Part L come into effect (currently scheduled for 2013).

All new non-residential developments in Central Lincolnshire over 1000m² gross floor area should aim to achieve the BREEAM "Very Good" standard or equivalent, with immediate effect.

If this policy option is to be applied it should require submission of final Code certificates and post-construction BREEAM certificates, as appropriate.

Climate Change Adaptation

All new development will be expected to be adaptable to climate change in terms of the design and layout of both buildings and associated external spaces. In achieving developments which are adaptable to climate change, developers should have regard to the following:

How their design, orientation, materials and construction will minimise overheating and cooling needs.

How development will incorporate green infrastructure, including tree planting, green roofs and walls, and soft landscaping, where possible.

How Sustainable Drainage System (SUDS) can be implemented, and where possible aiming to achieve greenfield run-off rates. Runoff should be managed as close to its source as possible, in line with the following hierarchy:

- Store rainwater
- Use infiltration techniques (porous surfaces) when possible
- Attenuate rainwater in ponds for gradual release
- Attenuate rainwater by storing it in tanks for gradual release
- Discharge rainwater into existing waterway.

Approach to Policy Implementation

A Code for Sustainable Homes and/or BREEAM pre-assessment or equivalent should accompany a planning application to provide assurance that the design will achieve the required rating. An interim design stage certificate is required before construction can start on site and, following completion, the post-construction review (PCR) and subsequent formal certification is required. Where cost associated with a pre-assessment is considered unreasonable due to the size and/or type of development, negotiations should be made with the planning authority to ascertain supply of details of how the policy can be met.

8.3.3 Policy Options: Strategic Sites

Policy Options Development Context

The PPS1 Supplement on Climate Change encouraged setting specific policy and targets for strategic sites where greater opportunities exist to reduce CO_2. Strategic sites are still being identified, but once they have and likely uses and densities are known, the JPU should include suitable carbon reduction targets based on opportunity on the site. It may also be suitable to set higher Code and BREEAM or equivalent target aspirations where they are believed to be achievable. The JPU should also seek opportunities to set higher targets on sites that come forward where significant potential is present. Targets can be set in the Core Strategy for strategic sites, and also through Development Briefs. The development typologies developed as part of this study should be used as a tool to help the JPU identify the likely carbon reduction capability of sites, and the viability of such measures. Any assumptions to be made in the typologies may not reflect the eventual site proposals. Therefore, the energy strategies submitted for each site should discuss the proposals' potential and outline how the carbon reduction target will be met (or where it cannot, how carbon reduction can be increased as far as feasible).

Policy Option:

Strategic Sites

Where suitable strategic sites come forward, we recommend the Central Lincolnshire authorities require the following:

An energy strategy, including phasing requirements, should be developed for the entire site and surrounding area. This will guide the installation of low carbon infrastructure in a coordinated way, and ensure that individual developments on the site can be taken forward in a carbon and cost-efficient manner. All energy strategies for sites in or near feasible district heating areas, as identified in the Energy Opportunities Map should include feasibility assessments for district heating and CHP.

Based on feasibility study results, carbon reduction targets relative to Building Regulation standards or the Code for Sustainable Homes/BREEAM or equivalent targets should be set for strategic sites to drive additional carbon reductions. Calculations showing the achievement of the required carbon reduction should be provided to the authorities using the standard methods outlined in Building Regulations. Target recommendations can be obtained from the typology assessment conducted as part of this study.

Approach to Policy Implementation

Reductions in carbon emissions should be supplied using the standard measurements from Building Regulations. An energy statement should be submitted with the planning application that clearly demonstrates how targets are met.

8.4 STRATEGIC INTERVENTIONS

The third policy area addresses strategic, stand-alone energy opportunities, and those that are not necessarily related to specific residential or non-residential development proposals. The individual policy options in this section may be better housed collectively under an energy opportunities policy.

8.4.1 Policy options: Renewable Energy Vision

Policy Options Development Context

The binding national renewable energy target of 15% of total energy to be generated from renewable sources by 2020 can be delivered through a combination of renewable electricity, heat, and transport fuel. In 2009, the government outlined how it planned to meet this target. The Renewable Energy Strategy set the following renewable targets: 30% of total electricity to be sourced from renewables, 12% of total heat, and 10% of total transport fuel. Planning plays a key role in all three of these areas.

The electricity portion of the targets set will partially come from the national government's contribution, including offshore wind turbines among other major projects. However, a substantial proportion is still expected to come from LPAs, where opportunities exist.

The East Midlands Regional Plan had set an indicative target for renewable energy of 23% of energy demand by 2020[59], while the national target for electricity is 30%. Both are technically feasible in Central Lincolnshire and there is a strong delivery ambition in a number of sectors. The delivery scenarios show that this target is achievable under both the 'business as usual' and the 'All Actions Adopted' scenario. Given the scale of potential in Central Lincolnshire, it is therefore recommended that a more aspirational target of 60% of electricity demand is set. This higher target is reflective of the nature of the area, with large rural areas and renewable resources and a relatively low

[59] AECOM (2009) Renewable Energy and Energy Efficiency Targets for the East Midlands.

population. Central Lincolnshire has a big opportunity to become a leading figure in renewable energy on a national scale.

The 12% heat target on a national scale will be delivered and supplied primarily in conjunction with the built environment, and therefore, Central Lincolnshire should contribute to that target wherever opportunities exist to take advantage of renewable heat. There are a few schemes currently in operation in the area, including the small district heating network in South Carlton. Gainsborough's Code 5 regeneration will also look to create a district heating scheme. Considering the heat densities of Gainsborough, Lincoln and Sleaford, the national heat target is recommended. Similarly, the delivery scenario testing shows this target is achievable.

Policy Option:

Central Lincolnshire demonstrates potential for inclusion of district heating, biomass heating and micro-generation and should aim to meet its proportion of the national renewable heat target of 12% of heat demand by 2020. 12% of heat demand in 2020 is equivalent to 342GWh.

The national indicative target of 30% of electricity demand coming from renewables is deliverable in Central Lincolnshire. Due to the scale of potential and delivery opportunities, a local target of 60% by 2020 should be set. 60% of electricity demand in 2020 is equivalent to 858GWh. To achieve this, the HMA will need to use its potential for wind energy, district heating networks, biomass, and other renewable energies.

Applications for low carbon and renewable energy installations are generally supported in the area, except where adverse effects would be demonstrated. The area is seeking new renewable energy generation capacity to deliver an appropriate contribution towards the UK Government's binding renewable energy target.

Approach to Policy Implementation

Monitoring of the targets included in the proposed policy can be calculated from the expected energy demand baseline. The energy baseline for Central Lincolnshire has been calculated and provided in Chapter 3.. The nature of the renewable energy resource in Central Lincolnshire means that much of the technical potential is for wind energy; however, solar photovoltaics, landfill gas utilisation, biomass energy utilisation, energy from waste, anaerobic digestion and micro-generation could also be delivered in the area and will make up a mix of opportunities that will be important factors in achieving targets.

8.4.2 Policy Option: Delivering the Energy Opportunities Map

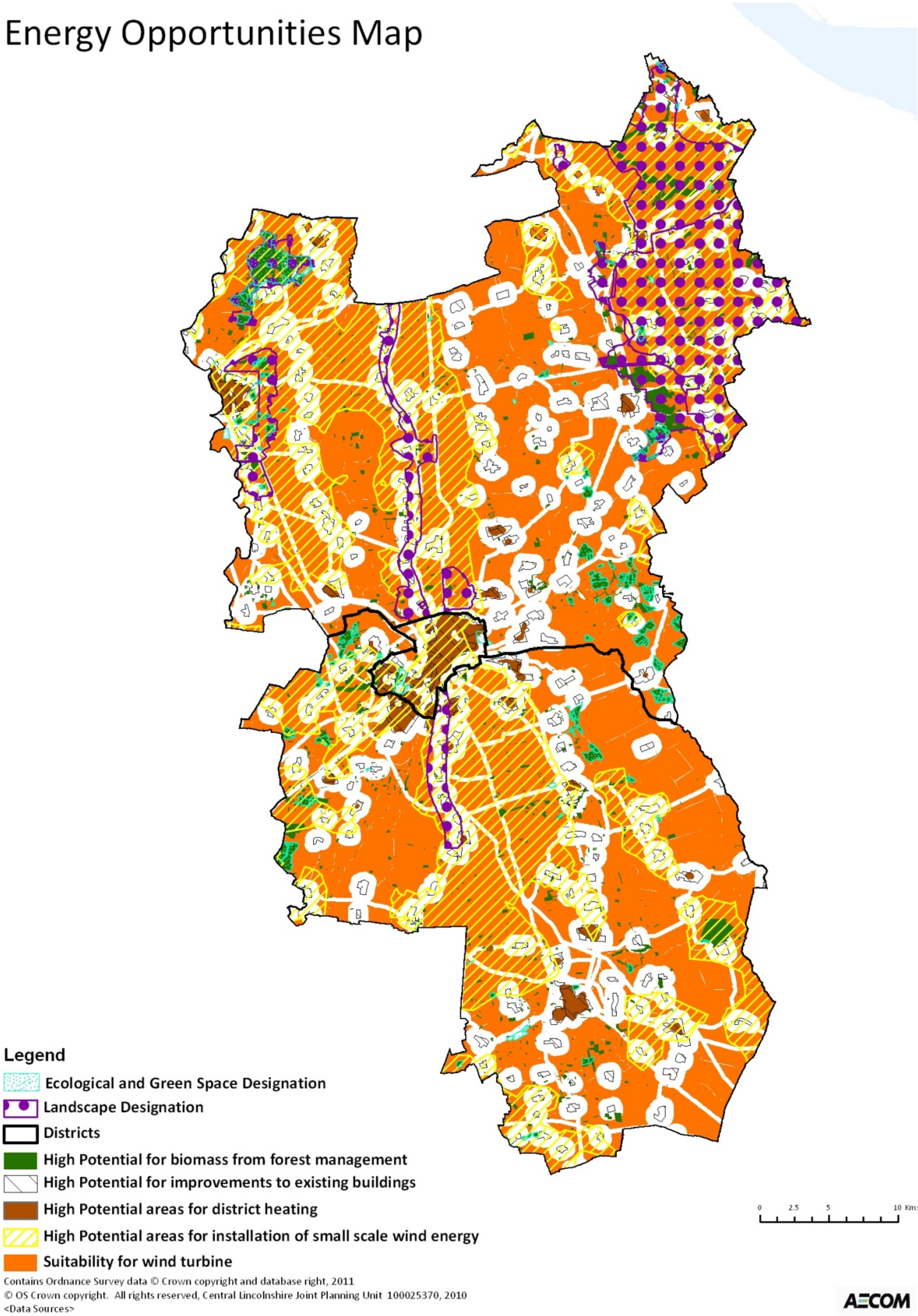

Figure 67: Energy Opportunity Map

Policy Option Development Context

The various decentralised low carbon and renewable energy opportunities across the HMA have been compiled to create an Energy Opportunity Map (EOM). The EOM acts as the key spatial map for energy projects in Central Lincolnshire. It presents a key evidence base, which underpins policies, targets and delivery mechanisms described here and can set out where money raised through allowable solutions or other funds (such as CIL and infrastructure funding) can be spent. The EOM should also be used to inform the Central Lincolnshire authorities' policy making, investment decisions, and other corporate strategies. It can be used to inform development decisions and discussions, but it only highlights areas with the greatest potential and as such it should not be used to dismiss proposals where site-based evidence shows there is an opportunity. The EOM can also be a useful tool for communities and other stakeholders to identify delivery opportunities.

Policy Option

Delivering the Energy Opportunities Map

Decentralised, low carbon and renewable energy is a priority for Central Lincolnshire. Planning applications for new development in Central Lincolnshire will need to demonstrate how they contribute to delivery of the 'Energy Opportunities Map'.

8.4.3 Policy Option: Priority Areas for delivery of District Heating

Policy Option Development Context

The planning policy approach represents the application of national policy to the specific Central Lincolnshire context. The draft NPPF, PPS1 Supplement on Planning and Climate Change and PPS22 (Renewable Energy) are all supportive of appropriate renewable energy, of which heat networks are a national priority. The draft NPPF states that local planning authorities should 'identify opportunities where development can draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers.

Precedent policy exists for these types of strategic areas within the draft Manchester City Council Core Strategy and Bristol Core Strategy. The Manchester City Core Strategy includes details of a policy relating to areas for low carbon, decentralised and renewable energy development. This precedent policy is listed below;

Policy Approach En 2 – Within Manchester it is considered that the following strategic areas will have a major role to play in achieving an increase in the level of decentralised, low carbon and renewable energy available:

- *Regional Centre, which also includes the Oxford Corridor and Sport city*
- *District Centres*
- *Inner Areas*
- *Strategic Housing sites*
- *Strategic employment sites*

The City council will work with all relevant stakeholders, which may include residents, private sector partners, utilities companies, neighbouring authorities and other public sector bodies, as appropriate, to bring forward more detailed proposals for decentralised low and zero carbon energy infrastructure in these areas.

Where investment or development is being undertaken into or adjacent to a public building, full consideration shall be given to the potential role that the public building can have in providing an anchor load with a decentralised energy network.

Bristol Core Strategy has taken a similar approach, encouraging renewable development where appropriate to the landscape and prioritising CHP and district heating in key urban areas:

'Proposals for the utilisation, distribution and development of renewable and low carbon sources of energy, including large-scale freestanding installations, will be encouraged. In assessing such proposals the environmental and economic benefits of the proposed development will be afforded significant weight, alongside considerations of public health and safety and impacts on biodiversity, landscape character, the historic environment or the residential amenity of the surrounding area.

The use of combined heat and power (CHP), combined cooling, heat and power (CCHP) and district heating will be encouraged. Development will be expected to incorporate, where feasible, low-carbon energy generation and distribution by these means. Within Heat Priority Areas, development will be expected to incorporate infrastructure for district heating, and will be expected to connect to existing systems where available.'

The priority areas listed in the policy option below have been identified based on the analysis in this study. The purpose of the policy is to prioritise district heating in areas where opportunities are the greatest.

Policy Option

Applications for development will be favourably considered which will support the delivery of district heating:

DISTRICT HEATING PRIORITY AREAS

The Energy Opportunities Map (EOM) highlights the areas in Central Lincolnshire with high heat density, particularly in the major settlements of Lincoln, Gainsborough and Sleaford. The Central Lincolnshire authorities should consider these as priority areas for delivering district heating systems.

The Central Lincolnshire authorities will support the delivery of district heating in these areas and will work with all relevant stakeholders, which may include residents, private sector partners, utilities companies, neighbouring authorities and other public sector bodies, as appropriate, to bring forward more detailed proposals for district heating in these areas.

Development within the priority area should install the secondary elements of a district heating network (i.e. from the wider network to properties), unless it can be shown not to be viable or feasible. Should development come forward prior to a district heating network being in place, developers should provide a containerised energy centre to provide temporary supply. Where appropriate, applicants may be required to provide land, buildings and/or equipment for an energy centre to serve proposed or multiple developments.

New residential and commercial development should be designed to maximise the opportunities to accommodate a district heating solution where feasible, considering: density; mix of use; layout; and phasing.

Approach to Policy Implementation

Developments greater than 10 dwellings within or near the district heating priority areas should investigate the feasibility of installing a district heating network within the site. A planning application should provide details of how the opportunities will be implemented to allow the LPA to coordinate expansion of the network across priority areas. Where infrastructure installation is deemed to infeasible, details of the viability assessment should be provided with the application.

As a means of fulfilling the intention of installing district heating networks, it is recommended that a Local Development Order (LDO) is designated, either for district heating networks across Central Lincolnshire or specifically in priority areas. Introduced in the 2004 Planning and Compulsory Purchase Act and amended by the 2008 Planning Act, LDOs grant permission for types of development specified in the Order and by so doing, removes the need for developers to submit a planning application. A pilot is underway for the Barking Power Station strategic heat main promoted by the London Development Agency. Barking and Dagenham have recently received funding for a pilot project using a LDO for implementing a district heating system.

If the nature and/or size of the strategic sites identified prove to be significant enough, they should complete an energy strategy to ensure that the best options are identified, taking into account the whole site and its surroundings. The energy strategy should outline the proposed options and how these will be delivered in coordination with other area-wide initiatives.

8.4.4 Policy Option: Large Scale Energy from Wind

Policy Option Development Context

Within this report, the ability for the rural areas of Central Lincolnshire to obtain energy from wind has been highlighted. While the Central Lincolnshire authorities, in particular North Kesteven and West Lindsey, face numerous challenges in increasing the adoption of this resource, none of them are insurmountable. If wind energy is going to be delivered to a significant extent, the JPU and partner authorities will need to develop a clear policy position and strategy for its effective uptake. PPS1, PPS22 and the draft NPPF state that local authorities should develop positively worded policies for renewables (while avoiding adverse effects). The draft NPPF states:

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

- *have a positive strategy to promote energy from renewable and low-carbon sources, including deep geothermal energy*
- *design their policies to maximise renewable and low-carbon energy development while ensuring that adverse impacts are addressed satisfactorily*
- *consider identifying suitable areas for renewable and low-carbon energy sources, and supporting infrastructure, where this would help secure the development of such sources*
- *support community-led initiatives for renewable and low carbon energy, including developments outside such areas being taken forward through neighbourhood planning, and*
- *Identify opportunities where development can draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers.*

In the third point above, the draft NPPF in footnote suggests the use of the National Policy Statement for Renewable Energy Infrastructure to assist in identifying suitable areas. This Policy Statement, while intended for very large installations (over 50MW), provides clear guidance on all possible impacts of wind energy to be considered. It also clearly outlines an approach to visual impacts that have been a key issue in the determination of local wind energy determinations in the past:

- On heritage considerations, it states: '*onshore wind turbines are generally consented on the basis that they will be time-limited in operation... therefore take into account the length of time for which consent is sought when considering any indirect effect on the historic environment, such as effects on the setting of designated heritage assets'.*
- On appropriate distances from existing residences, it states: '*there are existing operating wind farms where commercial scale wind turbines are sited close to residential dwellings. The [decision authority] should consider any evidence put before it on the experience of similar-scale turbines at similar distances to residential properties'.*
- On visual impact from designated areas, it states: '*The fact that a proposed project will be visible from within a designated area should not in itself be a reason for refusing consent'*.

Following the implication of the draft NPPF, the design and planning advice given in the National Statement should be utilised to frame decisions around wind energy and other major renewable installations. However, for wind energy in particular, there are a number of wide-spread concerns (both valid and sometimes misinformed) that can act to clutter the planning process. For ease and consistency in planning decisions, but also for general education and engagement, it may therefore be useful to develop supplementary planning documents (SPDs) that give guidance on the issues and benefits to be considered and how they should be assessed. The Central Lincolnshire authorities could develop these individually but for efficiency a collaborative effort should be made across Central Lincolnshire or Lincolnshire County.

Cumbria County has created a thorough wind energy SPD to guide wind development. Cumbrian local planning authorities jointly developed the SPD to ensure consistent renewable energy policies across the county. The SPD outlines: the need for renewables as well as the national and regional targets; factors that need to be considered before wind turbine development can be approved; Cumbria's ability and capacity for delivering wind energy; community and stakeholder engagement; and the importance of surrounding site characteristics and good design. North Lincolnshire has also developed a similar SPD to provide guidance on renewable energy.

A large scale wind policy, which provides effective guidance for the delivery of wind energy in Central Lincolnshire will be crucial to the delivery of wind turbines in the area. Should a wind energy SPD be produced, it could provide further detail which is unsuitable for Core Strategy policy wording.

There are currently no well known examples of specific wind energy development policies in the UK that positively encourage wind development, but also identify and measure adverse effects in an objective manner. The following case study of regional advice to local authorities has been highlighted by the government as best practice:

Regional renewable energy planning in North East England

A Renewable Energy Strategy for the North East of England was prepared during 2003 under the guidance of a steering group which included representatives from GO-NE, the North East Assembly, government agencies, local authorities, the region's universities, environmental groups and different sectors of the renewable energy industry. In preparing the Strategy the region's potential resources were assessed using a number of tools including a geographic information system, complemented by grid and landscape studies. It was concluded that 10% of the electricity consumed in the region could be supplied by a range of renewable energy sources by 2010, and that this could be increased towards 20% if a strategic wind farm were to be developed within Kielder Forest. These targets were put forward for inclusion within forthcoming RSS.

Having assessed the region's resources and established targets the Strategy also put forward suggested RSS criteria-based policies which would help deliver the targets, and identified the broad areas where hydro, biomass and wind projects may be considered appropriate. These broad areas are shown in the "Draft Indicative Diagram" below.

The suggested criteria policies RE 2&3 below, while giving particular encouragement to developments in the areas shown in the diagram, also make it clear that projects in other areas will also be encouraged. One of the benefits of taking the proactive approach adopted by the NE Strategy has been to highlight the substantial potential of the Kielder area for wind, biomass and hydro power.

RE 2 – Spatial Strategy for Onshore Wind Development

In preparing policies and proposals for onshore wind projects Development Plans should conform to the following spatial strategy, broadly illustrated in the Renewable Energy Indicative Diagram:

a) Within designated National Parks, AONBs and Heritage Coasts wind developments should be limited to individual turbines of no greater than 100kW installed capacity, to provide power to off mains properties and other small users.
b) Kielder Forest should be the subject of further investigation to see if it could become a Strategic Wind Resource Area, where positive encouragement will be given to major wind farm developments.
c) Particular encouragement should be given to the development of small to medium scale wind farms in the locations broadly illustrated in the Renewable Energy indicative Diagram and described in Annex 3 of the Regional Renewable Energy Strategy.
d) Encouragement should also be given for wind developments in other parts of the Region, including appropriate urban and brownfield locations.
e) Preference should be given to concentrated rather than dispersed or scattered patterns of wind development.
f) In all cases proposals must be fully assessed against Policy RE3. Point (d) is especially important in that it does not exclude sites elsewhere in the region, subject to the criteria being met.

RE 3 describes *Factors to be considered in Planning for Wind Farms*. These include: residential amenity (on noise and visual grounds); safe separation distances; nature conservation features; landscape characteristics and visibility; heritage designations; green belts; and any visual impact of new grid connection lines.

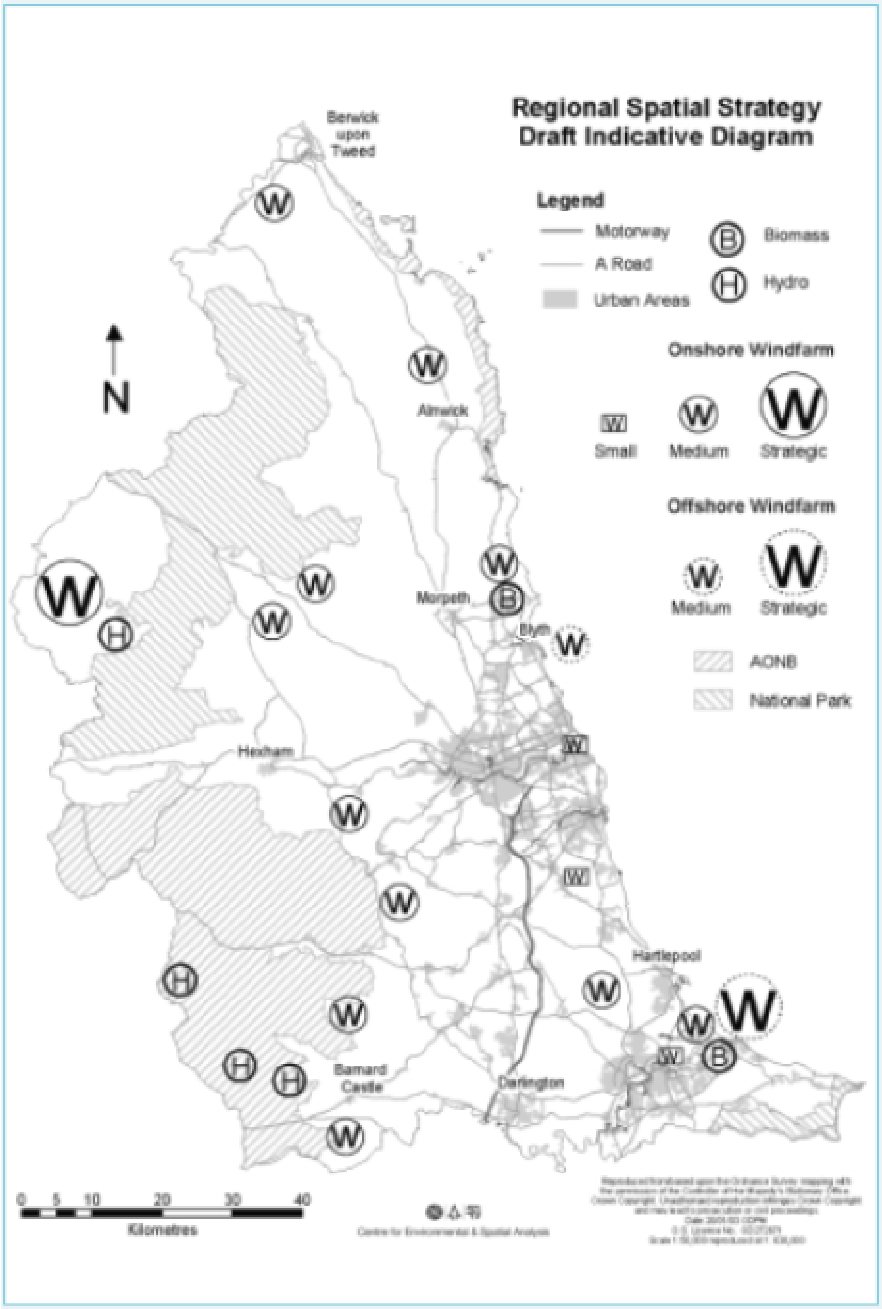

Figure 68: Wind Opportunities in North East England

The Energy Opportunities Map, or a specific wind potential map could be used in the same manner as the wind opportunities map in the North East example to direct and inform wind development. However, this map should not be used to preclude or to guarantee wind development, as it is based on a set of technical assumptions and is intended as guidance not evidence. Site based studies may demonstrate feasibility in areas not highlighted in the Energy Opportunities Map.

Delivery of the targets may be influenced by the presence of the Lincolnshire Wolds, located to the northeast of Market Rasen. It is important for the JPU and the partner authorities to work with the Wolds to determine suitable policy for this important landscape area, and whether there is a differentiation in policy according to the type or location of renewable energy.

Planning Recommendation

Central Lincolnshire authorities should collaborate to develop guidance for officers, members and communities discussing the wind potential in the area and the various considerations. The guidance should cover relevant planning policy and targets, the area's ability to deliver wind energy, potential opportunities and barriers, effective means of engaging stakeholders and the community, and how appropriate design can mitigate losses.

Planning Recommendation:

The Central Lincolnshire authorities should engage with the Lincolnshire Wolds AONB to develop a clear policy on wind turbine installations and bio-crop growth within the AONB. We recommend that policy for wind energy be tied to a flexible visual impact assessment process, rather than a blanket restriction. A smaller wind turbine size limit may be suitable for policy regarding the Wolds.

Policy Option

Wind energy is a key opportunity for Central Lincolnshire, and wind energy development proposals will be supported by the Central Lincolnshire authorities provided that they are designed and located to ensure there will be no significant adverse impacts on communities, economies or the environment.

Particular encouragement will be given to the wind energy developments in the locations broadly illustrated in the Energy Opportunities Map. Encouragement will also be given for wind developments in other parts of Central Lincolnshire, including appropriate urban and brownfield locations.

Applications would be encouraged from community groups and individuals.

Approach to Policy Implementation

If Central Lincolnshire authorities wish to support the policy option and its targets, it will need to develop clear decision guidelines to ensure consistency of decisions. In the context of national policy in the draft NPPF, the guidance in the National Policy Statement on Renewable Energy Infrastructure should be used to give overarching direction and key issues to be considered. Broader guidance and educational initiatives may be beneficial to clearly define and test local concerns.

8.4.5 Policy Option: ALLOWABLE SOLUTIONS

Policy Option Development Context

The Government's proposed zero carbon approach introduces the concept of 'Allowable Solutions'. Allowable Solutions allow developers to contribute to carbon reductions on-site, near-site or off-site to reach their equivalent zero carbon target. The framework for Allowable Solutions is still under development, and at the time of writing, the delivery arrangements and responsibilities are unknown. The Zero Carbon Hub produced a paper (July 2011) titled 'Allowable Solutions for Tomorrow's New Homes: Towards a Workable Framework' which sets out draft proposals for Allowable Solutions. The paper provides guidance on a number of aspects as to how Allowable Solutions may be implemented. It suggests that Local Authorities will have the opportunity to play a key role in determining and delivering allowable solutions if they so choose. From a Local Authority perspective, the development of an Allowable Solutions policy could help to ensure that:

- Allowable solutions are selected that have broader advantages for local communities;
- Strategic low carbon and renewable energy projects are given focus and underlying funding;
- Local government can play a direct role in delivery; or
- Solutions that involve multiple Local Authorities can be coordinated and delivered.

In the absence of a local policy related to Allowable Solutions, it is suggested developers will be able to select and contribute funding to solutions provided by the free market.

There are broadly two types of policy that could be developed by a Local Authority to direct Allowable Solutions:

1. A policy that requires developers to contribute to a selected list of local projects. This list allows the authority to focus on the initiatives that are seen to be most beneficial to the area. It is likely that the Authority would need to compile an evidence base to ensure that the required list is both cost and carbon efficient. The projects can be delivered by a third party.
2. A policy that directs contributions from developers to a Community Energy Fund which would be directly administered by the Local Authority. This option gives the Local Authority itself an opportunity to control and deliver projects. Where strategic projects are desired but lacking a clear delivery partner, this can provide a delivery mechanism. The Community Energy Fund could be collected through the Community Infrastructure Levy (CIL).

At this point in time, the future arrangements of Allowable Solutions are unclear. However, to avoid delay in Allowable Solutions coming forward from 2016, the Zero Carbon Hub recommends that initiatives are taken now by Local Authorities to develop policy requirements and the evidence base to support the selection of Allowable Solutions. To give flexibility to the policy (both in development time and content), it is recommended that the policy details are outlined in an SPD.

The paper states: *'An Allowable Solutions policy, which should include:*

- *A mechanism for approving particular Allowable Solutions within the overall local plan:*
- *Evidence that Allowable Solutions included in the local plan represents the most cost effective ways of delivering carbon emissions reduction in the Local Planning Authority area.*
- *A clearly stated pricing policy for Allowable Solutions (Local Planning Authorities should not be able to charge any more than the national price ceiling for carbon).'*

Planning Recommendation:

The Central Lincolnshire Authorities should develop a strategic stance on whether an Allowable Solutions policy should be developed for each authority. The need for a policy should be based on a cost-carbon-benefit analysis of the possible local projects that could be funded by Allowable Solutions contributions. This evidence base will be necessary for policy development but could also be a useful coordinating mechanism to identify delivery partners and opportunities. Based on the delivery opportunities associated with favoured projects, either a list of favoured projects could be developed for reference within policy or a decision can be made to directly lead delivery through the Local Authority using a Community Energy Fund. Costing of projects can be used to determine a charging rate included in CIL to collect funding for the Community Energy Fund.

Policy Option

The Central Lincolnshire Authorities are supportive of carbon reduction solutions that bring wider benefits to communities. Contributions to Allowable Solutions shall be made in accordance with the policies outlined in the Allowable Solutions SPD.

Approach to Policy Implementation

Methods of implementation of allowable solutions policies are still unclear at this stage, but it is recommended that Central Lincolnshire closely follow government progress in this area. Other authorities are also tackling the issue, and lessons can be learnt from others exploring the process.

8.4.6 Policy Option: Adaptation Strategy

Policy Option Development Context

The 'Delivering a Sustainable Central Lincolnshire: Portrait of Place' Report discusses some serious challenges for the area associated with predicted climate change. There are strategic interventions that could be applied to lessen risks to vulnerable communities and infrastructure. One of the more pressing issues for Central Lincolnshire requiring attention is flooding mitigation measures.

Using the Portrait of Place report as an evidence base, the individual authorities within Central Lincolnshire should develop a Climate Change Adaptation Action Plan that sets out clear actions to help the authority area and its assets adapt to the predicted effects of climate change. The strategy should prioritise actions depending on the level of risk and exposure. Risk should be assessed based on the social, economic and environmental impacts. A coordinated strategy could be developed between authorities, building from initial work undertaken at the County level. This strategy should be coordinated with local green infrastructure strategy and flood management plans.

Planning Recommendation:

The Planning Authorities should use Portrait of Place study to understand local vulnerabilities, either at a Central Lincolnshire wide or individual authority level. Following from this a climate action plan for Central Lincolnshire could be developed to identify and prioritise solutions. This should be taken forward as a collaborative approach between planning and wider Local Authority services and in coordination with the development of the Lincolnshire Climate Change Strategy. In this way, the Central Lincolnshire authorities should develop a clear Climate Change Adaptation position with supporting policies to structure the response to climate change risk.

Policy Options:

The Core Strategy should support adaptation measures that need to occur separate from new residential or commercial developments (e.g. improvements in existing areas, strategic adaptation measures):

The Central Lincolnshire authorities will support and encourage the integration of strategic climate change adaptation measures in the area, including the provision of green infrastructure, SUDS and flood risk management features and the improvement of the built environment to manage future climate impacts.

Approach to Policy Implementation

Adaptation measures should be further investigated and prioritised. There is a clear opportunity to support general adaptation measures throughout Central Lincolnshire. It will be important to ensure adaptation measures are in keeping with the needs of designated areas such as conservation areas and the AONB, and that they deliver local architectural, biodiversity and amenity priorities.

8.5 MONITORING

Key to delivering an effective area-based low carbon and renewable energy strategy is ensuring that a record of renewable installations is kept up-to-date. Information contained within this report captures Central Lincolnshire's current and projected installed base of renewables. However, this should only be viewed as a portrait –circumstances are likely to change over time. For this reason, it will be important to continually update the renewable energy database, which accounts for planning applications – approvals and refusals – as well as opportunities, and constraints as they arise.

Although the National Indicators have been abolished, similar information will need to be regularly collated to understand how effectively the policies are being delivered. This is also an opportunity to update and/or create a set of locally specific indicators for transitioning to a low carbon economy that can feed into future Annual Monitoring Reports (AMR) either for Central Lincolnshire, or its respective local authorities.

Monitoring should be directly related to the planning approach and policy recommendations outlined above and will require close liaison and feedback from Development Management fo0ficers:

Existing development – This study provides a baseline of the energy demands and carbon emissions from existing buildings. Understanding the activities that have been undertaken and where through the influence of publically sponsored initiatives, such as through the Green Deal or SPD guidance, should be recorded.

New Development – As the standard assessment procedure (SAP) for Building Regulations will be used to outline carbon reductions it will be possible to monitor the relative carbon reductions of new development. Furthermore, the pre assessment and post build validation of Code for Sustainable Homes / BREEAM will guide the monitoring of wider sustainability objectives.

Strategic Sites – As higher performance is expected on strategic sites, and developments will require energy strategies, the ability to meet these standards should also be monitored to maintain viability.

Priority Areas for District Heating – It will important to keep an up to date and accurate picture of where district heating infrastructure has been delivered. Records of delivered district heating schemes should be kept centrally in GIS where possible to understand the delivery opportunities and constraints of schemes proposed in priority areas. The authorities should also monitor the proportion of carbon saving delivered through low carbon heat as a sub-set of total carbon savings.

Strategic Energy Developments – The authorities should continue to monitor the delivery of large, more strategic energy developments, such as wind farms, in relation to the Energy Opportunities Map. Where applications have been lodged but rejected, these should also be recorded along with the reasons for rejection within a central database.

Allowable solutions – Relating to the ability to deliver carbon savings on site will be the expectation of payment into allowable solutions. The Central Lincolnshire authorities should develop a list of local projects / initiatives to be delivered through allowable solutions. As such, it will be important to monitor the cost of carbon (if it chosen locally), how much is paid into the allowable solutions pot and the cost per carbon saving of the initiatives delivered (note that this may be incremental as the activity may have no initial benefit but unlock future viability).

Total Renewable Energy Delivery – understanding the improvements to the existing building stock, the efficiency of new development and the contribution of more strategic and community led infrastructure, the authorities should be able to monitor their overall contribution to reducing carbon emissions from electricity and heating through use of renewable energy. This should be related back to the total energy and carbon profile developed in this study to calculate % reductions.

Further to these monitoring activities, the actions set out in the action plan will need reviewing to ensure they are undertaken. Although not necessarily directly related to policy implementation and appraisal, the actions set out in the implementation plan will provide the wider traction and organisational capacity that supports their realisation.

9 Action Plan

This chapter discusses an implementation plan, based partially on stakeholder consultations, to increase likely uptake of renewable and low carbon energy in Central Lincolnshire

9.1 INTRODUCTION

The previous three chapters outline opportunities for various stakeholders within Central Lincolnshire to increase the amount of renewable and low carbon energy. All stakeholders have many responsibilities, so it is important to highlight how they can effectively contribute to the increased uptake of renewables in Central Lincolnshire. This section looks to simplify actions, and base them on priority.

9.2 STAKEHOLDER PRIORITY ACTIONS

Based on the opportunities and constraints outlined for each delivery partner in chapter 6, actions that will foster delivery of renewable energy for each partner have been developed. In this section, the actions are grouped based on the delivery partner they will impact, rather than who could undertake the action.

Actions influencing Public Sector Delivery:

1. Work across Local Authority boundaries – While Lincoln, North Kesteven and West Lindsey operate as one planning unit for the purpose of the development of the Core Strategy, it is important that policies are enforced with consistency and also coordinated with wider County-wide guidance and initiatives. Knowledge sharing and communication will be important across Central Lincolnshire and the wider Lincolnshire County to ensure sensible and effective renewable energy delivery. A working group should be set up at a County level to ensure policy enforcement and guidance is delivery. This working group could be responsible for developing guidance on assessment and planning requirements surrounding renewable energy.

2. Undertake property energy audit of council buildings and assets – To gain an understanding of what public sector assets are available and how they can be used to help deliver renewable and low carbon energy schemes. This should include land, services, and building assets, with a review of how each could contribute to renewable and low carbon energy and where the greatest potential may lie.

3. Adopt energy efficiency renewable energy on all properties – Based on the asset energy audit, identify funding streams and conduct improvements to council assets.

4. Allowable Solutions Identification and Delivery Strategy – The final component to the drive towards zero carbon development – allowable solutions – will enable local authorities to implement a community energy fund. Central Lincolnshire planning authorities should identify which solutions work best, and design a delivery strategy for their implementation.

5. Scope and conduct feasibility studies to deliver strategic projects such as district heating– District heating can provide significant energy and CO_2 reduction in urban areas, but will usually require the connection of a range of public sector and private sector buildings to achieve the necessary diversity. The public sector can play an important role in developing district heating projects by supporting the early feasibility stages, and coordinating the various parties. Partnerships with the private sector can mean that private sector expertise is included. Local councils can lead coordination of these schemes, identifying the best scheme and developing a delivery plan with partners. The Carbon Trust offers support and funding to Local Councils to conduct feasibility studies.

6. Establish an Energy Services Company (ESCo) – Work with enthusiastic residents and businesses, to establish a council led ESCO to help deliver energy projects that are in the interest of the wider community and council.

7. Act as facilitator – Identify and establish a multi-disciplinary group of stakeholders to meet as needed to discuss how to overcome barriers in the delivery of renewable and low carbon energy. The council is in a prime position to coordinate separate bodies, and support projects through the early phases helping to de-risk them to attract commercial investment.

8. Promotion – The public sector has an important role to play in promoting energy efficiency and renewable and low carbon energy to homes and businesses. Information from the public sector can be seen as objective and not driven by commercial needs. The local authorities in Central Lincolnshire need to continue and expand the range of promotional work, including educating the public about the wider low carbon agenda and providing accurate and useful information which can help dispel myths (for example around wind turbines).

9. Supporting community groups – The public sector can have an important role in the support of community groups through the provision of guidance, facilities and expertise. Community groups can be used by the public sector to help promote and educate local residents. A community information and support service could be established for community groups interested in taking renewable energy projects forward.

10. Establish county or region-wide local authority expertise network – Local authorities can work together to improve their understanding of renewable energy and the best way to implement it. This might take the form of renewable energy training, or improved communication with respect to sharing of policies and best practices.

11. Public sector to coordinate a fund for energy projects – There are a number of sources of funding for public sector projects. As discussed in chapter 6, these funding sources include: CESP, Eaga Partnership Charitable Trust, Salix, and East Midlands Improvement and Efficiency Partnership. Investigating opportunities with these funds and others will be key to developing energy projects in the public sector.

Actions influencing private sector

12. Feasibility studies for renewables for businesses and landowners – Some of the most cost effective options for low and zero carbon technologies existing in the private sector. Organisations should assess which options may be viable for their buildings and activities and conduct feasibility work. Financial incentive schemes should be examined including the Feed-in-Tariff and Renewable Heat Incentive schemes, along with other incentives such as enhanced capital allowances. A central coordination point could be set up to help and direct private sector partners to expertise for feasibility studies to be conducted. Similar previous studies could also be shared through this coordination.

13. Perform energy life cost analysis – Energy savings and new technologies might seem like an expensive up-front capital expenditure, but they often are cost effective on a lifecycle basis. Private sector organisations need to understand the lifecycle cost issues, including rising energy prices and future carbon taxes, in combination with the commercial gains from "being green" to be able to make well informed decisions.

14. Auditing of resources – Companies and organisations should take a holistic review of their activities and inputs and outputs to identify where improvements can be made. In many organisations, waste streams can be valuable for either re-use or recycling, or even as a feedstock for energy from waste. Audits should be made of all potential resource streams.

15. Establish potential to deliver community energy schemes – Large scale schemes such as district heating can require the involvement of both private sector and public sector organisations. The private sector should work closely with the public sector to help identify and develop schemes. This can be an opportunity the private sector to benefit from public sector financing and de-risking, whilst providing private sector expertise.

16. Investigate Best Practices within industry – Where there are many examples of energy efficient practices, this can be an indication of cost effective improvements which can be implemented. Sharing information and case studies through business and industry forums could help to build confidence and stimulate delivery.

17. Partner within industry – Partnering with similar private enterprises and other local organisations can achieve economies of scale and allow greater energy and CO_2 savings to be made economically. This can benefit the wider business community. Private sector organisations need to identify where partnerships could be developed and set up new networks, business forums, and funding mechanisms. Opportunities for the sharing of resources should be identified and acted on. For example, one company's waste could be another company's resource.

18. Develop private sector champions – Currently, there are a number of private sector actors, such as Lincoln College, University of Lincoln, and Branston Potatoes that have successfully contributed to an increase in renewable and low carbon energy in Central Lincolnshire. However, there is no active network of champions in the private sector currently. There is an opportunity for a private sector stakeholder to lead the cause in this sector, and gain a competitive advantage in the process.

19. Foster local construction skills – In order for the renewables sector to contribute to Central Lincolnshire's economy, it will be important to develop the relevant skills for locals. Industry can partner with private sector education to develop the relevant skills and signal their interest in establishing a local renewable energy sector.

20. Create local innovation hubs – With the growing focus on renewable energy and technology, there is an opportunity to foster a low carbon economy. With the high potential for a variety of renewable energy in Central Lincolnshire, it is sure to be of growing interest. Providing incentives to locate in the area will be important to the economic evolution in Central Lincolnshire.

21. Co-ordinate and promote private funding – There will be a need for source funds, which make private schemes viable.

Actions influencing community groups and individuals

22. Educate –Using community facilities, such as libraries, community halls and museums, community groups can host events to disseminate information to residents about reducing CO_2 emissions and low carbon renewable energy opportunities. Disseminating delivery models and case studies that have been previously successful is another way community groups and individuals can educate the wider community.

23. Engage with energy developers – Communities can engage with energy developers who are proposing local renewable energy schemes. By working with developers for the early stages, the acceptability of projects can be increased enabling them to proceed through planning with reduced opposition and be constructed earlier. In return communities can negotiate with the developer to deliver community benefits, such as a share in the ownership or annual payments.

24. Engaging with private industry – Community groups have the potential to engage with private sector organisations to assist with community activities and developing good local interactions. Through the support of community groups, private sector companies can gain greater buy-in to local communities, promoting their social responsibility, and assisting with the development of local energy projects led by local communities. This can take many different forms, including smart meter pilot projects, which have worked well in the past.

25. Express views to local council – As the Central Lincolnshire local planning authorities work on behalf of the community, they are much more likely to facilitate renewable energy if the community supports it. Community groups should actively engage with the planning authorities to ensure that strategic plans are acceptable and provide real benefits for individual communities.

26. Establish a community ESCO – Community groups can work with the local councils to establish an energy services company. This will allow the development of smaller local projects which may benefit the community financially. ESCOs can benefit from the local knowledge and vast range of expertise available within local communities.

27. Fund feasibility studies for community schemes – As community grassroots projects can deliver "on-the-ground" results, funders often prefer to fund community projects. The local council should be able to support communities to source appropriate funders for local schemes.

28 .Partner with similar community organisations – Smaller community groups will increase their visibility and power if they partner together on similar initiatives. In addition, there may be opportunities to take advantage of group purchasing (i.e. economies of scale) of renewable technologies in the process.

29. Support community champions – As volunteer organisations, which operate on behalf of the community, it is vital that all other delivery partners do their best to provide support. This support could come in the form funding, technical knowledge, marketing and advertising, or simply acknowledgement of their hard work.

30. Use public sector powers to support residents – As identified in the delivery chapter, there are various models that the public sector can use to make delivery of renewable energy more affordable for local residents. These include discounts provided through bulk buying, lease and rental schemes, and Property Assessed Clean Energy.

Actions influencing Energy Developers

31. Implement clear and supportive policy – Supportive policy has substantial influence over how much renewable energy is installed in Central Lincolnshire. Favourable policies will positively impact all other stakeholders. Providing clear guidance and policy is important to give stakeholders the confidence to invest in feasibility work and develop projects. Without this, the level of risk may be too high.

32. Engage early with local communities and councils – Energy developers should engage the community and local authority as early as possible to provide insight into how to mitigate any objections whenever considering an energy project.

33. Employ local skills and expertise – Energy developers have the opportunity to support local communities through local employment and working with local training facilities such as Lincoln College. The support for local skills and employment will help promote a working relationship with local communities and assist with the acceptance of projects.

34. Develop new business structures – Energy developers have the opportunity to develop and invest in new business structures for projects which both involve local communities (for example through shared ownership) and provide an economic benefit to the local economy and communities.

35. Participate in partnerships with public sector organisations – This can provide the opportunity for developing projects were additional support and de-risking from the public sector can make a scheme viable. Through the participation in partnerships in the early phases of projects (such as a district heating scheme), the private sector companies are well placed for taking over and expanding schemes once early higher risk phases have passed. Working with the public sector provides schemes with low cost finance which may not be otherwise available.

36. Engage with local private sector organisations – There may be the potential for energy developers to engage with, and potentially partner with local private sector companies to deliver energy schemes which are too complex or expensive for the private sector to invest in, but which can provide long term economic benefits. One example is a large CHP installation which a private sector company may benefit from in terms of reduced energy costs and CO_2 emissions, but which is paid for and operated by an energy developer.

37. Improve Infrastructure and supply chain – The current energy infrastructure, such as power lines and pylons, require updating and an increased capacity. If energy developers are to delivery renewable energy, public funding will be required to remove these infrastructure barriers.

9.3 PARTNER PERSPECTIVES: SUMMARY OF THE STAKEHOLDER WORKSHOP 2

The focus of the workshop was to examine how each stakeholder group could do their part to maximise delivery of renewable energy in Central Lincolnshire. After presenting the study's conclusions about the amount of renewable and low carbon energy each stakeholder group was likely to deliver in a 'optimised' and a 'business-as-usual' scenario, it was the workshop attendees turn to interrogate the findings and suggest how they could work towards achieving the 'optimised' scenario for each delivery partner.

Figure 69: Workshop attendees deciding on the impact and ease of implementation for each action

After being separated into four delivery partner focussed groups – private sector, public sector, community groups, and energy developers – each group was given a list of actions that could work to improve uptake of renewables. They were then asked to rank actions on two scales: ease of implementation, and level of impact. Once priority actions were mapped based on these criteria, attendees were asked to 'vote' on what they personally believed were the most effective actions that could be taken forward to support local delivery.

Figure 70: Workshop attendees voting on the most important actions

As a group, attendees discussed the most important actions and questioned how these could be undertaken, by whom, by when and what support was needed. The top 5 actions are shown in Table 36:

Table 36: Top 5 actions required to increase renewable energy in Central Lincolnshire

Action	By whom
Implementing clear and supportive planning policies for renewable energy	Councils with support from waste department, community, and Environment Agency
Engaging early with the community in an open and transparent manner on energy projects	Energy developers and public sector coordination
Creating a public energy services company	Community leader
Co-ordinating a funding pot for public sector projects	Public sector leader
Establishing partnerships between community groups and energy developers	Proactive energy developers, and community groups with council support

While there was a lively discussion on all priority actions, much of the discussion focused on the merits of establishing an public sector owned energy services company so as to benefit the community financially as well as environmentally with a more resilient, and sustainable mix of energy sources.

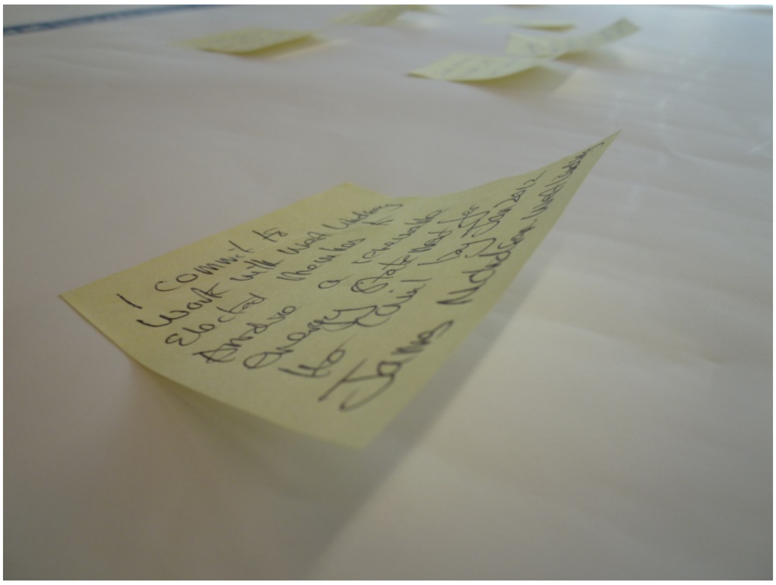

Figure 71: Personal commitments to delivering renewable and low carbon energy

To conclude the workshop, attendees were asked to write down one commitment they will personally make in the next 6 months to support delivery of low carbon and renewable energy in Central Lincolnshire and post it on the wall. Overall, the workshop provided an important venue for stakeholders to understand the potential for renewables and consider how they might make strides towards a more resilient Central Lincolnshire.

9.4 IMPLEMENTATION PRIORITIES

As resources and capacity are limited, it is important to prioritise actions which are likely to have the greatest effect on delivery. With the knowledge of how different actions can improve delivery rates for various partners established in the previous section, Table 37 sets out the actions based on priority. The table includes the actions, along with the main actors, the expected timeframe for delivery, what support could increase the likelihood of success, and the priority and taking action. The main actors are the people who are viewed as those who should take responsibility for delivering a specific action. Timeframes are listed as short-term, medium-term, and long-term – referring to the length of time before an action will have an impact. Support is classified as any person or group, or action that can facilitate the action being delivered effectively. Priority is listed as either high, medium, or low.

Table 37 separates actions based on five broad categories that describe the type of action:

1. Partnership Working: Actions concerning coordination and cross-partner activities
2. Education and Empowerment: Actions designed to promote skills and leadership
3. Investment and Resources: Actions that require direct funding or resources
4. Innovation: Actions that require further knowledge
5. Planning and Strategy: Actions that require new policy or strategy

Action numbers have been included in the first column and relate to the action numbers and additional information in the above section.

Table 37: Increasing Renewable Energy Uptake – Setting Implementation Priorities

Action #	Action Description	Main actor(s)	Timeframe	Support required from	Priority
	Partnership Working				
35	Participate in partnerships with public sector organisations to deliver large scale projects	Energy Developers	Long-term	Renewables champion on local authority council	High
23	Engage energy developers in discussions about potential to improve communities	Community group/ individual leader	Medium-term	Supportive energy developer Local council	High
9	Support community groups	Local councils	Short-term		High
32	Engage early with local communities and councils about large scale energy schemes	Energy Developers/ESCO	Medium-term	Community members Local council	High
17	Partner within industry and establish business forums	Private sector	Medium-term		Medium
7	Act as a leader and facilitator, coordinating separate bodies in the delivery of renewables	Local councils	Short-term		Medium
10	Establish county or region-wide local authority expertise network	Local councils	Long-term		Medium
24	Engage with private industry to support community initiatives	Community groups, local councils	Short-term	Local champions with private industries	Low
28	Partner with similar organisations	Leaders of various community groups	Short-term	Local council Other experienced communities	Low

	Education and Empowerment				
8, 22	Energy education and promotion	Community groups Schools and colleges Local councils	Short-term	Community buildings Advertising support	High
30	Use public sector powers to support residents	Local councils RSLs	Medium-term		High
29	Support community champions	Local councils Local businesses	Short-term		Medium
33, 19	Train and employ residents for low carbon economy jobs	Lincoln College University of Lincoln	Long-term	Energy Developers	Low
	Investment and Resources				
5	Scope and conduct feasibility studies to deliver strategic projects such as district heating	Local councils Hospitals University of Lincoln	Short-term	Private Sector Energy Companies Carbon Trust	High
12	Feasibility studies for renewables for businesses and landowners	Business and Industry Groups Farming Groups	Medium-term	Local Councils	High
37	Improve infrastructure and supply chains	Local councils	Long-term	Energy companies and developers	High
6, 26	Establish an Energy Company (ESCo)	Community groups	Long-term	Energy developers	High

		Local councils			
3	Public sector adoption of energy efficiency and renewable energy on all properties	Local councils Schools/colleges Hospitals RSLs	Long-term		High
27	Fund feasibility studies for community schemes	Local councils	Medium-term	Funding organisations	High
21	Co-ordinate and promote private funding	Private sector	Medium-term		High
11	Public sector to coordinate a fund for energy projects	Local councils Schools	Medium-term	West Lindsey Council, and others who have successfully obtained funding	High
14	Audit resource use	Industry sector Agriculture and farming sector	Short-term	Industry groups Farming groups	Medium
2	Public sector undertake property energy audit of council buildings and assets	Local councils	Long-term		Medium
	Innovation				
4	Allowable solutions identification and delivery	Local councils	Medium-term	Other councils who have been through the process e.g. Woking BC on delivery and Huntingdonshire on allowable solutions	High
34	Establish new business models that consider how communities can benefit from energy schemes	Energy Developers	Medium-term	Leadership within community	Medium
13	Perform an energy life cost analysis	Large energy users	Short-term	Industry groups	Medium

20	Create local innovation hubs	Local councils Energy-focused businesses	Long-term	Higher education – universities and colleges	Medium
18	Develop private sector champions	Local business leader	Medium-term		Medium
16	Investigate best practices within industry	Industry and business groups Farming groups	Medium-term		Low
	Planning and Strategy				
31	Public sector implement clear and support policy	Local councils			High
1	Work across local authority boundaries and at a County level to establish consistent guidance	County-wide working group	Short-term		Medium
15	Establish potential to deliver community energy schemes	Private sector	Medium-term		Medium
25	Express views to local council	Community groups/individuals	Short-term	Local council	Medium

APPENDIX A: ADDITIONAL MAPS

This appendix contains tables and figures taken from the EM Low Carbon Energy Study to support the text in Chapter 5 of this report.

Table A1: Technical potential for Central Lincolnshire. Source - EM Low Carbon Energy Study

	Lincoln				North Kesteven				West Lindsey (Outside AONB)			
Technology	2020 (MW)	2020 (GWh)	2030 (MW)	2030 (GWh)	2020 (MW)	2020 (GWh)	2030 (MW)	2030 (GWh)	2020 (MW)	2020 (GWh)	2030 (MW)	2030 (GWh)
Large Wind	4.36	6.87	4.36	6.87	1,215.21	1,916.15	1,215.21	1,916.15	1,308.04	2,062.52	1,308.04	2,062.52
Medium Wind	0.44	0.69	0.44	0.69	25.29	39.88	25.29	39.88	25.60	40.36	25.60	40.36
Small Wind	5.73	9.04	5.73	9.04	603.38	951.41	603.38	951.41	723.78	1,141.26	723.78	1,141.26
Small Scale Wind <6kW	0.00	0.00	0.00	0.00	81.33	113.99	81.33	113.99	95.24	133.49	95.24	133.49
Managed Woodland (heat)	0.18	0.71	0.18	0.71	4.25	16.75	4.25	16.75	5.52	21.76	5.52	21.76
Managed Woodland (elec)	0.03	0.23	0.03	0.23	0.70	5.27	0.70	5.27	0.91	6.86	0.91	6.86
Energy Crops (heat) Medium	7.78	30.67	8.56	33.74	41.86	165.01	46.05	181.53	29.26	115.34	32.18	126.85
Energy Crops (elec) Medium	1.34	10.10	1.47	11.07	7.20	54.24	7.92	59.67	5.03	37.89	5.53	41.66
Agricultural Arisings	0.04	0.24	0.04	0.24	17.37	91.28	17.37	91.28	19.45	102.24	19.45	102.24
Waste Wood (heat)	0.67	3.54	0.74	3.91	0.40	2.12	0.45	2.34	0.30	1.57	0.33	1.73
Waste Wood (elec)	0.79	4.14	0.87	4.57	0.47	2.47	0.52	2.73	0.35	1.83	0.38	2.02
Poultry Litter	0.00	0.00	0.00	0.00	3.83	20.11	3.83	20.11	3.21	16.88	3.21	16.88
Wet Organic Waste	0.29	1.52	0.29	1.52	2.59	13.62	2.59	13.62	5.69	29.90	5.69	29.90
Biomass Co-firing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Municipal Solid Waste (MSW)	2.95	15.51	3.25	17.06	3.81	20.02	4.19	22.02	2.87	15.07	3.15	16.58
Commercial and Industrial	3.53	18.56	3.71	19.51	2.11	11.10	2.22	11.67	1.56	8.22	1.64	8.64
Landfill Gas	0.00	0.00	0.00	0.00	2.28	12.01	0.62	3.27	0.24	1.27	0.07	0.35
Sewage Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.66	0.16	0.71
Hydro	0.00	0.00	0.00	0.00	0.04	0.21	0.04	0.21	0.10	0.52	0.10	0.52
Solar PV	35.00	27.59	43.48	34.28	31.69	24.98	35.60	28.07	25.86	20.39	28.16	22.20
Solar Thermal	30.57	13.39	39.04	17.10	27.84	12.19	31.75	13.91	22.22	9.73	24.52	10.74
Heat Pumps	173.39	394.91	194.58	443.18	213.42	486.09	223.21	508.38	169.69	386.49	175.43	399.56
Total (electricity)	54.50	94.49	63.67	105.08	1,997.30	3,276.75	2,000.81	3,279.35	2,218.08	3,619.35	2,221.12	3,626.17
Total (heat)	212.59	443.22	243.10	498.64	287.77	682.16	305.71	722.91	226.99	534.89	237.98	560.65

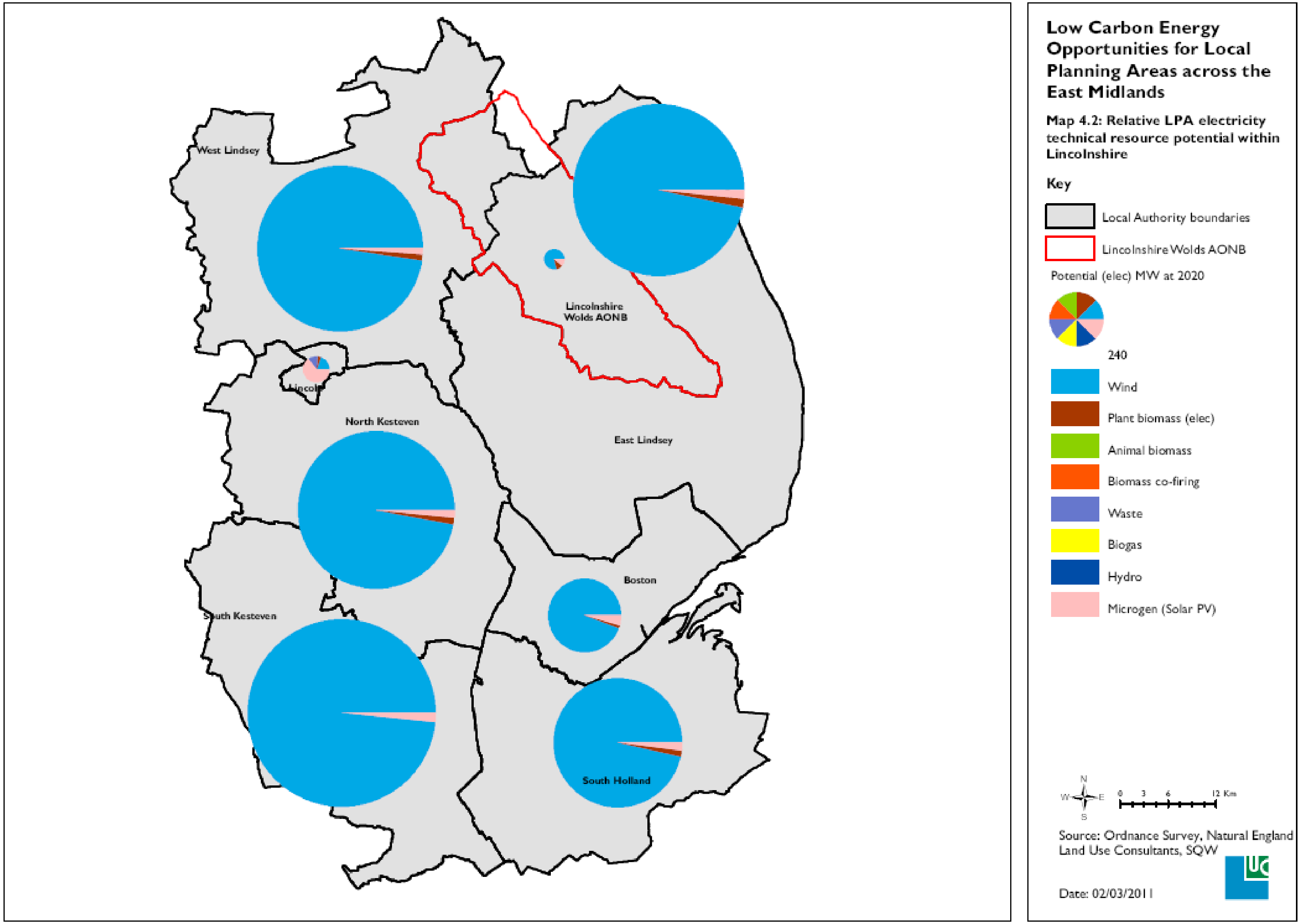

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Figure A1: Resource potential from across Lincolnshire. Source - EM Low Carbon Energy Study

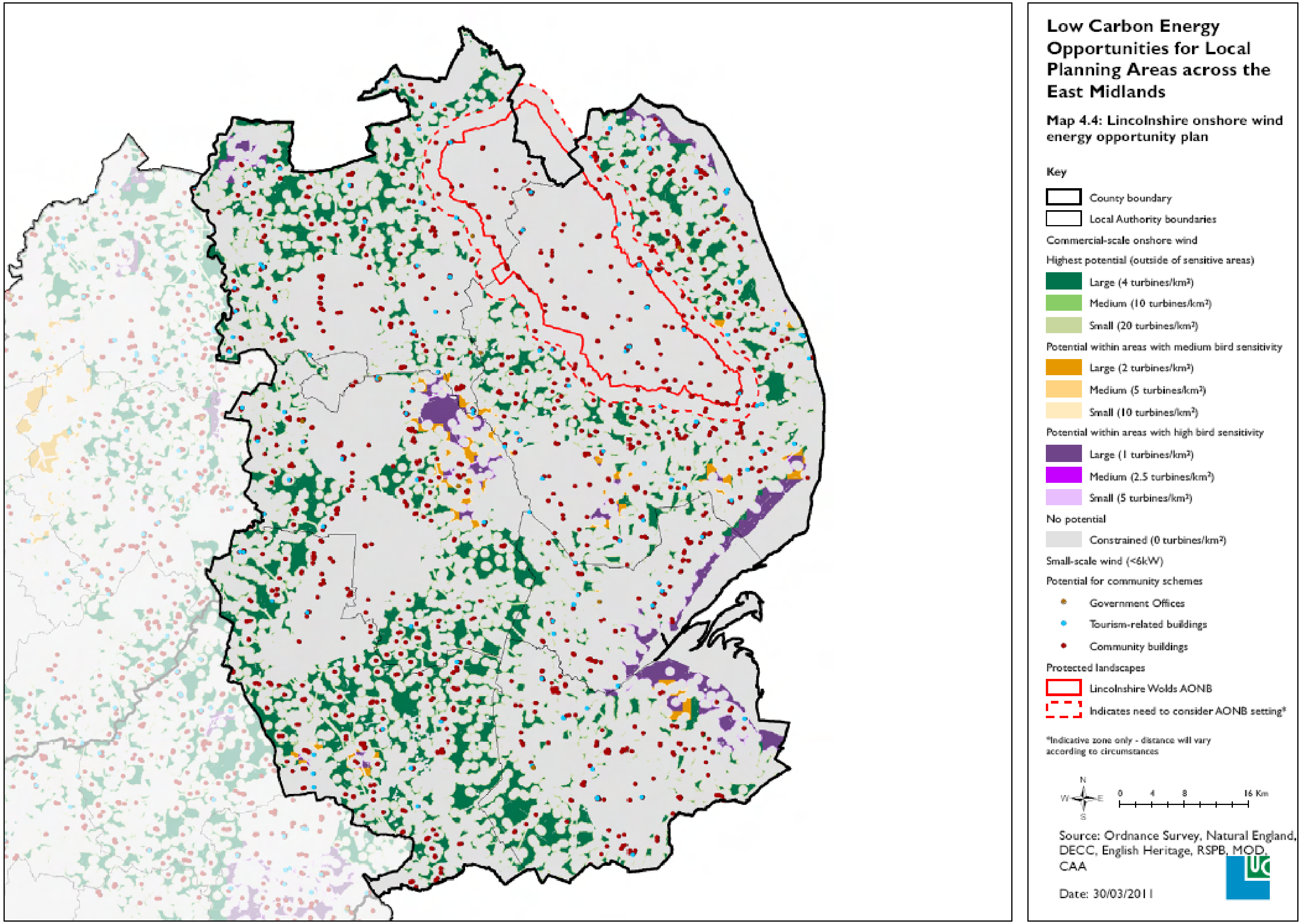

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Figure A2. Wind opportunity map for Lincolnshire. Source - EM Low Carbon Energy Study

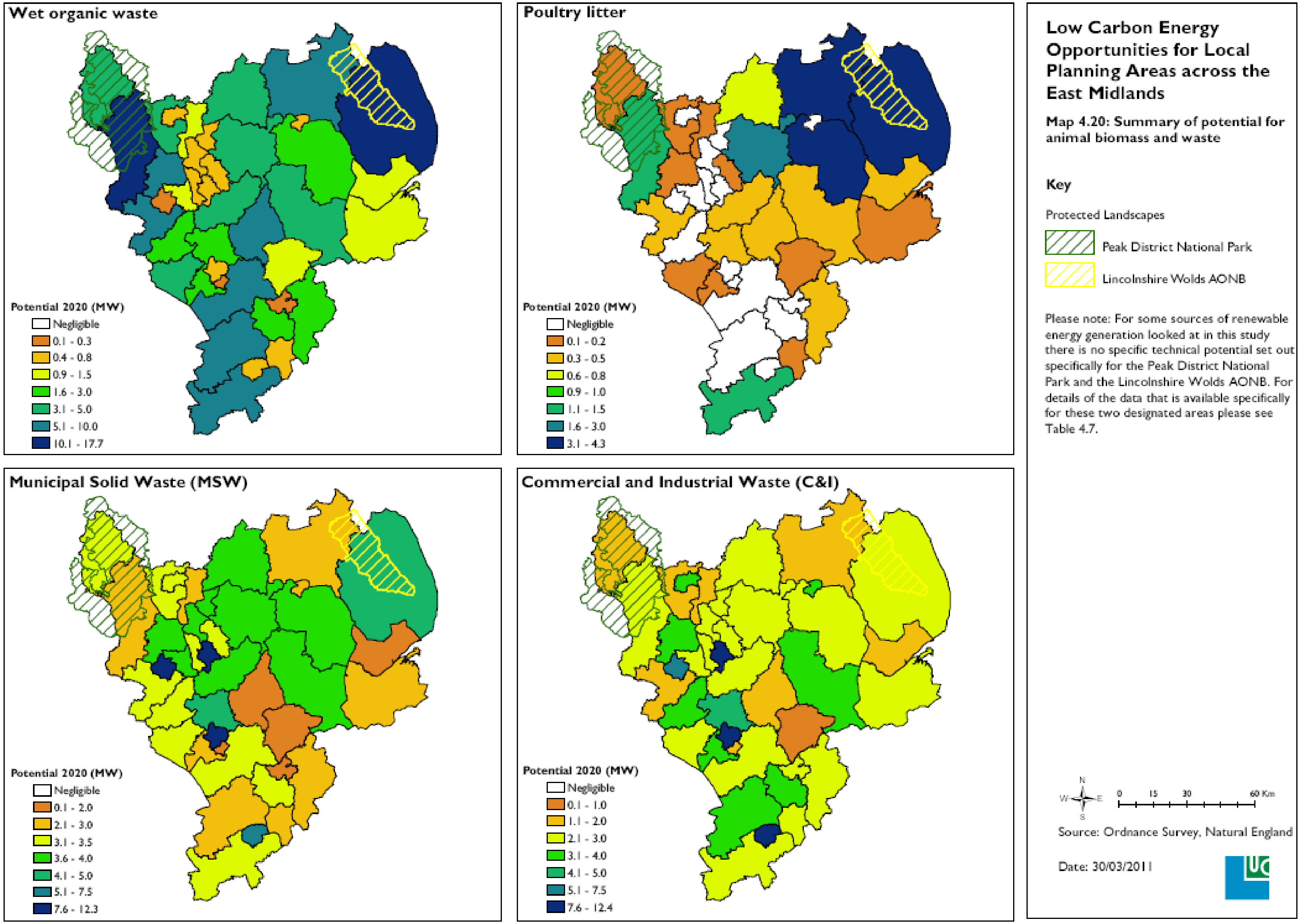

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Figure A3: Animal biomass and waste potential. Source - EM Low Carbon Energy Study

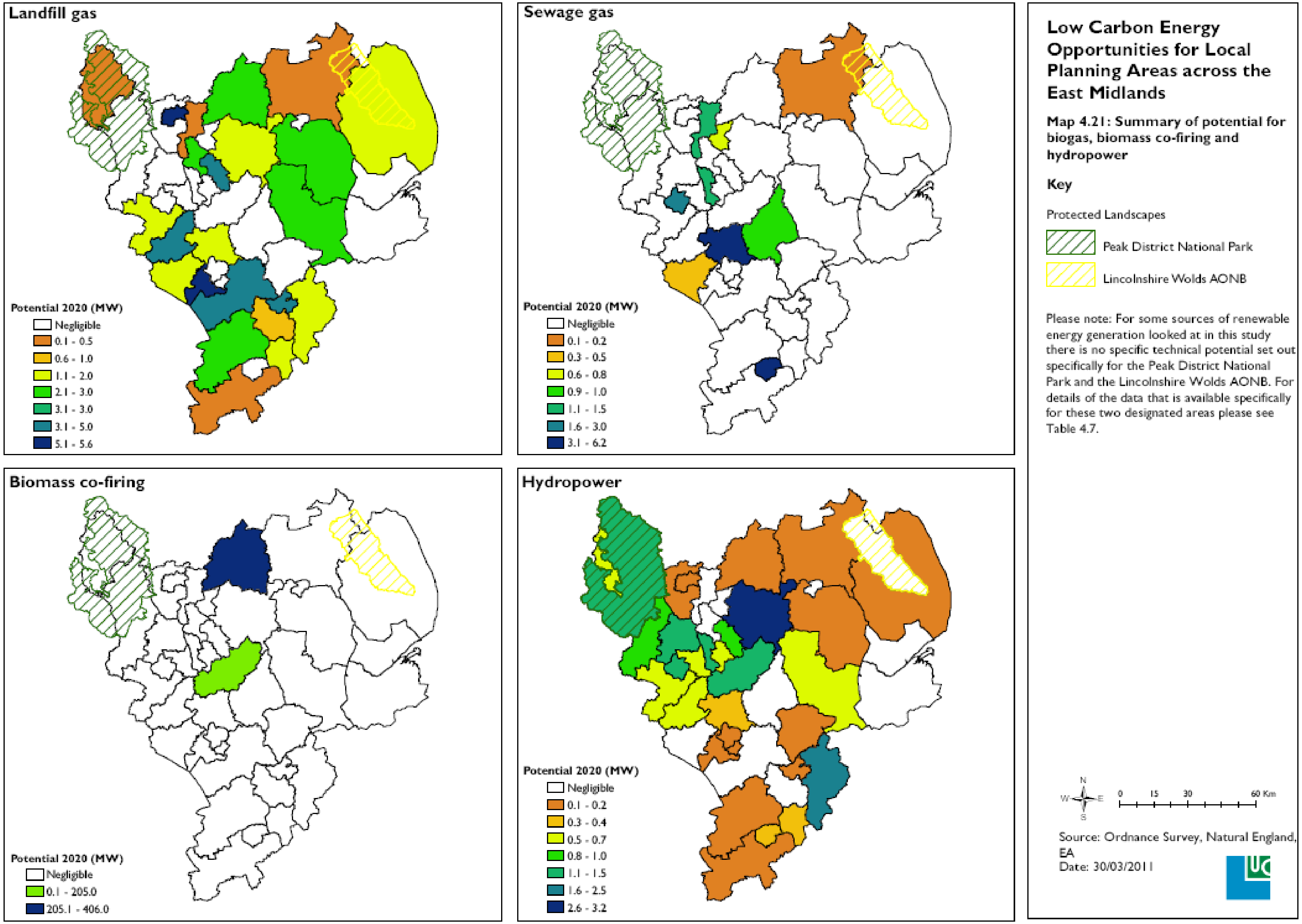

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Figure A4. Biogas, biomass, co-firing and hydropower. Source - EM Low Carbon Energy Study

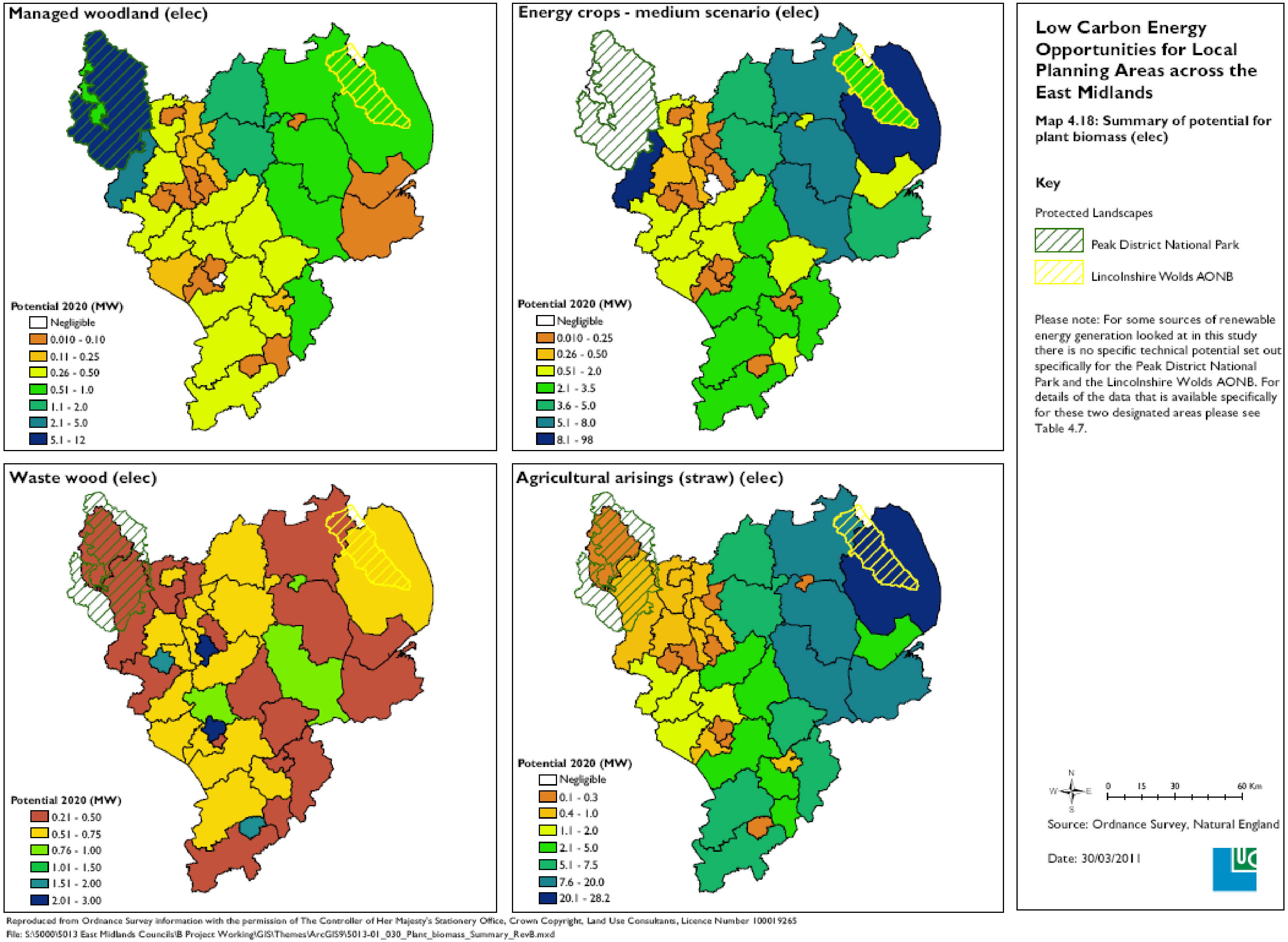

Figure A5. Plant biomass (heat). Source - EM Low Carbon Energy Study

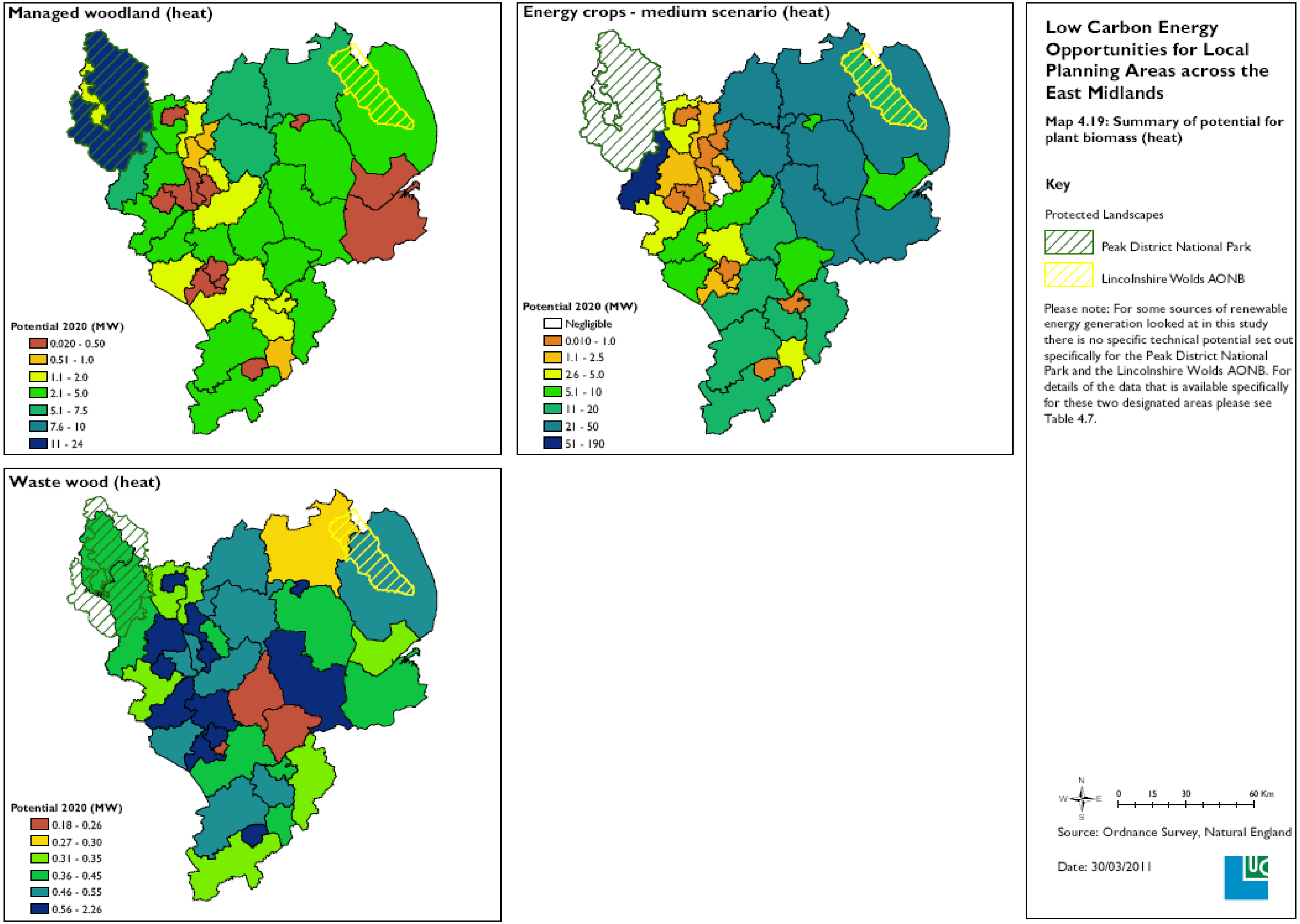

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Figure A6. Plant biomass (elec). Source - EM Low Carbon Energy Study

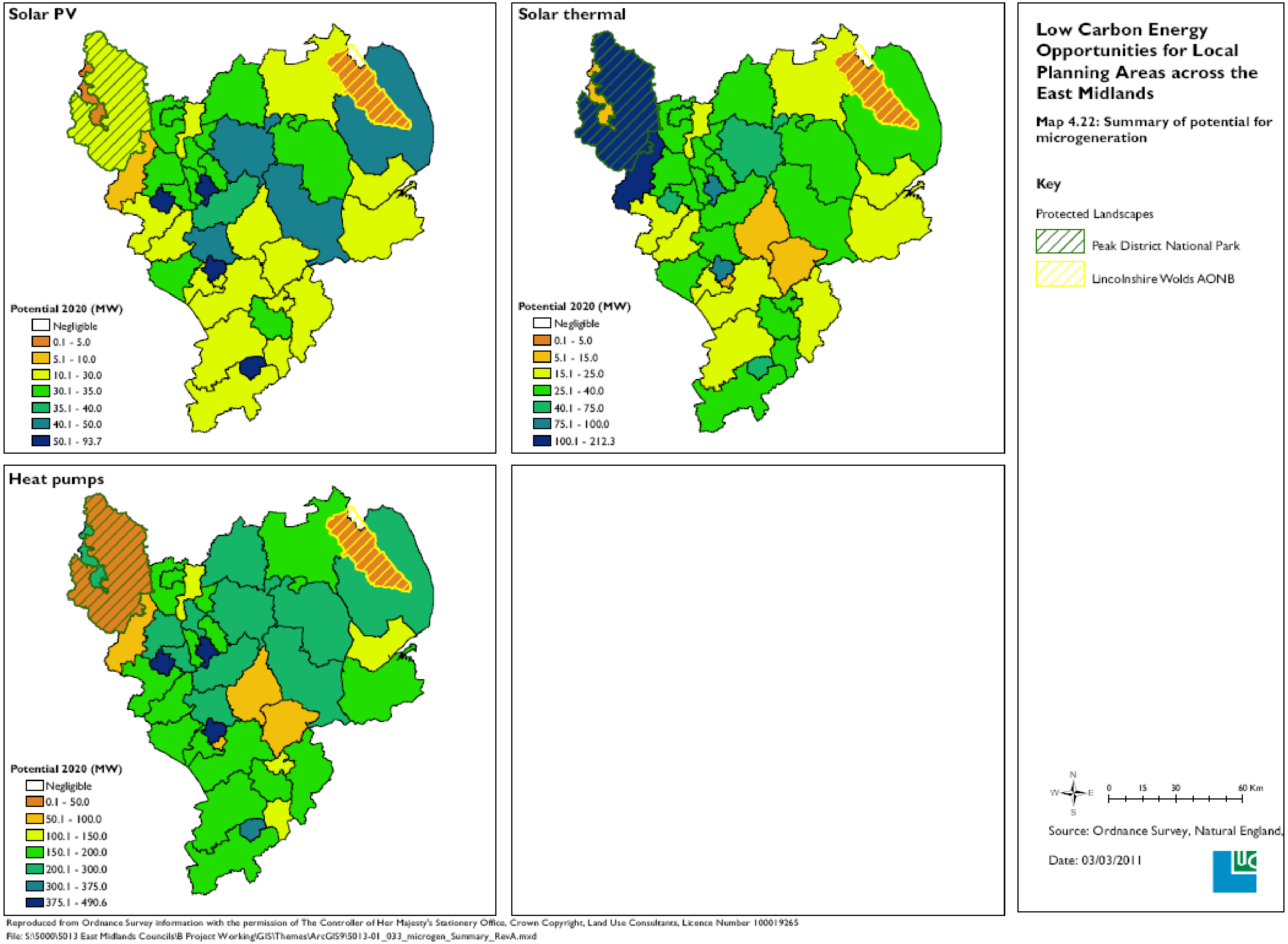


Figure A7. Micro-generation. Source - EM Low Carbon Energy Study

APPENDIX B: SITE TESTING

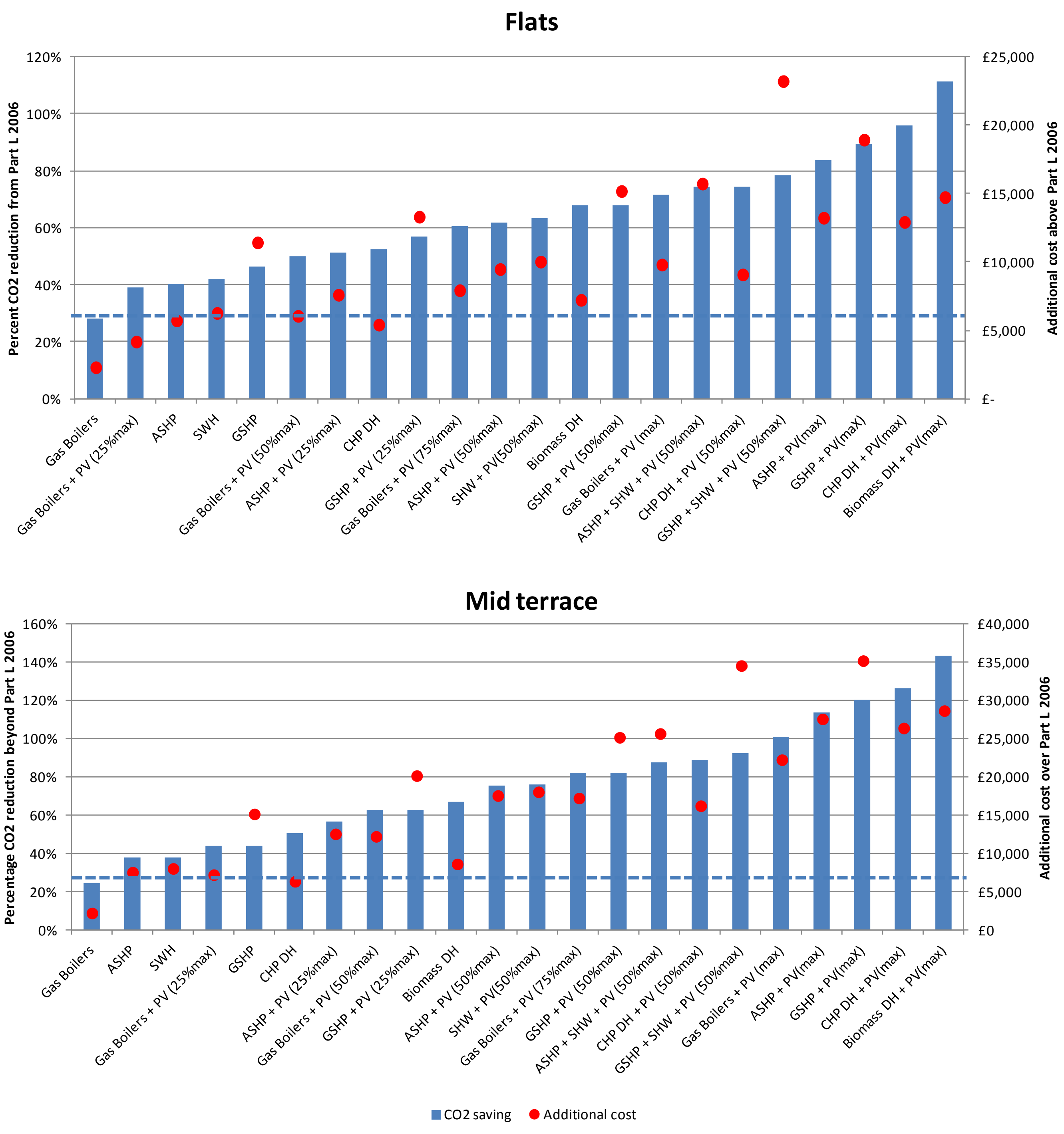
This appendix presents results of potential technical solutions for reducing CO_2 emissions from each of the building types in each development typology. For each building, the following information is shown:

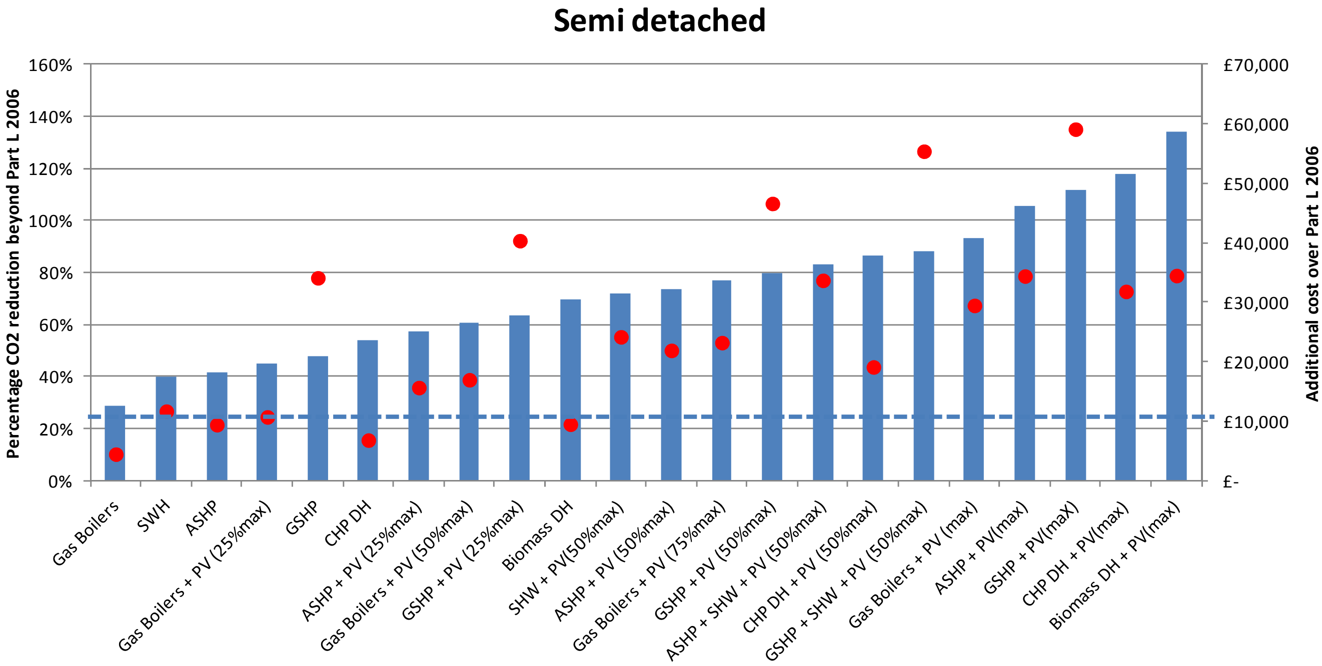
- CO2 reductions above Part L 2006.
- An indication of the Part L 2010 pass level.
- An indication of the costs of achieving the CO2 reduction levels (beyond Part L 2006).

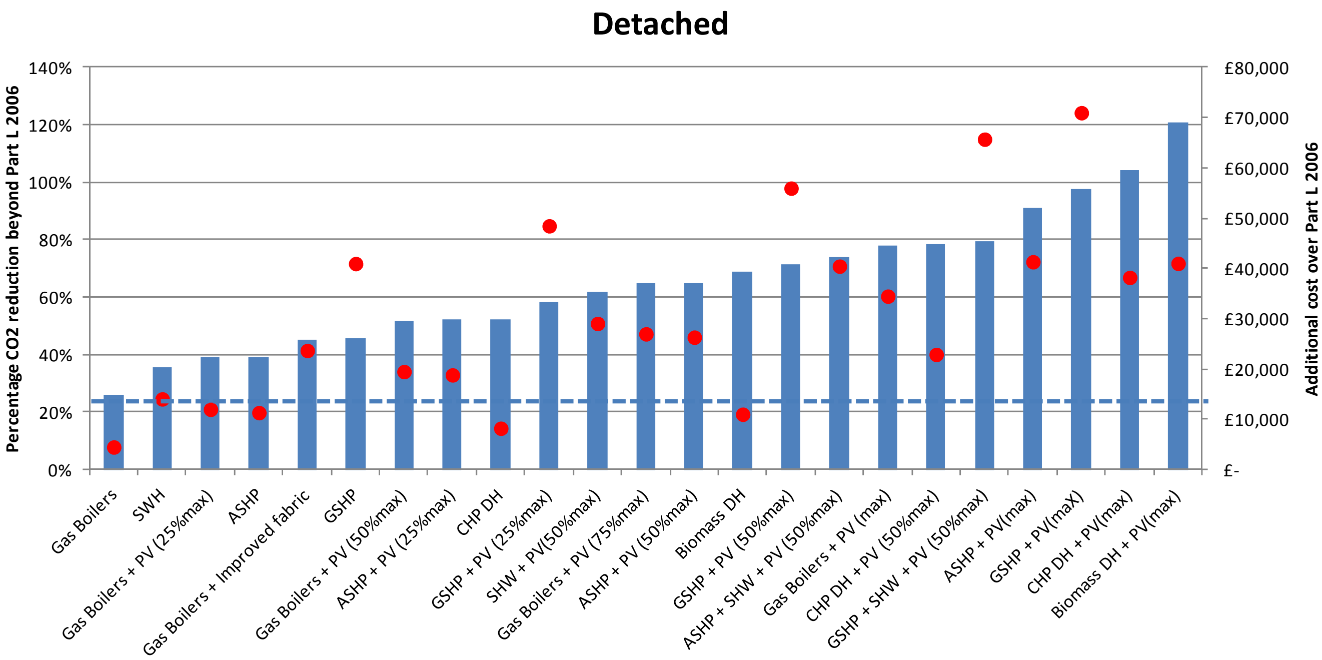
Key to charts

- Each vertical bar shows one CO_2 measure option.
- The blue bars indicate the size of the CO_2 reduction in terms of percent improvement over Part L 2006.
- The red data points indicate the capital cost of including the measure. Note that costs are per dwelling for houses, and per square metre for non-domestic buildings.
- The horizontal dashed line indicates a Part L 2010 pass of 25% improvement over Part L 2006 for domestic buildings.
- The shaded area on the non-domestic charts indicates a range of possible carbon compliance levels for future building regulations, effectively the maximum reduction which is deemed economically viable.

SITE 1: LARGE URBAN EXTENSION / ECO TOWN




Semi detached
Percentage CO2 reduction beyond Part L 2006
Additional cost over Part L 2006
160%
140%
120%
100%
80%
60%
40%
20%
0%
£70,000
£60,000
£50,000
£40,000
£30,000
£20,000
£10,000
£-
Gas Boilers
SWH
ASHP
Gas Boilers + PV (25%max)
GSHP
CHP DH
ASHP + PV (25%max)
Gas Boilers + PV (50%max)
GSHP + PV (25%max)
Biomass DH
SHW + PV(50%max)
ASHP + PV (50%max)
Gas Boilers + PV (75%max)
GSHP + PV (50%max)
ASHP + SHW + PV (50%max)
CHP DH + PV (50%max)
GSHP + SHW + PV (50%max)
Gas Boilers + PV (max)
ASHP + PV(max)
GSHP + PV(maX)
CHP DH + PV(max)
Biomass DH + PV(max)


Detached
Percentage CO2 reduction beyond Part L 2006
Additional cost over Part L 2006
140%
120%
100%
80%
60%
40%
20%
0%
£80,000
£70,000
£60,000
£50,000
£40,000
£30,000
£20,000
£10,000
£-
Gas Boilers
SWH
Gas Boilers + PV (25%max)
ASHP
Gas Boilers + Improved fabric
GSHP
Gas Boilers + PV (50%max)
ASHP + PV (25%max)
CHP DH
GSHP + PV (25%max)
SHW + PV(50%max)
Gas Boilers + PV (75%max)
ASHP + PV (50%max)
Biomass DH
GSHP + PV (50%max)
ASHP + SHW + PV (50%max)
Gas Boilers + PV (max)
CHP DH + PV (50%max)
GSHP + SHW + PV (50%max)
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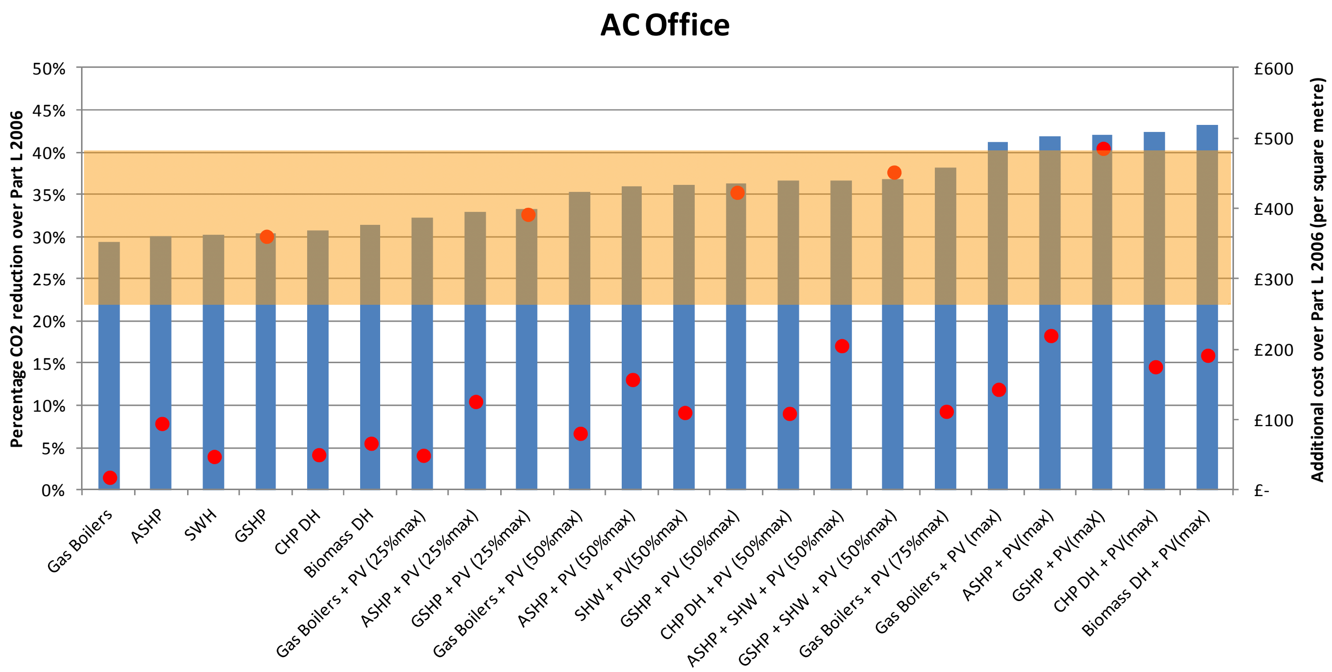
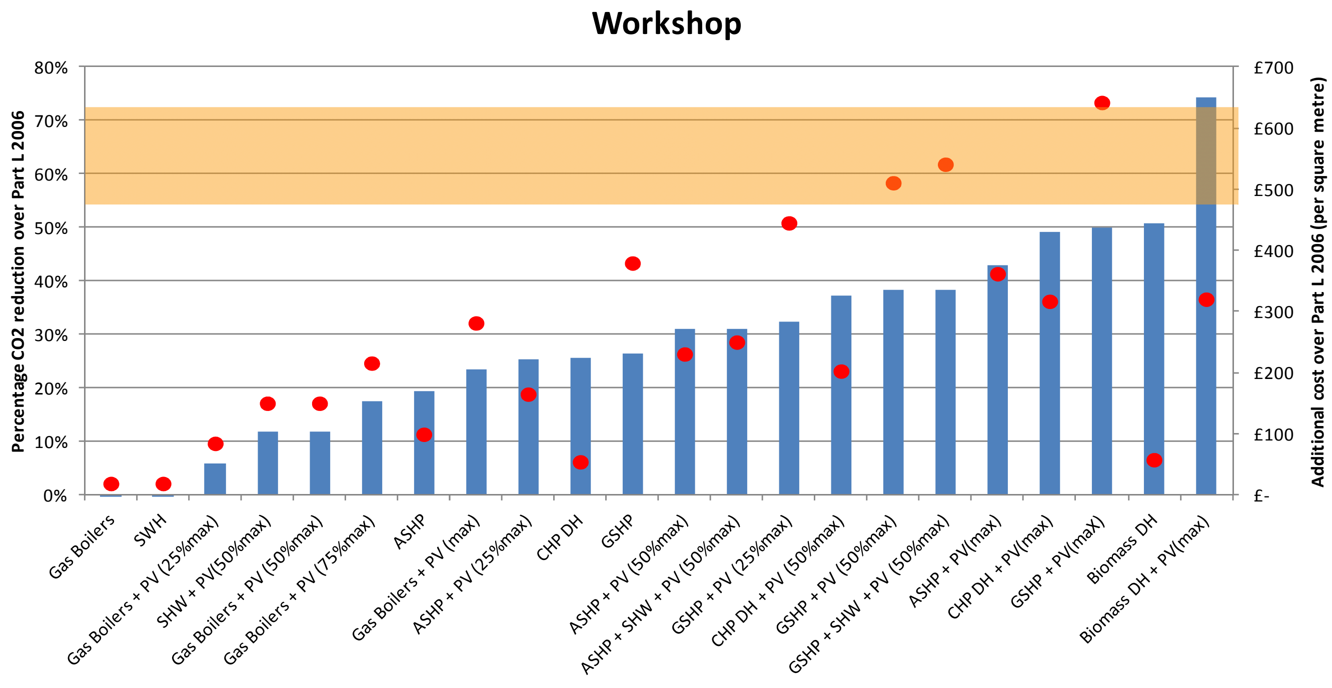
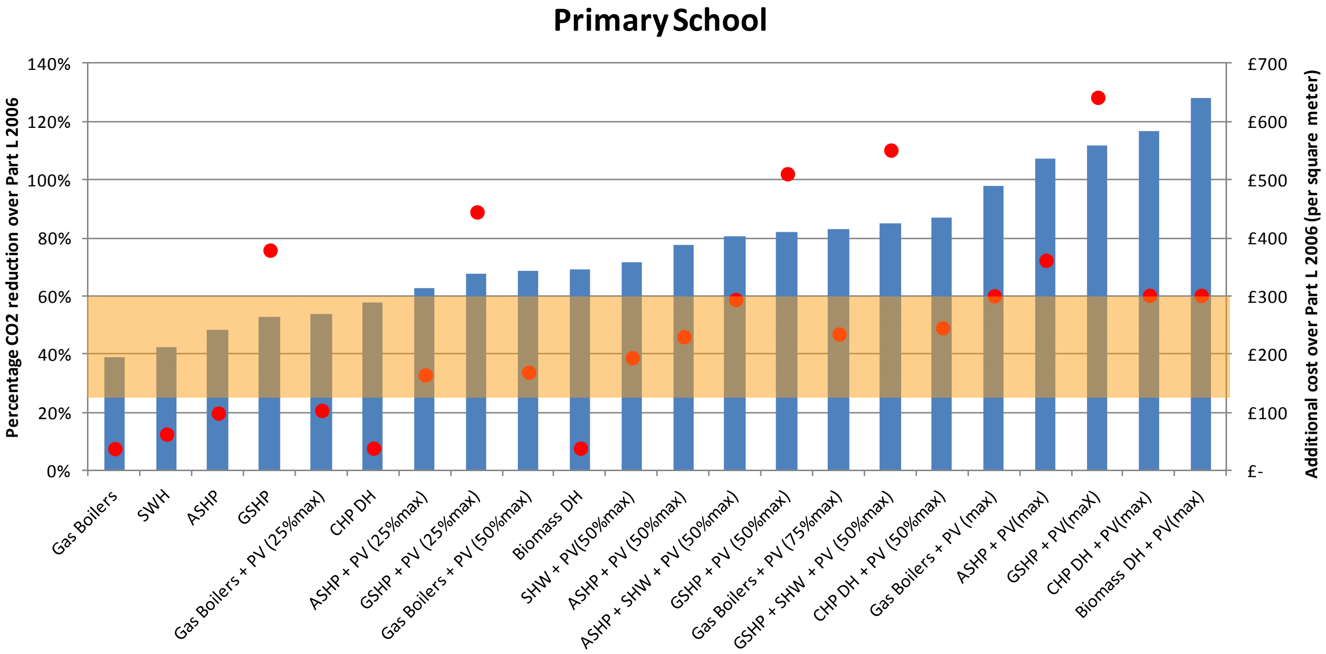
CHP DH + PV(max)
Biomass DH + PV(max)

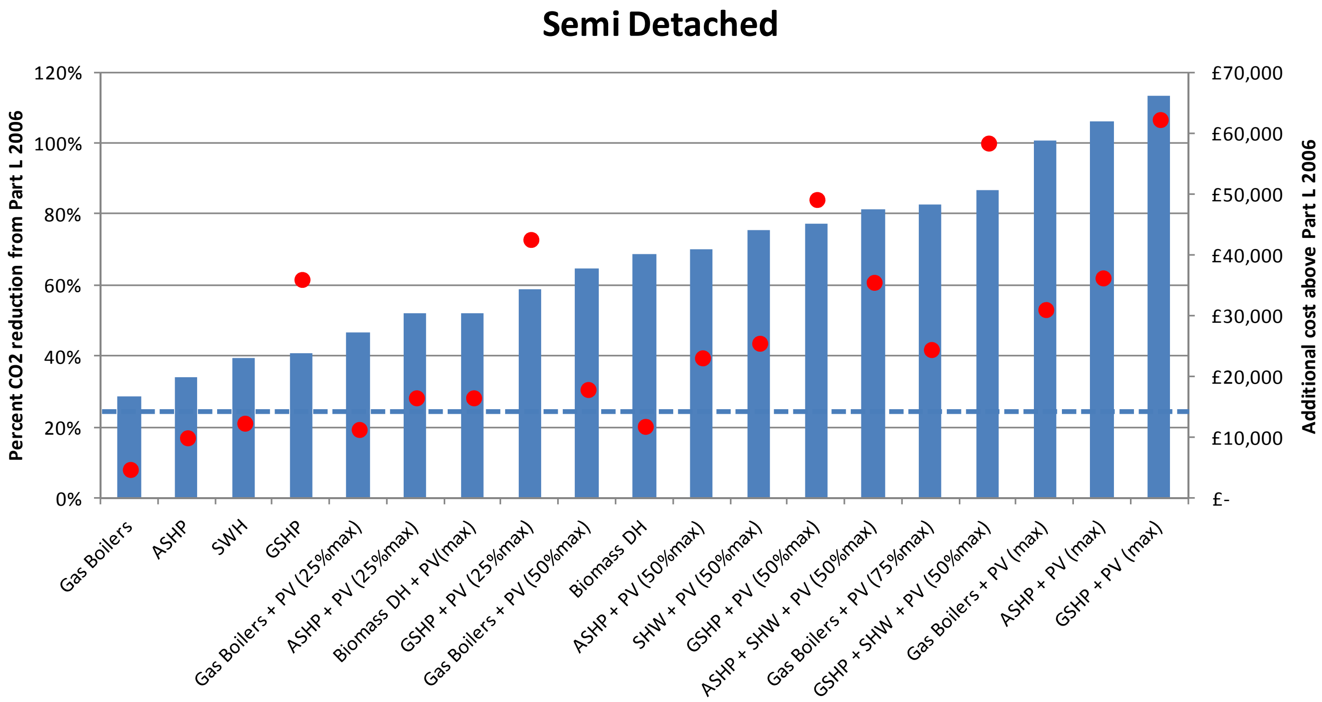


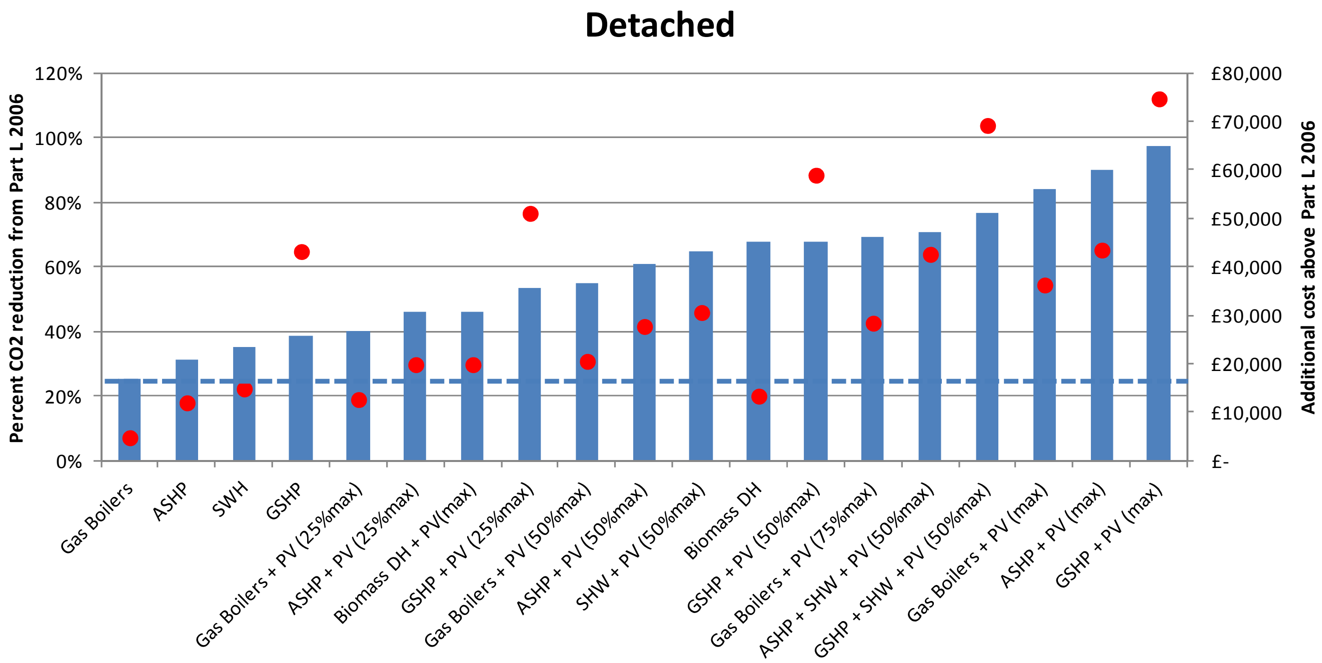


Note – the range of possible carbon compliance levels for the workshop is based on information for warehouses. The energy demands for industrial type buildings can vary widely, a wide range of servicing options. Therefore this range may only represent a certain subset of warehouse type buildings. The gap between CO_2 savings and carbon compliance in this chart should therefore not be use to suggest that larger CO_2 reductions are viable in all cases.

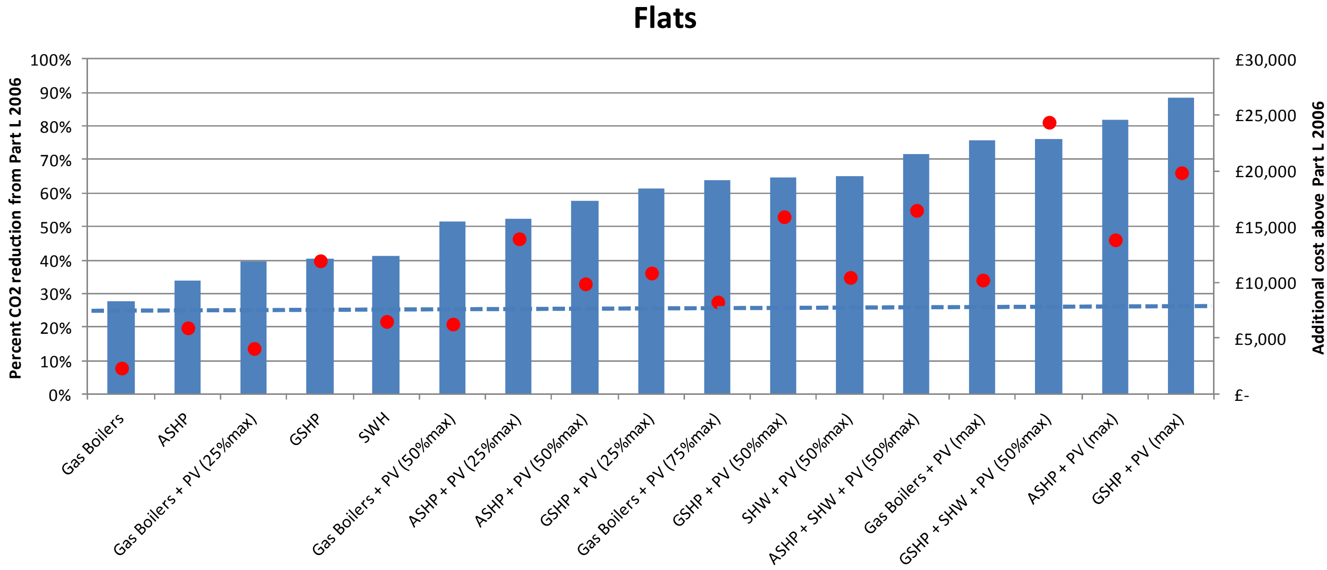

Primary School
Percentage CO2 reduction over Part L 2006
Additional cost over Part L 2006 (per square meter)
140%
120%
100%
80%
60%
40%
20%
0%
£700
£600
£500
£400
£300
£200
£100
£-
Gas Boilers
SWH
ASHP
GSHP
Gas Boilers + PV (25%max)
CHP DH
ASHP + PV (25%max)
GSHP + PV (25%max)
Gas Boilers + PV (50%max)
Biomass DH
SHW + PV(50%max)
ASHP + PV (50%max)
ASHP + SHW + PV (50%max)
GSHP + PV (50%max)
Gas Boilers + PV (75%max)
GSHP + SHW + PV (50%max)
CHP DH + PV (50%max)
Gas Boilers + PV (max)
ASHP + PV(max)
GSHP + PV(maX)
CHP DH + PV(max)
Biomass DH + PV(max)

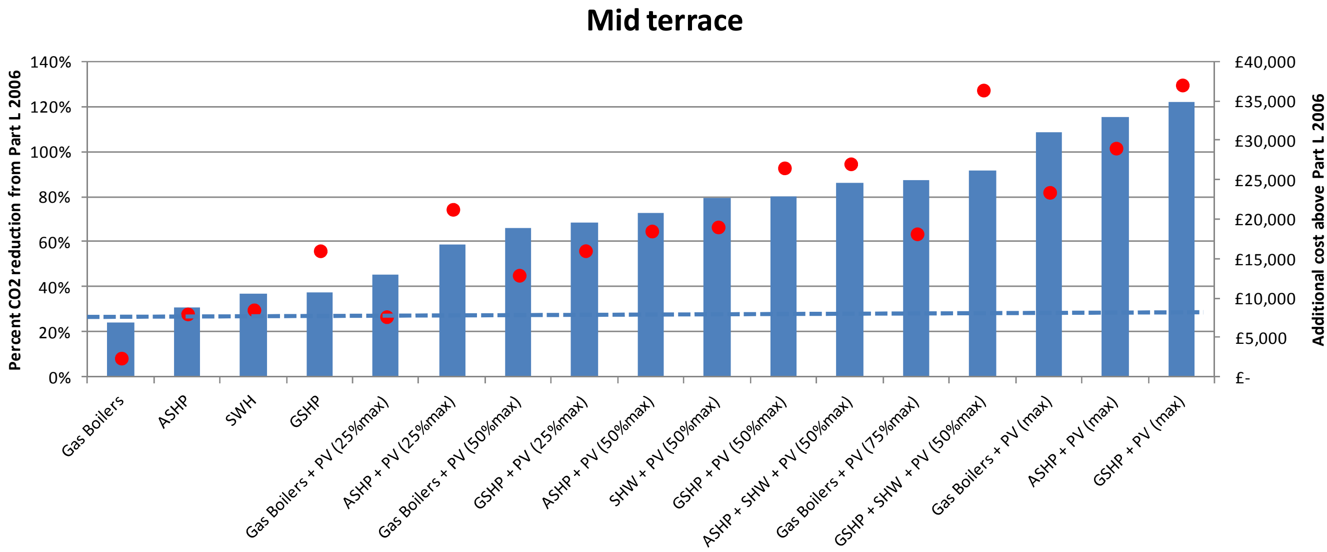
SITE 2: SMALL RURAL DEVELOPMENT

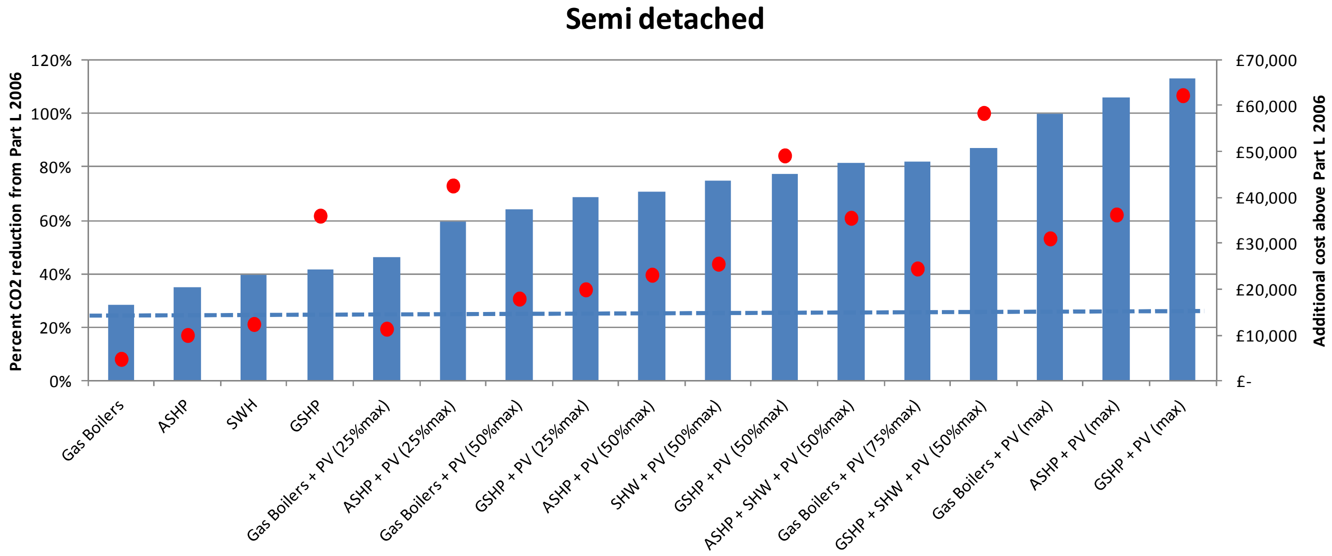


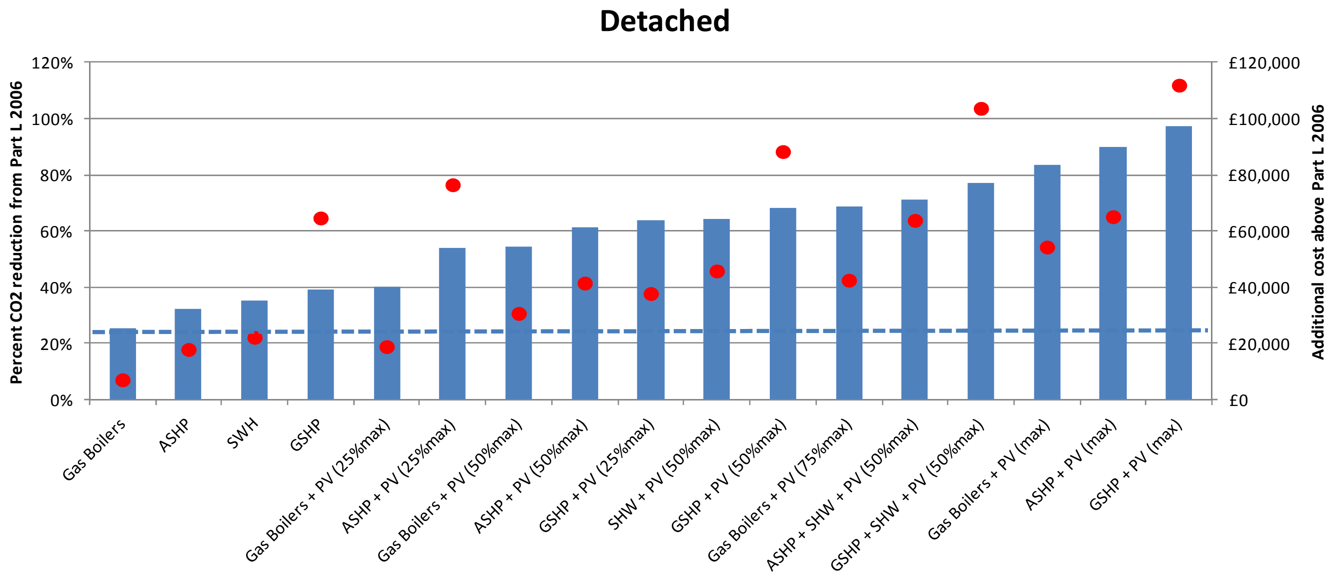


SITE 3: MEDIUM URBAN INFILL DEVELOPMENT

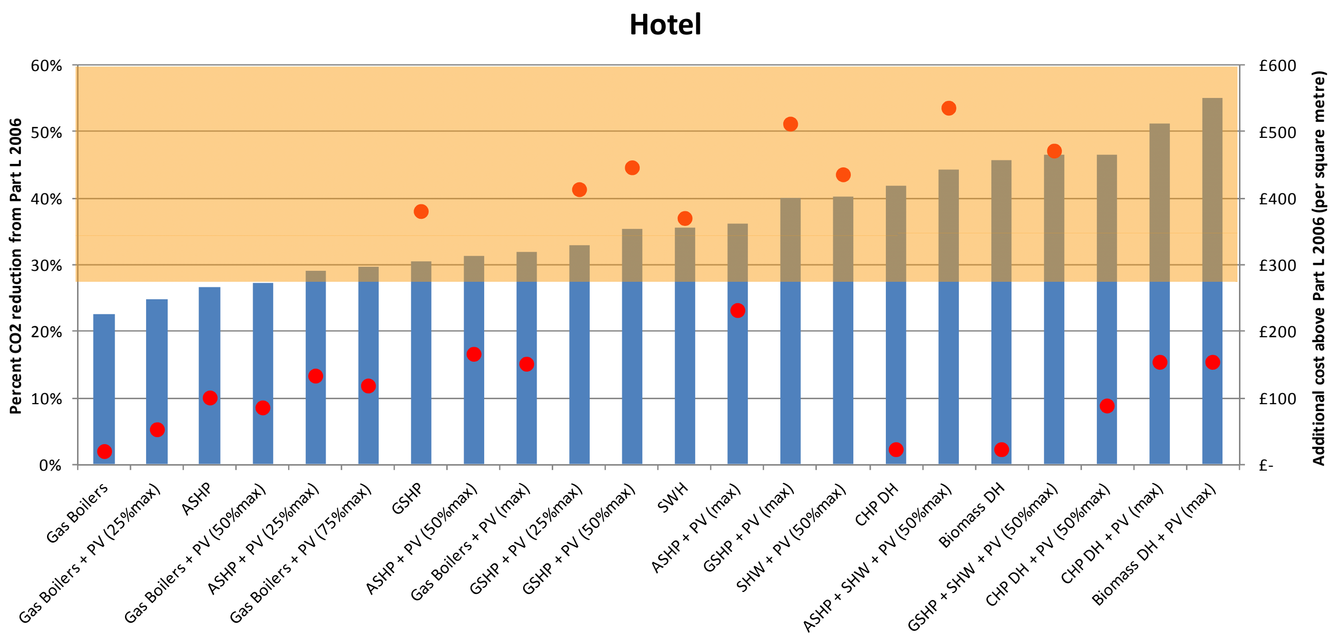


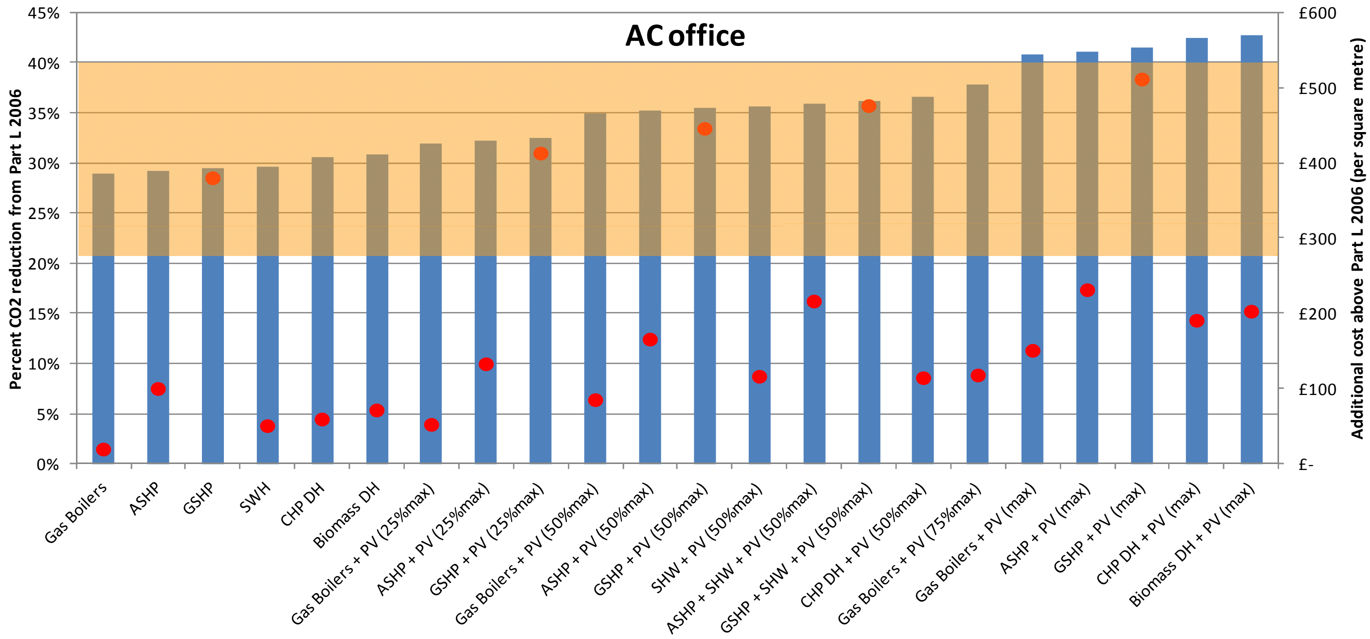



Semi detached
120%
100%
80%
60%
40%
20%
0%
Percent CO2 reduction from Part L 2006
£70,000
£60,000
£50,000
£40,000
£30,000
£20,000
£10,000
£-
Additional cost above Part L 2006
Gas Boilers
ASHP
SWH
GSHP
Gas Boilers + PV (25%max)
ASHP + PV (25%max)
Gas Boilers + PV (50%max)
GSHP + PV (25%max)
ASHP + PV (50%max)
SHW + PV (50%max)
GSHP + PV (50%max)
ASHP + SHW + PV (50%max)
Gas Boilers + PV (75%max)
GSHP + SHW + PV (50%max)
Gas Boilers + PV (max)
ASHP + PV (max)
GSHP + PV (max)

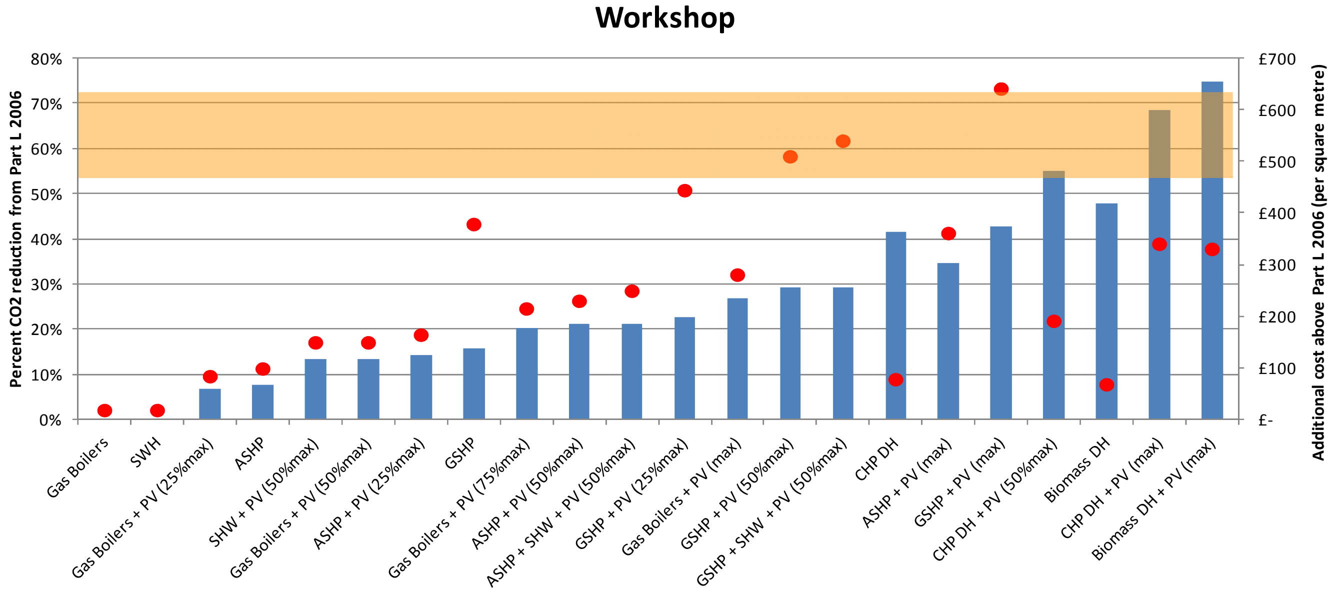

Detached
120%
100%
80%
60%
40%
20%
0%
Percent CO2 reduction from Part L 2006
£120,000
£100,000
£80,000
£60,000
£40,000
£20,000
£0
Additional cost above Part L 2006
Gas Boilers
ASHP
SWH
GSHP
Gas Boilers + PV (25%max)
ASHP + PV (25%max)
Gas Boilers + PV (50%max)
ASHP + PV (50%max)
GSHP + PV (25%max)
SHW + PV (50%max)
GSHP + PV (50%max)
Gas Boilers + PV (75%max)
ASHP + SHW + PV (50%max)
GSHP + SHW + PV (50%max)
Gas Boilers + PV (max)
ASHP + PV (max)
GSHP + PV (max)

SITE 4: BUSINESS PARK

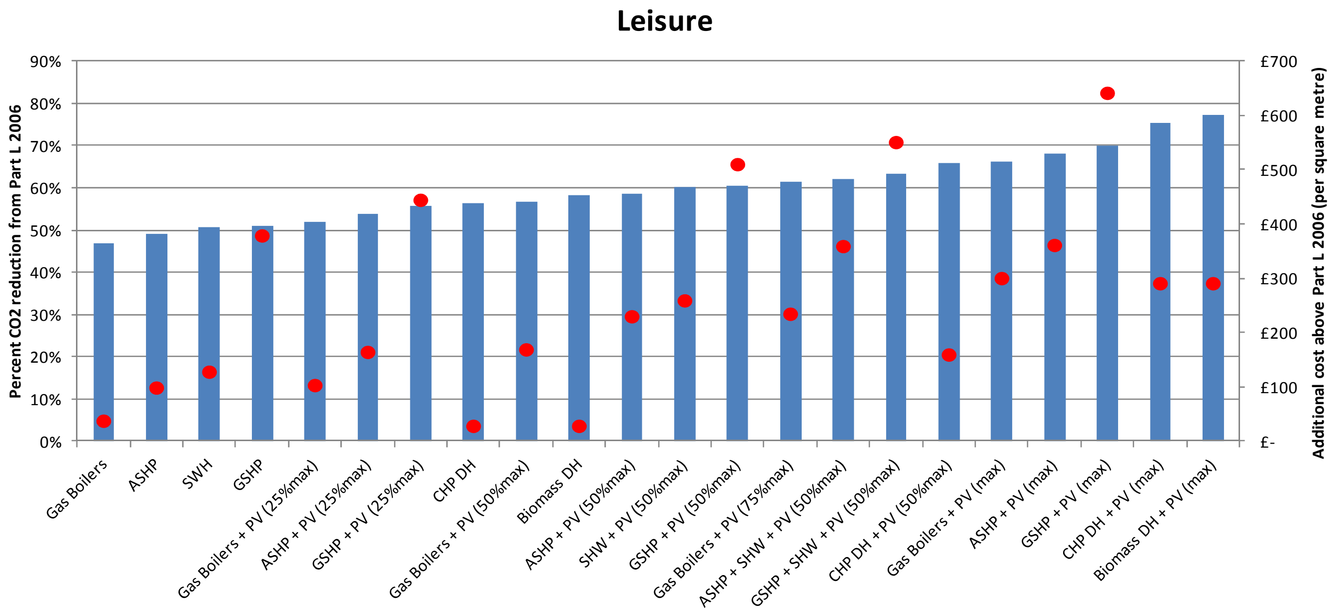




Note that the carbon compliance band includes both 3 star and 5 star hotels.



Note – the range of possible carbon compliance levels for the workshop is based on information for warehouses. The energy demands for industrial type buildings can vary widely, a wide range of servicing options. Therefore this range may only represent a certain subset of warehouse type buildings. The gap between CO_2 savings and carbon compliance in this chart should therefore not be use to suggest that larger CO_2 reductions are viable in all cases.

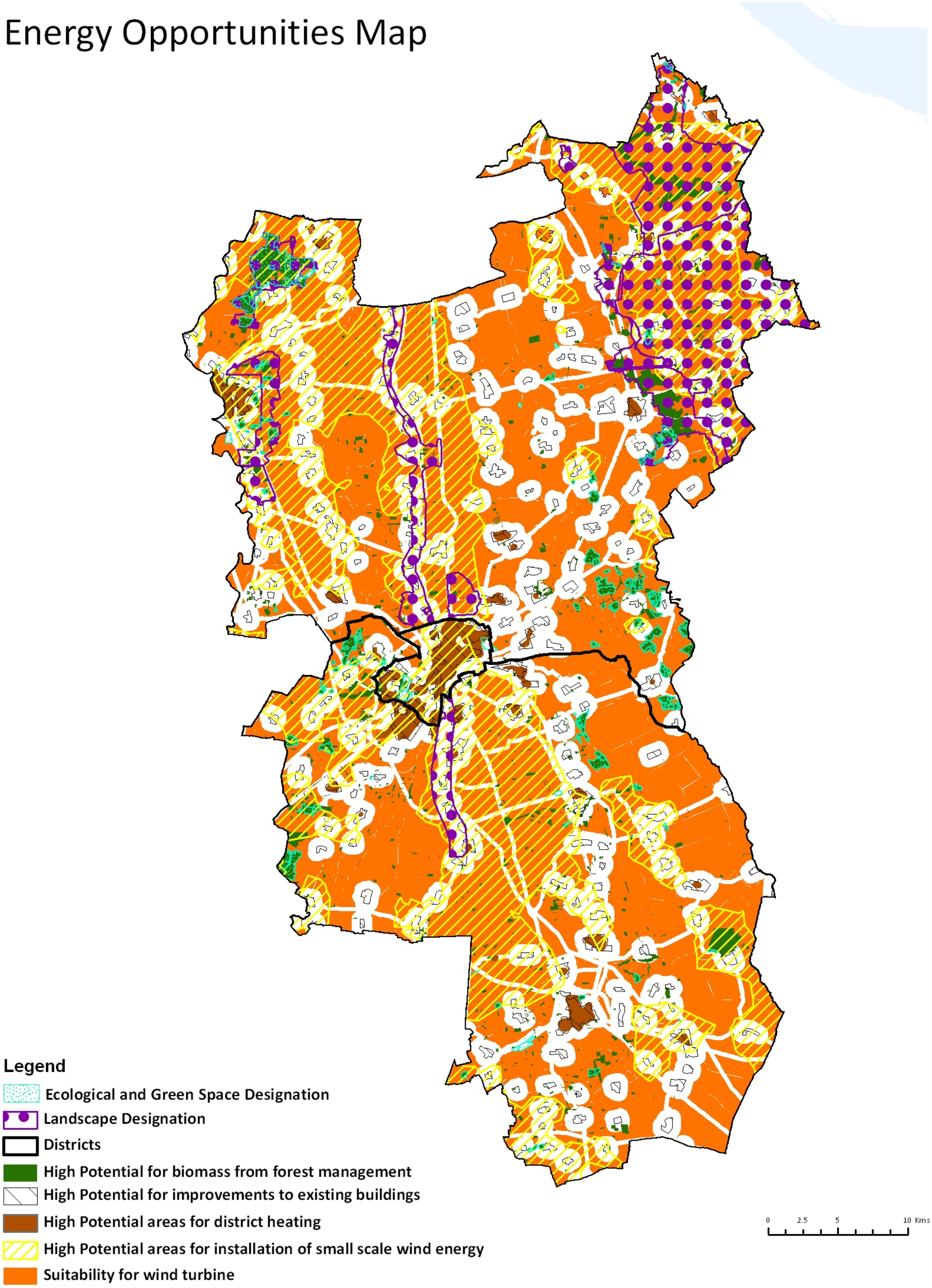


Note that potential CO_2 compliance bands are not shown for the leisure centre. Due to the variability in design and use, and the relatively small number of leisure buildings constructed as part of the non-domestic stock, a decision was taken not to examine these in the recent Government analysis.

APPENDIX C: A3 ENERGY OPPORTUNITY MAP

This appendix provides a larger version of the Energy Opportunities map/

Energy Opportunities Map



<Data Sources>