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South Downs National Park Renewable and Low Carbon Energy Study – Main Report

Prepared for the South Downs National Park Authority by AECOM

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Overview of the South Downs National Park

To fulfil its planning responsibilities, the South Downs National Park Authority (SNDPA) needs to develop policies, based on robust evidence, to restrict, promote and shape development in certain locations, protect the environment and support the vitality of communities. As such, the SDNPA is in the process of developing their Local Plan (proposed to cover the period to 2034). Supporting evidence of which this study forms a component will inform the SDNPA's approach and policies to reducing development related carbon emissions and delivering renewable and low carbon energy.

To develop these policies, the SDNPA needs to investigate the key building related carbon emission issues specific to the South Downs area. As such, they have set out a two phase study. The first phase, a scoping study of the key issues and recommendations for further work, was completed in August 2012[1]. It found:

- Binding legislative and regulatory drivers for reducing carbon emissions associated with the built environment which impact on the statutory duties of local planning authorities such as the SDNPA;
    - The Climate Change Act 2008 sets out a binding national target of reducing carbon emissions by 80% based on 1990 levels by 2050. Although this is a national target across all sectors, there is particular emphasis on reducing emissions associated with building performance and in energy generation/distribution as this makes up nearly 2/3 of total emissions. It is also recognised that this reduction can only be achieved with each level of administration taking action to reduce emissions across measures they can directly and indirectly influence.
    - There is a statutory duty on local planning authorities to take steps to address the effects of climate change through their plans and the NPPF makes provision for local authorities to support energy efficiency improvement measures and plan for low carbon and renewable energy technologies.
    - Changes to building regulations will require improvement in the performance of new buildings and it is expected that a future 'zero carbon policy' will provide a mechanism for developments that cannot reduce all regulated emissions from a development to pay for 'allowable solutions' to offset residual emissions. The allowable solutions would be managed in part by the local authority. In line with the Localism agenda, there is a focus on empowering local communities to implement renewable energy most appropriate for their circumstances.

[1] South Downs National Park Renewable and Low Carbon Energy Study – Scoping Report (AECOM, August 2012),

- There is some regional and local understanding of renewable and low carbon technology capacity potential in the area. This provides SDNPA with a valuable resource to build on and start to consider in developing its own policies.

In response to the legislative challenges and policy drivers; to fill in the gaps in knowledge across the sub-region and to capitalise on the lessons from elsewhere, the scoping study recommended further work which has been completed in this second stage to:

- **Establish an energy and carbon profile** for the South Downs National Park area. This will set the baseline energy demands and related carbon emissions from the existing building stock. See chapter 2
- Identify opportunities for **improving the energy performance of the existing building stock**. See chapter 3.
- Evaluate the **energy performance of new buildings** expected to be built within the Local Plan period, and review the potential to warrant improvement and the relative cost of carbon reduction targets more stringent than those proposed through planned revisions to Part L of the Building Regulations. See chapter 4.
- **Determining the potential and evaluating the appropriateness of strategic renewable and low carbon resources** in order to help develop policies that support low carbon energy supply whilst recognising the special nature of the South Downs landscape. See chapter 5.
- A **summary of key findings** is presented in chapter 6.

A summary of each of these chapters is provided below.

Chapter 2 Establish an energy and carbon profile

This section establishes a baseline position for the energy use and related carbon emissions within buildings in the South Downs National Park area. In addition, this section also seeks to forecast the energy use and associated carbon emissions related to future growth. It highlights that within the SDNP there is higher than average electricity, and where available, gas consumption. Furthermore, there are a significant number of properties off the national gas grid. These properties generally use more carbon intensive fuels to heat space and water. The energy demand from non-domestic buildings makes up about 27% of the energy demand in the SDNP. The table below illustrates that the buildings within the South Downs National Park use around 2,287GWh of energy. The generation of this energy, either supplied through the national grid or within buildings emits in the region of 675 thousand tonnes of carbon each year.

Table i: Total energy use in the South Downs

	Energy Use [MWh] (%)	Carbon Emission [tCO2/yr]
Total Domestic Energy Use	1,667,816 (73)	476,184
Total Non-domestic Energy Use	619,454 (27)	199,254
Total Energy Use	**2,287,271**	**675,438**

The graph below sets this baseline level of building energy related carbon emissions across the South Downs Local Plan period to 2034. It also highlights what an 80% reduction in building related energy emissions would look like based on 1990 levels by 2050 in line with the Climate Change Act. Taking into consideration progress towards the target that has already been made, and assuming that the SDNP has mirrored national progress[2], the SDNP would need to reduce the building energy related carbon emissions to 164751tCO_2/yr. To be on course to achieve this target by the end of the Local Plan period, building related carbon emission reductions would have to reach the '2034 Target'. The graph also shows the projected carbon savings from national priority projects.

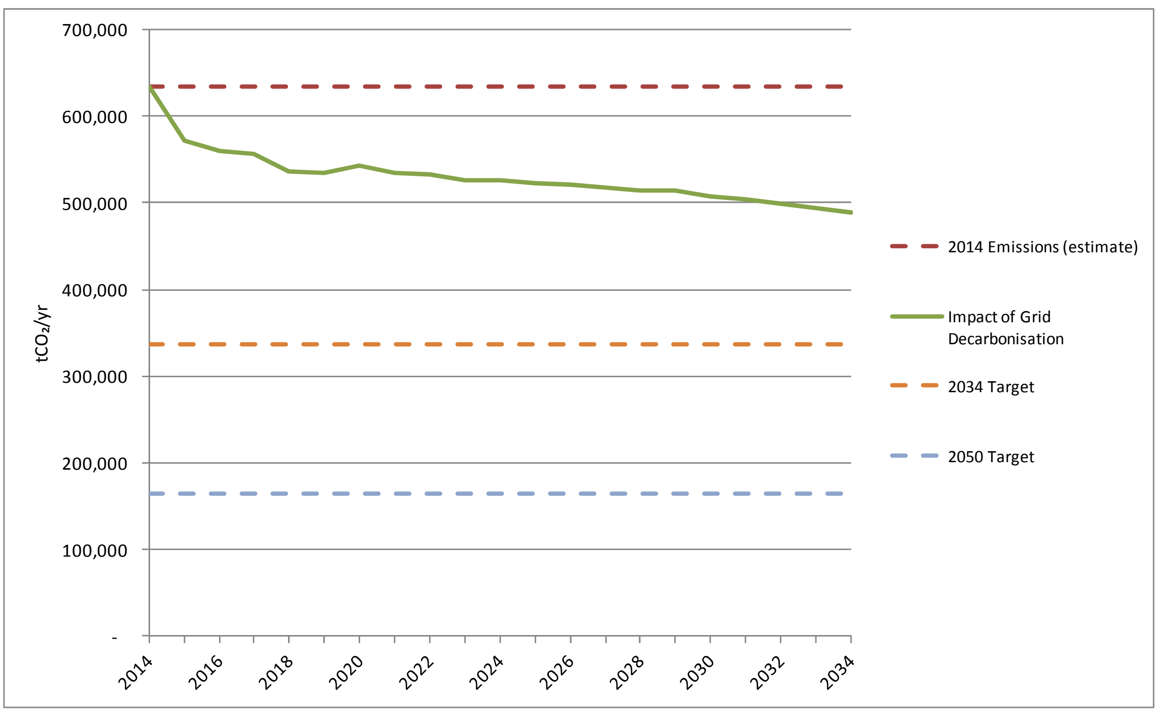

Figure i: 2012 baseline emissions and reduction targets

[2] DECC Annual Statement of Emissions for 2010 which stated that their 1st Carbon Budget target of 23% target reduction over 1990 levels was met

Chapter 3: Improving the energy performance of the existing building stock

There are approximately 60,500 homes in the South Downs National Park. The majority of these homes, around 60%, are outside of the main settlements of Lewes, Petersfield, Midhurst, Liss and Petworth. Furthermore, around 60%[3] of all housing comprises either detached or semi-detached properties. Rural, larger and older properties often experience higher heat losses. This is exacerbated by the fact that a significant number of properties, 19,535 homes, are off the gas-grid; which leads to increased heating requirements, resulting in higher carbon emissions, higher heating bills and putting more people at risk of fuel poverty.

This section appraises a variety of carbon reduction strategies. The carbon saving potential is illustrated in the table and graph below. Despite the significant potential carbon savings associated with building scale carbon reduction measures available, it still falls significantly short of the 2050 target. This challenge is further compounded by the fact that it is highly unlikely that this level of uptake of carbon reduction measures is deliverable; particularly on recent evidence of uptake rates, coordination of numerous small scale measures and potential cumulative impacts.

Table ii Carbon Saving Potential

Carbon reduction strategy	Total carbon saving potential from measure tCO_2/yr	Running carbon saving potential by 2034 tCO_2/yr
Baseline	675,438	675,438
National strategies to decarbonise the grid	186,140	489,298
Residential energy efficiency measures in the SDNP	50,024	439,274
Off grid fuel switching to Biomass	51,854	387,420
Non-domestic energy efficiency measures in the SDNP	21,018	366,402
Residential microgeneration measures in the SDNP	38,866	327,536
Non-Domestic microgeneration measures in the SDNP	32,405	295,131

[3] Draft South Downs National Park Authority State of the Park report 2012 (SDNPA 2012)

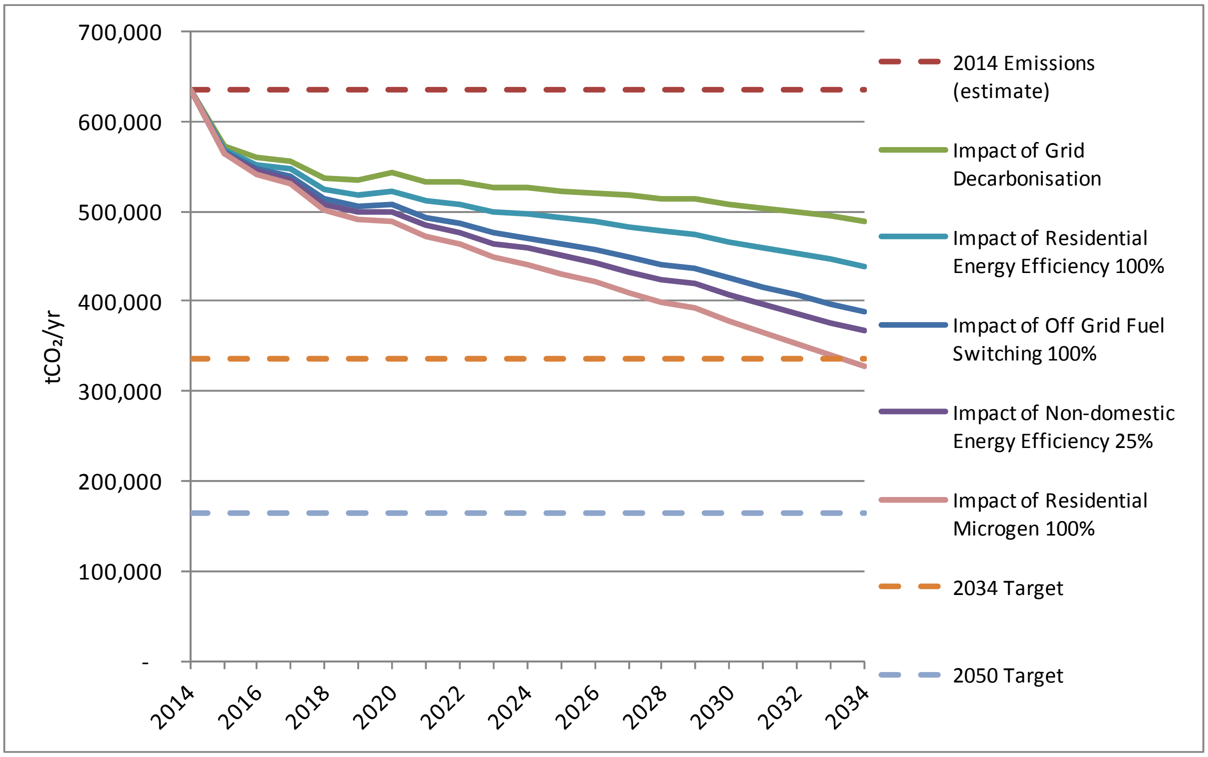

Figure ii: Additional predicted potential carbon savings from 100% uptake of microgeneration on residential properties

Chapter 4: The Energy Performance of New Buildings

The SDNPA currently do not have specific domestic and non-domestic development growth targets. The South Downs National Park Housing Requirements Study (2011) does however highlight the need for greater supply of affordable family housing. To meet this need based upon a mix of 50% affordable housing and 50% market housings would require 380 homes per annum to be built. Achieving this level of growth is, however, likely to be challenging given that historic build out rate since 2010 equates to around 250 homes per annum. To estimate the additional energy demand and associated carbon emissions resulting from this new housing it has been assumed that this trend will continue. The mix of dwelling types has also been assumed to remain similar to the current housing mix of 45% detached, 40% semi-detached, 10% terraced and 5% apartments and that the energy performance of these new buildings meets the expected carbon compliance standards proposed for the 2016 revision to Part L of the Building Regulations.

The South Downs National Park Employment Land Review (2012) highlights that there is sufficient employment land available and that there is unlikely to be significant demand for new non-domestic development. As such, it has been assumed that there will be no net increase in non-domestic buildings. Any improvement to the energy performance of non-domestic buildings over the local plan period is captured in the next chapter which looks at potential efficiency improvements. The graph below shows that the anticipated increase in carbon emissions associated with future growth is minimal, c13,053 tonnes.

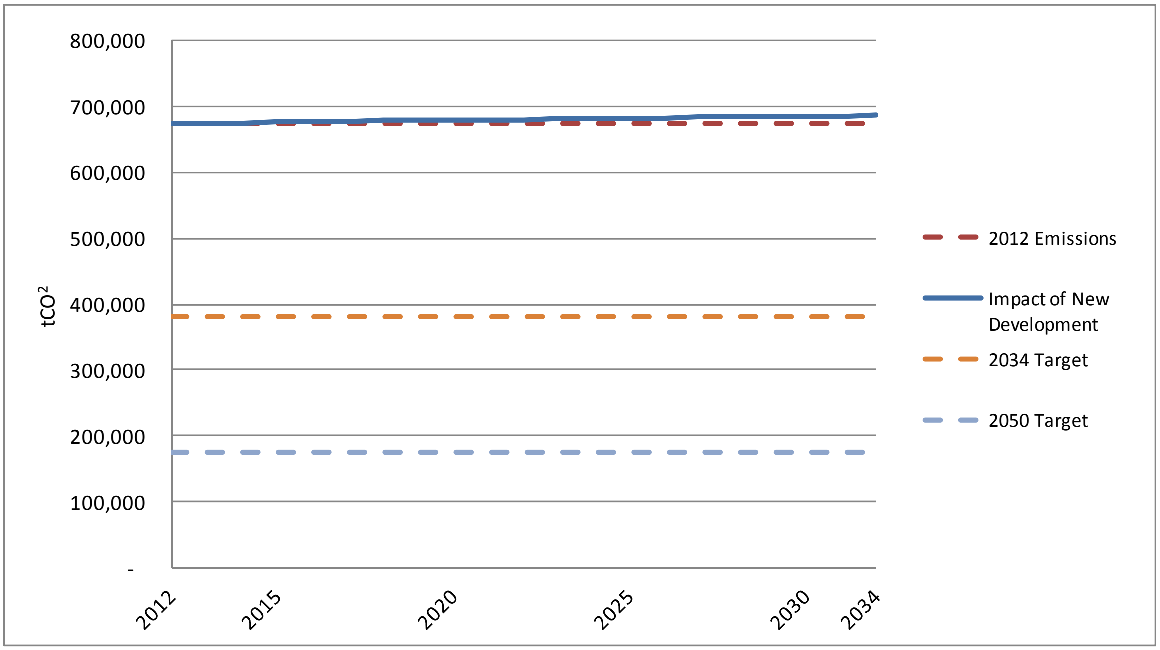

Figure iii: increase emissions due to new development

This chapter also appraises the cost benefit of proposed changes to Part L of Building Regulations or reaching different levels of the Code for Sustainable Homes or BREEAM. It highlights that given the proposed changes to Building Regulations Part L, the anticipated zero carbon policy and the additional cost associated with meeting higher levels of Code/BREEAM, it would be difficult for the SDNPA to justify a carbon reduction target significantly higher than that proposed by Building Regulations. More cost efficient carbon savings should be sought through the development of locally defined allowable solutions to work in conjunction with the Green Deal.

Chapter 5: Determining the potential and appropriateness of strategic renewable and low carbon technologies

Once opportunities for demand reduction are exhausted, further carbon reduction can only be achieved through lowering the carbon content within the energy supply. At present current installed capacity of renewable and low carbon technology in the SDNP is a minimal 5.6MWh. This section therefore draws on DECC's Renewable and Low-carbon Energy Capacity Methodology for the English Regions (2010) to estimate the total theoretical potential for low carbon and renewable energy supply drawn from resources within the South Downs National Park.

It highlighted that the SDNP is rich in renewable and low carbon resources. Wind resources could theoretically deliver 4,351,092MWh of electricity (twice the total electricity demand in the South Downs) and biomass could theoretically deliver 210,087MWh of heating. However, it is the natural resources of the National Park with the potential to generate renewable energy that also contribute to its special character. An indiscriminate approach to delivering renewable and low carbon infrastructure would damage this special character and as such, a more sophisticated approach of identifying suitable areas and approaches needs to be adopted in planning policy and the SDPN management plan.

Chapter 6: Summary of Key Issues for the National Park Management Plan and Local Plan

This chapter sets out key issues for the SDNPA to consider in developing the National Park Management Plan and Local Plan:

To improve the performance of the existing building stock the SDNPA should:

- Establish an approach to attracting Green Deal funding, perhaps in collaboration with emerging procurement arrangements with West Sussex County Council. Focus for retrofit should be on off grid properties.
- Seek to leverage ECO or other funding (perhaps through Allowable Solutions) to target harder to reach measures to deliver alongside Green Deal.
- Develop a 'consequential improvements' policy to require property owners seeking to extend their property to make additional energy efficiency improvements to the rest of their property.
- Review the position on microgeneration to actively support uptake, for example on large warehouses, but to limit it in more sensitive locations. This might need to be through an Article 4 directive to alter permitted development rights.

In considering policies for new development the SDNPA should consider that:

- Given the proposed changes to Building Regulations Part L, the anticipated zero carbon policy and the additional cost associated with meeting high levels of the Code for Sustainable Homes, it would be difficult for the SDNPA to justify a carbon reduction target significantly higher than that proposed by Building Regulations. More cost efficient carbon savings should be sought through the development of locally defined Allowable Solutions to work in conjunction with the Green Deal.

To support the development of appropriate strategic renewable infrastructure the SDNPA should:

- Develop a robust policy position on the types and locations where renewable energy developments may be appropriate, taking into consideration a full landscape and visual impact assessment as well as public consultation.
- Support the development of the biomass / woodfuel market. Although woodfuel is potentially plentiful, both the supply side and demand side of the market need to be supported. Furthermore, it is important that in the development of the woodfuel market the wider services that woodlands provide are not damaged and, where possible, enhanced; these include water management,

biodiversity, recreation and wider ecosystem services. As such, to encourage the uptake of woodfuel the SDNPA should consider:

- Working with land owners and the Forestry Commission to bring more woodland in to active management for wood fuel.
- Support for the uptake of woodfuel heating within new developments, off grid properties, publically owned and large institutional buildings and where possible wider heating networks. In particular, the SDNPA should investigate opportunities for working with the large rural estates as they are in single ownership and often off the national gas grid.

Background to the study

1 Background to the Study

1.1 Overview of the South Downs National Park

Covering an area of 1,653 km^2 (618 $miles^2$) of unique and biodiverse landscape of southern England, the South Downs National Park (SDNP) is the newest of the UK's 15 National Parks. Building on its recognised status as an Area of Outstanding Natural Beauty, the South Downs' designation as a National Park affords this special area further protection through the 1995 Environment Act. As such, as the administering body the SDNP Authority (SDNPA) primary purposes are to:

- conserve and enhance the natural beauty, wildlife and cultural heritage of the area, and
- promote opportunities for the understanding and enjoyment of the Park's special qualities by the public.

In addition to the high quality environment, the SDNP is home to around 110,000 people distributed across a multitude of communities including the market towns of Lewis, Petersfield and Midhurst and numerous attractive villages, hamlets and farmsteads. As such, the SDNPA also has a duty:

- to seek to foster the economic and social well-being of the communities living within the National Park

By shaping the future of development, planning has a central role to play in balancing these priorities. On formation, the SDNPA became the statutory Planning Authority for the National Park area. In performing this role, the SDNPA will have to work closely with the 15 authorities (11 local authorities, one unitary authority and three county councils – see figure 1) that fall in part within the Park boundary. The SDNPA and Local Authorities have therefore established a unique partnership with 11 of those authorities whereby the Local Planning Authorities (LPAs) will maintain responsibility for day to day processing and determination of the great majority of all planning applications, whilst the SDNPA will focus on more significant development that might have an impact on the unique nature of the Park. For the other 4 LPAs (Arun, Brighton and Hove, Eastbourne and Wealden), all planning applications in the Park are dealt with by the SDNPA directly.

Figure 1: South Downs National Park Overview Plan.

Legend
District Boundary
South Downs National Park

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1.2 Scoping renewable energy and carbon reduction opportunities in the South Downs

To fulfil its planning responsibilities, the South Downs National Park Authority (SNDPA) needs to develop policies, based on robust evidence, to restrict, promote and shape development in certain locations, protect the environment and support the vitality of communities. As such, the SDNPA is in the process of developing their Local Plan (proposed to cover the period to 2034). Supporting evidence of which this study forms a component, will inform the SDNPA's approach and policies to reducing development related carbon emissions and delivering renewable and low carbon energy.

To develop these policies, the SDNPA needs to investigate the key building related carbon emission issues specific to the South Downs area. As such, they have set out a two phase study. The first phase, a scoping study of the key issues and recommendations for further work, was completed in August 2012[4]. It found:

- Binding legislative and regulatory drivers for reducing carbon emissions associated with the built environment which impact on the statutory duties of local planning authorities such as the SDNPA;

    - The Climate Change Act 2008 sets out a binding national target of reducing carbon emissions by 80% based on 1990 levels by 2050. Although this is a national target across all sectors, there is particular emphasis on reducing emissions associated with building performance and in energy generation/distribution as this makes up nearly 2/3 of total emissions. It is also recognised that this reduction can only be achieved with each level of administration taking action to reduce emissions across measures they can directly and indirectly influence.

    - There is a statutory duty on local planning authorities to take steps to address the effects of climate change through their plans and the NPPF makes provision for local authorities to support energy efficiency improvement measures and plan for low carbon and renewable energy technologies.

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[4] South Downs National Park Renewable and Low Carbon Energy Study – Scoping Report (AECOM, August 2012),

- There is some regional and local understanding of renewable and low carbon technology capacity potential in the area. This provides SDNP with a valuable resource to build on and start to consider in developing its own policies.

- Lessons from other National Parks highlight that they play an important role in implementing climate change mitigation and adaptation measures.

    - Taking a leadership role in retrofitting their own properties and in facilitating the delivery of energy schemes are two ways that National Park Authorities can work towards reducing their environmental impact. They are also well placed to promote low carbon and renewable energy sources as effective alternatives. This is especially important for district heating networks that require an investment in infrastructure.

    - Retrofitting existing housing stock to be more energy efficient. This is often particularly important due to the nature of the existing housing stock in National Parks which are often older, larger and rural (frequently offgrid) which negatively impacts their energy performance.

    - Establishing partnerships with local organisations is essential to capitalising on the potential for low carbon and renewable energy schemes. As with many partnerships, establishing what benefits the National Park can offer potential partners has been cited as an important component to enticing organisations to work with National Park authorities.

    - Education and promotion of low carbon and renewable energy is another important role for National Parks. Delivering on the potential for these technologies in National Parks requires community involvement. Parks that have been successful in delivering these schemes have an active and engaged community on whom they can rely. Fostering this type of community begins with education and promotion.

    - Where possible, energy schemes should look to benefit the community financially. Establishing an industrial and provident society can be challenging, but its profits can enable investment in additional renewable energy schemes.

    - An open approach to planning is important. While large scale low carbon and renewable energy schemes may not be appropriate to all areas, capitalising on a National Park's renewable resource without sacrificing their landscape obligations is critical to reducing carbon emissions. For example, some National Park Authorities that do not support large scale wind turbines believe that small wind turbines should be standard on all farmsteads. Experience in Wales suggests that appropriate landscapes might exist even in National

Parks; the National Park authorities should not reject these applications without consideration.

In response to the legislative challenges and policy drivers; to fill in the gaps in knowledge across the sub-region and to capitalise on the lessons from elsewhere, the scoping study recommended further work which has been completed in this second stage to:

- **Establish an energy and carbon profile** for the South Downs National Park area. This will set the baseline energy demands and related carbon emissions from the existing building stock. See chapter 2
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- **Determining the potential and evaluating the appropriateness of strategic renewable and low carbon resources** in order to help develop policies that supports low carbon energy supply whilst recognising the special nature of the South Downs landscape. See chapter 5.
- A **summary of key findings and next steps** is presented in chapter 6.

Establishing an Energy and Carbon Profile for the SDNP

2 Establishing an Energy and Carbon Profile for the SDNP

2.1 Introduction to building related energy

This section establishes a baseline position for the energy use and related carbon emissions within buildings in the South Downs National Park area. This will help assess the scale of the carbon reduction challenge, and provides the basis from which the impact of future carbon reduction measures can be measured. Two forms of energy are generally used within buildings: heat and electricity. Heat is used to warm spaces and water as well as for cooking. Electricity is used to power appliances, lights and also can be used for heating. There are a number of different fuels used to supply both heat and electricity. Each of these different fuels provides energy with varying levels of efficiency and, for those fuels that are burnt, to generate either heat or electricity, they emit varying degrees of carbon dioxide and other greenhouse gases. As such, understanding the type of fuel used, how much energy is generated and how efficiently it is generating that energy, it is possible to work out the associated carbon emissions.

This section also seeks to forecast the energy use and associated carbon emissions related to future growth.

Energy use is measured in watts per hour (Wh). That is the amount of power (in watts (W)) expended for one hour (h) of time. The energy used in buildings is generally expressed in kilowatt hours (kWh). Each kWh equals 1,000Wh.

2.2 Energy Performance of existing residential buildings

Grid Supplied Properties

For the vast majority of buildings, electricity is supplied via the national electricity grid. The national electricity grid is powered by numerous ways, including burning natural gas (contribution to grid - 40.7%), coal (29.2%), nuclear (19.1%) and renewable sources (9.2%). Similarly, most buildings are on the national gas grid which supplies natural gas to be burnt within buildings for heating.

Table 1: Average energy consumption in kWh per residential consumer (DECC, 2010)

	South Downs Local Plan Area	South East	UK
Electricity (kWh)	5,516	4,659	4,360
Gas (kWh)	14,877	15,382	15,156
Total	20,393	20,041	19,516

The table above highlights that residential properties in the South Downs National Park area generally used more energy per metre than elsewhere in the South East or wider UK. This is particularly true for electrical energy which is considerably higher than elsewhere. This is most likely due to the fact that, as a rural area, a significant proportion of properties are not connected to the gas grid and are likely to be using electricity for some heating (see next section). Alternatively, this indicates that more electrical appliances are being used within homes than elsewhere. Surprisingly however, gas consumption is lower in the South Downs National Park Area. Usually in low density areas such as the South Downs it would be expected that gas consumption is slightly higher. This is because buildings in denser areas often have connecting walls and therefore experience reduced heat loss. The figures above, however, suggest that where gas is used in the South Downs, it is used relatively efficiently. Furthermore, as significant areas are off the gas grid, gas consumption is going to be used more in the built up areas only, correlating with the theory that buildings in denser areas lose less heat.

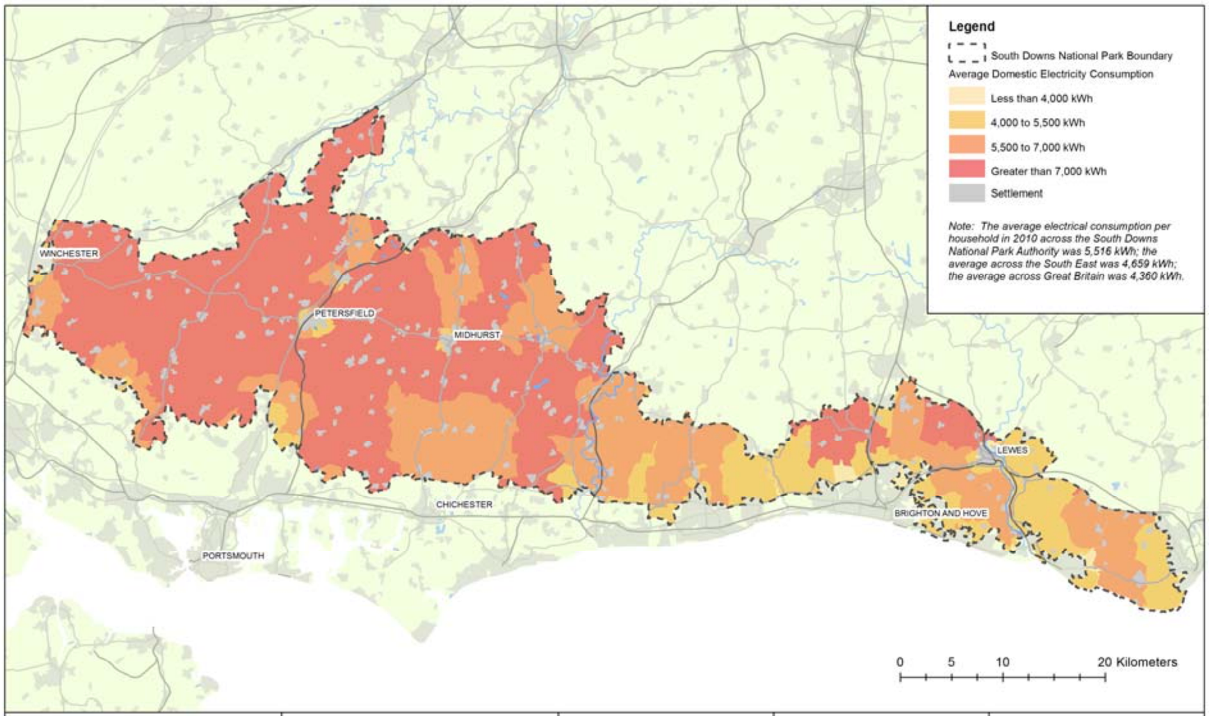

Figure 1: Average domestic electric use by LLSOA (DECC, 2010)

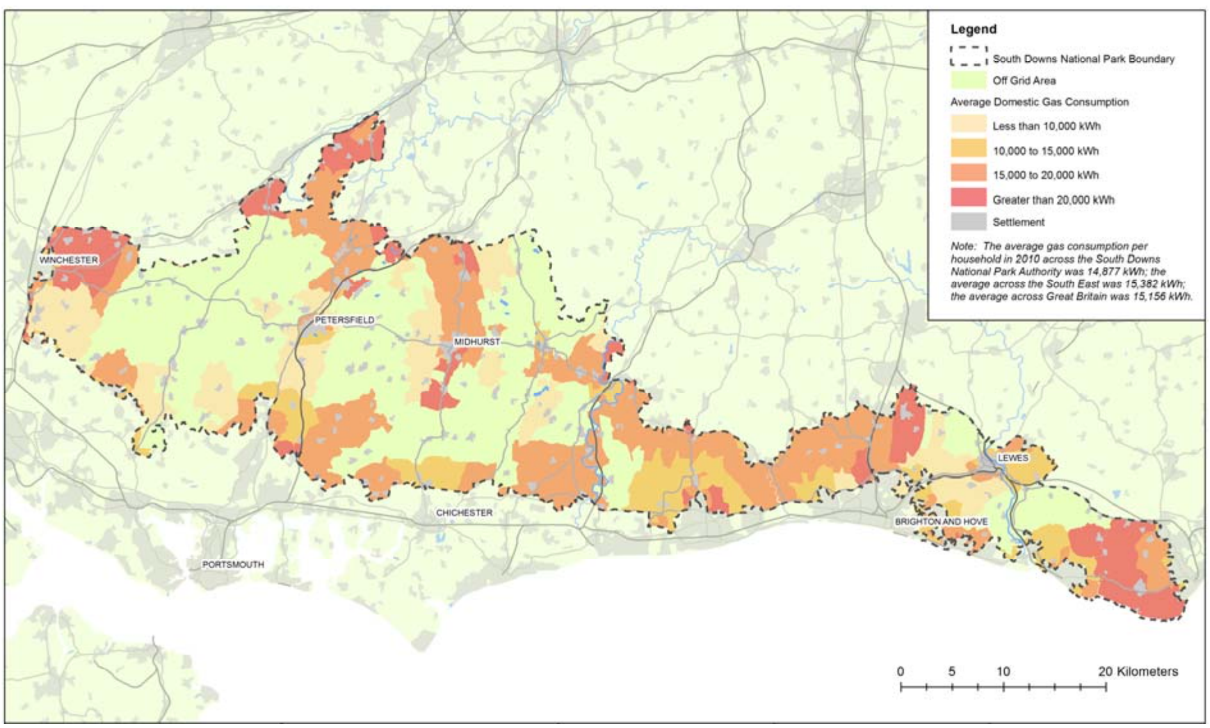

Figure 2: Average domestic gas use by LLSOA (DECC, 2010)

Off Grid Properties

Although nearly all houses are connected to the electricity grid, the cost associated with laying gas pipelines in rural areas means that nearly one third (19,535) of the c60,500[5] households within the South Downs National Park Area are off the national gas grid[6].

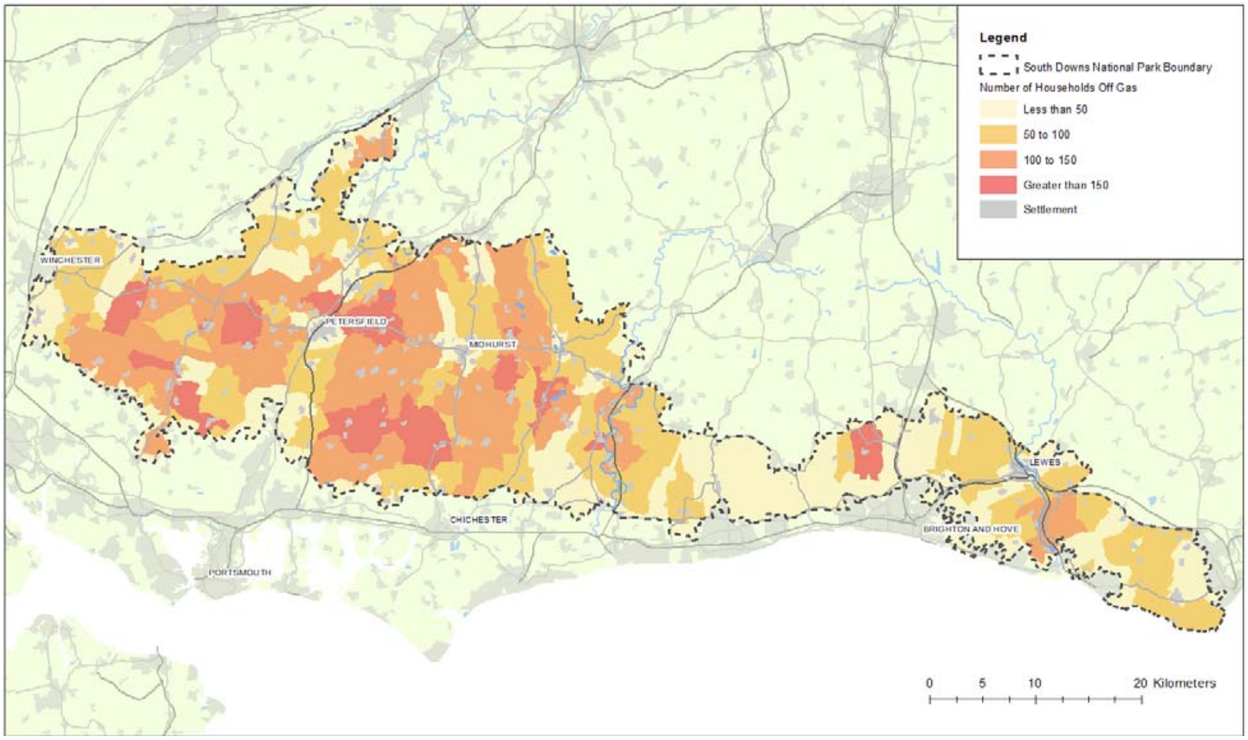

Figure 3: Number of households off the gas grid

Off grid properties use a variety of fuel sources for heating. DECC record the total domestic use of coal, manufactured fuel (coke), petroleum (LPG) per Local Authority area. By knowing the total number of properties that are 'off grid' for each local authority area, the average domestic energy consumption per 'off grid' property was calculated for the South Downs National Park. The proportion of electrical energy used for heating has been derived from the total electrical consumption from 'Economy 7'[7] within offgrid areas.

Table 2: Energy use by fuel type for 'off grid' properties across the SDNPA

	Coal [MWh]	Manufactured Solid Fuel [MWh]	Petroleum [MWh]	Electricity [MWh]
Off Grid Households	25,972	21,201	167,593	146,210

5 Based on the Census Output Areas that are more than 50% within the South Downs National Park boundary.
6 Defined as 'Hard to Treat Homes' by the Centre for Sustainable Energy, 2003
7 DECC Total Sub National Final Energy Consumption 2005 to 2009

Increasingly wood fuel is being used as a heating fuel source. As will be discussed in chapter 5, there is considerable opportunity for increasing the number of homes heated through woodfuel, however to date statistics as to how much woodfuel is currently being used for heating is limited. Although it is understood that several estates and larger buildings, such as Stansted Park and some schools use biomass boilers, current uptake is likely to be a small proportion of the overall energy use and, as wood fuel is considered net-zero carbon, it has not been included here.

Relative Carbon Emissions

The total domestic energy consumption across the South Downs National Park Authority is therefore:

Table 3: Total domestic energy use by fuel type across the SDNPA

	Energy Use [MWh] (%)	Carbon Factor [tCO2 per MWh][8]	Carbon Emission [tCO2] (%)
Coal[9]	25,972 (1.6)	0.34021	8,836 (2)
Manufactured Solid Fuel[10]	21,201 (1.3)	0.33307	7,061 (1)
Petroleum[11]	167,593 (10)	0.21455	35,957 (7)
Natural Gas	989,959 (59)	0.18521	183,350 (39)
Electricity [Heating]	146,210 (8.8)	0.52037	76,083 (16)
Electricity [Lighting & Appliances]	316,881 (19)	0.52037	164,895 (35)
Total	**1,667,816**	**-**	**476,184**

[8] 2012 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting
[9] Coal [Domestic]
[10] Petroleum Coke
[11] Petroleum based products including LPG and kerosene heating oil

2.3 Current energy demand of existing non-domestic buildings

Grid connected properties

Although DECC's Sub National Energy Consumption Statistics report on the total electrical and natural gas use [kWh] for non domestic properties, establishing the use within the South Downs National Park is more difficult to establish than for domestic properties. This is because DECC report energy use for non-domestic properties at a large Middle Layer Super Output Areas[12] (MLSOA) scale. As a number of MLSOAs transect the South Downs National Park Boundary the energy consumption data are likely to represent an over estimation of energy demand. The table below provides an overview of electrical energy use and energy from gas supplied by the national grid.

Table 4: Total non domestic energy use by fuel type across the SDNPA

	Energy Use [MWh]	**Carbon Factor [tCO2 per MWh][13]**	**Carbon Emission [tCO2]**
Natural Gas	367,262	0.18521	68,021
Electricity	252,192	0.52037	131,233
Total	**619,454**	**-**	**199,254**

[12] Middle Layer Super Output Areas is a geographical area used for statistical analysis and comprising of around 2,000 to 6,000 homes
[13] 2012 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting

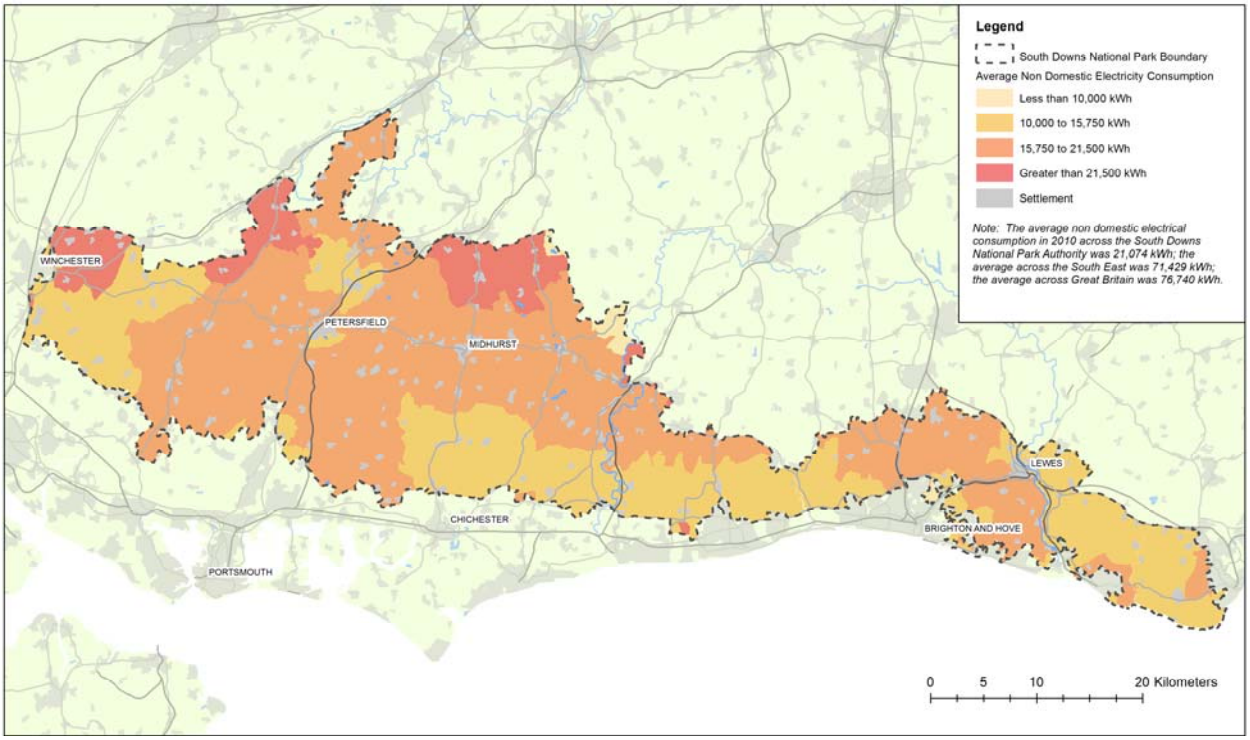

Figure 4: Average electricity use by non-domestic customer (DECC, 2010)

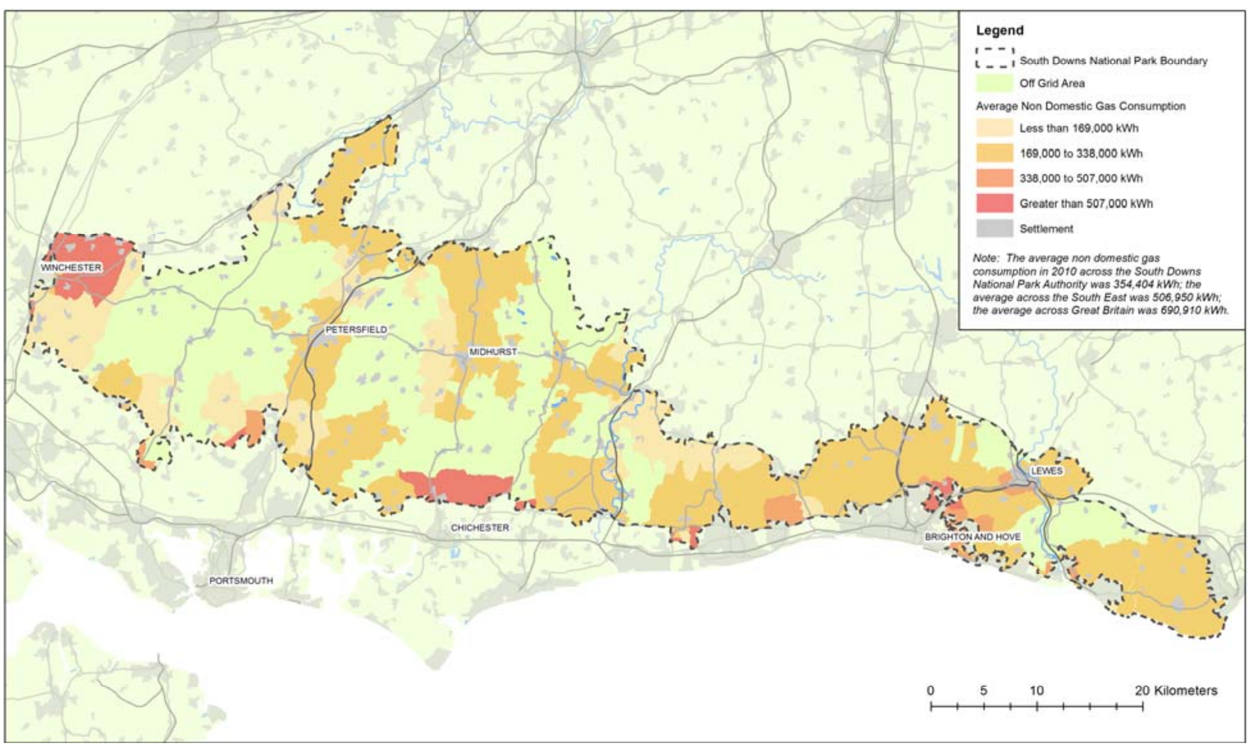

Figure 5: Average gas use by non-domestic customer (DECC, 2010)

Off grid properties

The energy consumption data for other fuels used by non domestic properties as reported in DECC Total Sub National Final Energy Consumption (2009), including coal, manufactured solid fuels, and petroleum products is reported at a local authority area only. Unlike domestic properties where information can be cross referenced with off grid data and proportionally allocated, this is not possible for non-domestic properties as it is not possible to ascertain the number or nature of offgrid non-domestic properties. Looking across the total mix of fuel sources across all the Local Authorities that transect the National Park shows that other fuels account for just over a quarter of energy use. The vast majority of this is made up of petroleum based fuels such as LPG.

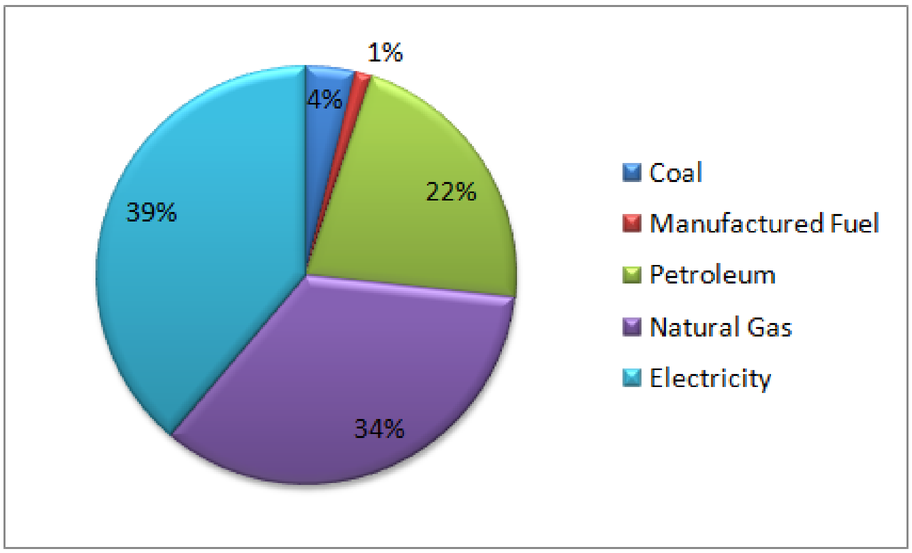

Figure 6: Proportion of energy consumption across all districts that intersect the SDNAP

2.4 Total current energy use

Notwithstanding the limitations highlighted above for non-domestic energy use data; the buildings within the South Downs National Park use around 2,287GWh of energy. The generation of this energy, either supplied through the national grid or within buildings emits in the region of 675 thousand tonnes of carbon each year.

Table 5: Total energy use in the South Downs

	Energy Use [MWh] (%)	Carbon Emission [tCO2/yr]
Total Domestic Energy Use	1,667,816 (73)	476,184
Total Non-domestic Energy Use	619,454 (27)	199,254
Total Energy Use	**2,287,271**	**675,438**

The graph below sets this baseline level of building energy related carbon emissions across the South Downs Local Plan period to 2034. It also highlights what an 80% reduction in building related energy emissions would look like based on 1990 levels by 2050 in line with the Climate Change Act. Taking into consideration progress towards the target that has already been made, and assuming that the SDNP has mirrored national progress[14], the SDNP would need to reduce the building energy related carbon emissions to 164751tCO_2/yr. To be on course to achieve this target by the end of the Local Plan period, building related carbon emission reductions would have to reach the '2034 Target'.

[14] DECC Annual Statement of Emissions for 2010 which stated that their 1st Carbon Budget target of 23% target reduction over 1990 levels was met

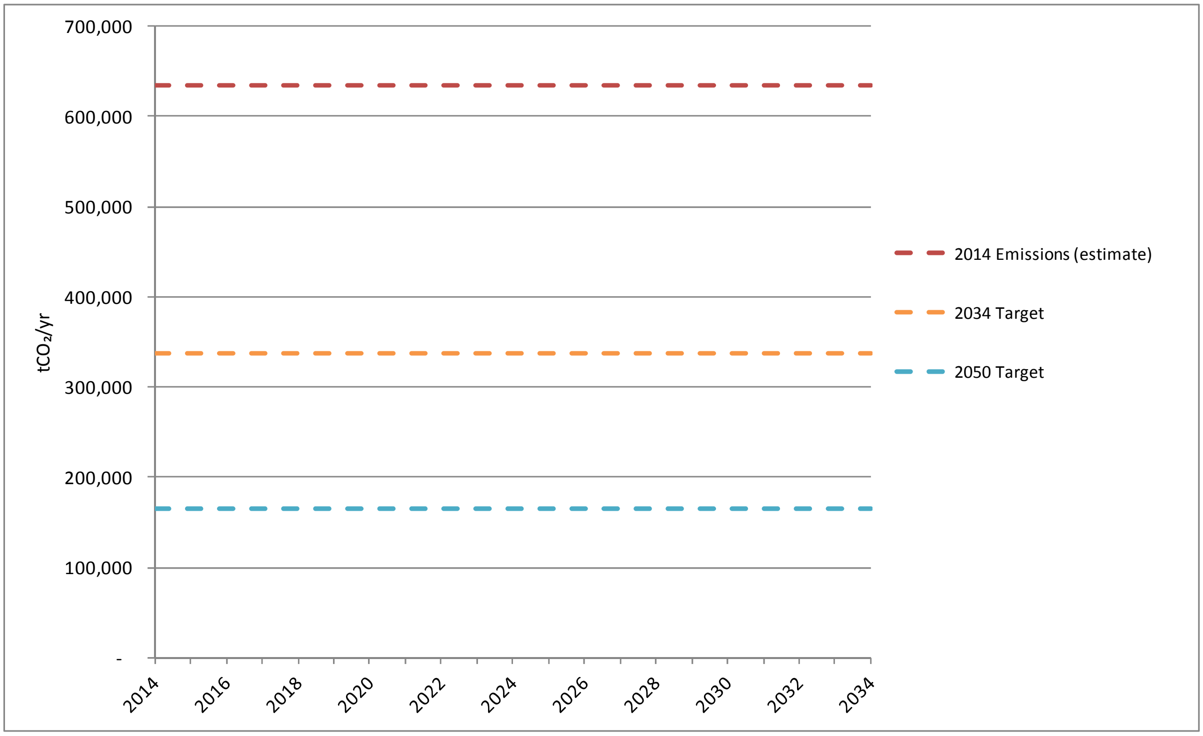

Figure 7: 2012 baseline emissions and reduction targets

2.5 National strategies to decarbonise the grid

Over the period to 2032 the DECC predict that the carbon intensity of the electricity grid to reduce as the electricity generation switches from existing fossil fuel power stations (particularly the planned closure of existing coal-fired power stations) to low and zero carbon energy generation (including renewables, new nuclear power plants and gas power plants including ones with carbon capture and storage). The gas grid mix is assumed to remain relatively constant to 2032, though increased use of liquefied natural gas may slightly increase the carbon intensity associated with gas consumption.

The impact of the decarbonisation of the electricity grid on CO_2 emissions from buildings in the SDNPA has been estimated using projected electricity carbon emission factors. A series of future carbon emission factors were calculated by AECOM based on the total expected UK power generating mix.

In the document 'Updated energy and emissions projections 2011'[15], DECC provides predictions for a range of scenarios for the UK generating mix for the period to 2030. The electricity emissions factors used have been based upon DECC's 'Baseline' scenario which takes into account central price and growth assumptions but only policies that existed before the UK's Low Carbon Transition Plan and assumes the generation mix illustrated in figure 8. It has been chosen as the scenario illustrated in this report as it provides a more conservative set of assumptions than the other scenarios tested. It assumes that the carbon intensity of the grid will decrease by around 30% compared to 2012 levels.

[15] DECC Updated energy and emission projections (baseline case projections), October 2011 – for years 2011-2030;

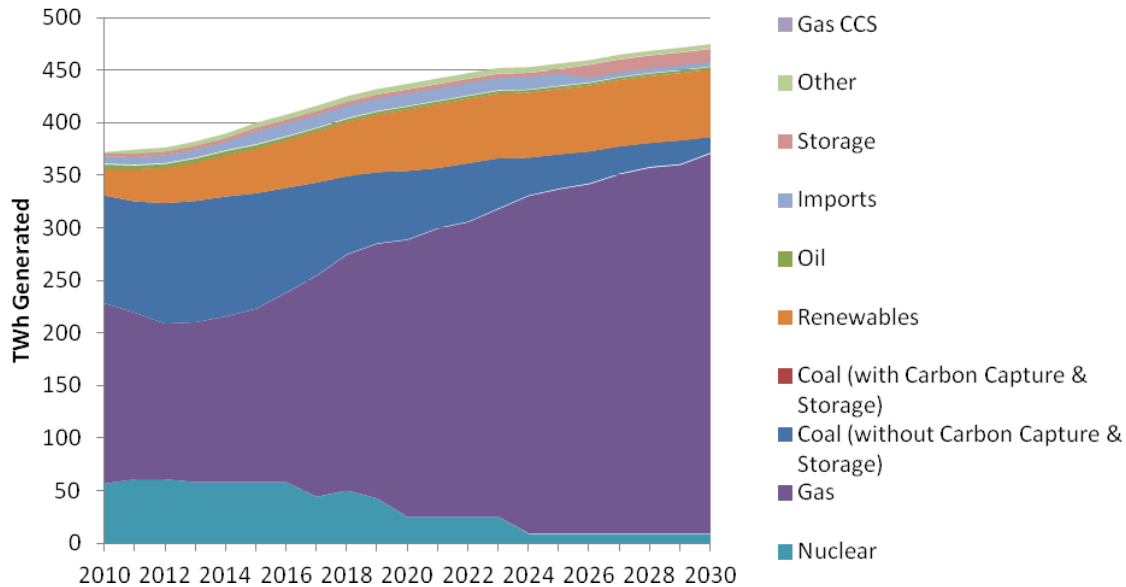

Figure 8: Electricity generation by plant type assumed under DECC Baseline scenario

To calculate emission factors from the DECC 'Updated energy and emissions projections 2011' the TWh of electricity generated were converted to fuel used using DUKES power station efficiency data (including 7% losses associated with transmission and distribution) and converted to carbon emissions equivalent using the DEFRA / DECC CO_2 emission factors for coal, gas and oil[16][17]. The average emissions factor was then calculated based on the weighted average emission factors of the fossil fuel of all the plant predicted to be built. This included renewables as well as gas.

It should be noted that projections of future decarbonisation of the grid are very uncertain and dependent upon national government policy, so should be treated with caution and reviewed over the period covered by this study, particularly as the ability to achieve local carbon reduction targets is significantly influenced by grid decarbonisation. However, recently the government's Gas Generation Strategy (2012) has suggested even more optimistic figures for grid decarbonisation in the short-medium term.

The graph below highlights that national strategies for grid decarbonisation could make a significant reduction on the projected carbon emissions associated with building energy within the South Downs National Park.; taking the National Park nearly halfway to the 2034 target.

[16] Gas emission factors have also been based on the DECC Local and Regional CO_2 Emissions Estimates factors. DEFRA / DECC's GHG Conversion Factors for Company Reporting, April 2012;

[17] Emission factors used by AEA in the DECC Local and Regional CO_2 Emissions Estimates for 2005-2010, August 2012, for the years 2005-2010.

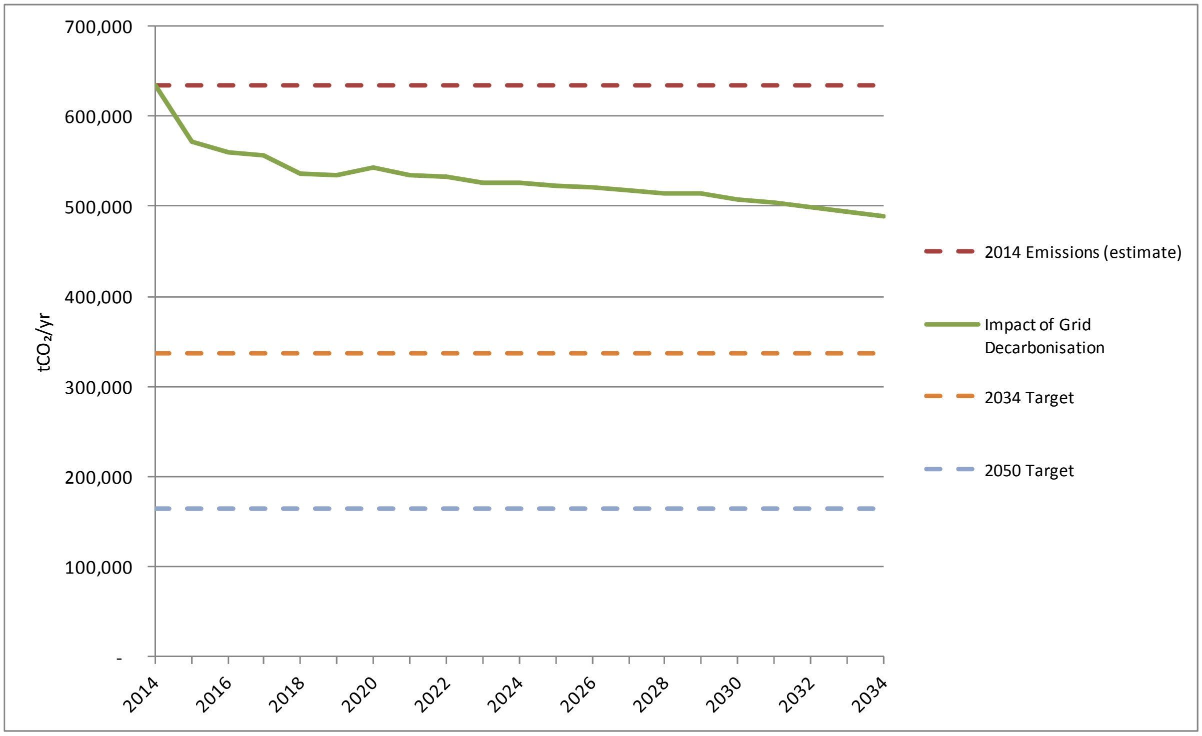

Figure 9: the impact of grid decarbonisation on carbon emissions in the South Downs National Park

2.6 Key findings from this chapter

- The total energy use is approximately 2,287,271MWh generating 675,438tCO2 per year.
- Domestic energy accounts for 73% of all the energy use and 70% of carbon emissions.
- Around 65% of carbon emissions from homes is related to residential heating (space and water), with the remaining 35% from electricity use for appliances. Improving the thermal performance of residential properties is therefore a priority.
- 41% of the emissions of residential heating emissions are from off grid properties, which make up only 32% of the total number of homes. Improving these properties is therefore a priority.
- Although grid decarbonisation will make a significant step in carbon reduction, it will not be sufficient to meet 2034 and 2050 reduction targets. As most buildings will remain by 2035, it is important that local measures to improve the efficiency of the existing building stock are realised.

Improving the Energy Performance of the Existing Building Stock

3. Improving the Energy Performance of the Existing Building Stock

3.1 Overview of key Issue

The carbon profile illustrated in the previous section highlights that the vast majority of building related carbon emissions are associated with the existing building stock, and predominantly from residential properties. This section therefore examines opportunities to improve the energy performance of the existing building stock.

Improving the energy efficiency of the existing stock will not only have a significant impact on carbon reduction, but will also deliver important social benefits by alleviating the effects of fuel poverty and raising the living standards of people living in hard to treat homes.

3.2 Profile of existing residential buildings

There are approximately 60,500 homes in the South Downs National Park. The majority of these homes, around 60%, are outside of the main settlements of Lewes, Petersfield, Midhurst, Liss, Petworth. Furthermore, around 60%[18] of all housing are either detached or semi-detached properties. Rural, larger and older properties often experience higher heat losses. This is exacerbated by the fact that a significant number of properties are off the gas-grid, which leads to increased heating requirements, resulting in higher carbon emissions, higher heating bills and putting more people at risk of 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[19] 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. As the map below shows, large areas of the National Park have 15% or more of people living in fuel poverty.

[18] Draft South Downs National Park Authority State of the Park report 2012 (SDNPA 2012)

[19] 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). This score can then be converted into a rating from A-G used for housing performance certificates.

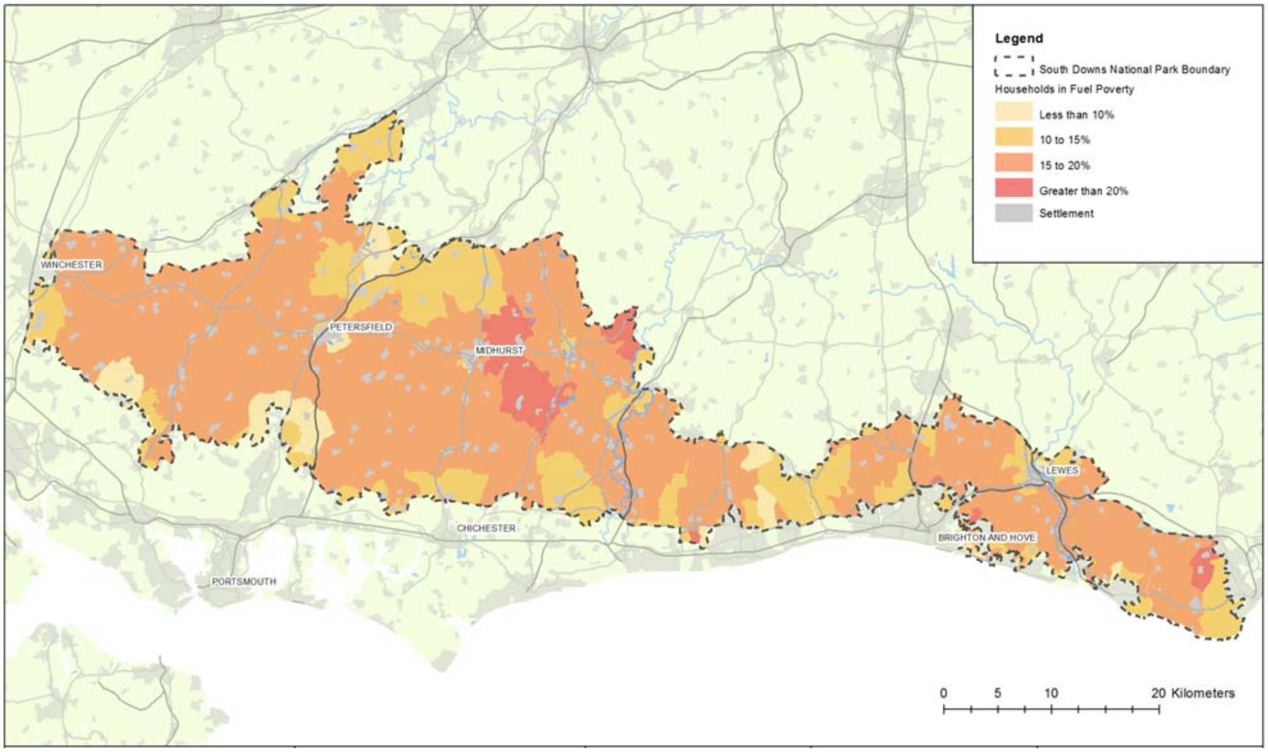

Figure 10: Fuel Poverty across the South Downs National Park

3.3 Energy Efficiency Potential - residential buildings

Analysis of the Homes Energy Efficiency Database (HEED) managed by the Energy Saving Trust currently provides the most comprehensive overview of the state of the existing building stock and opportunities for different types of retrofit energy efficiency measures. Although it is acknowledged that, given the complexity of the data, there will inevitably be some limitations and inaccuracies in the data it remains endorsed by DECC. The table below sets out an overview of the key findings from analysing HEED. It shows the estimated number of homes that require different types of retrofit measure as well as the relative estimated carbon savings and cost of installing these measures across all these properties, based on benchmark data. AECOM is aware, however, that HEED data has historically underestimated the potential for cavity wall and loft insulation. These findings are supported by West Sussex County Council, who is currently undertaking more detailed assessment of their existing stock and the potential for various energy efficiency measures. As such, there may be additional opportunities and the findings below should be considered a low estimate.

Table 6: Energy Efficiency Retrofit potential in the South Downs National Park

	No. of Properties with Potential	Installations per year to 2034 if all with potential implemented	Total Potential tCO_2 saved/yr in 2034	Estimated Capital Cost (£k)	Cost per tonne carbon saved (£k) per year[20]	tCO2 saved per £1k per year
Cavity wall insulation*	5,667 (9%)	283	2,900	£9,180	£3.17	0.3
Solid wall insulation	5,377 (9%)	269	9,500	£44,100	£4.64	0.2
Loft insulation *	3,563 (6%)	178	1,200	£670	£0.56	1.8
Loft top-up*	13,023 (22%)	651	1,300	£2,460	£1.89	0.5
Boiler replacement	22,246 (37%)	1,112	24,700	£56,060	£2.27	0.4
Window replacement	6,195 (10%)	310	4,200	£12,230	£2.91	0.3
Domestic Smart meters - by 2018	60,493 (10%)	10,082	6,300	£12,160	£1.93	0.5
Totals	n/a	12,885	50,100	£136,860	£2.73	0.4

* Note: thought to be underestimated

[20] Note that this cost is based only on capital works. It does not include costs associated with recruiting properties and installation.

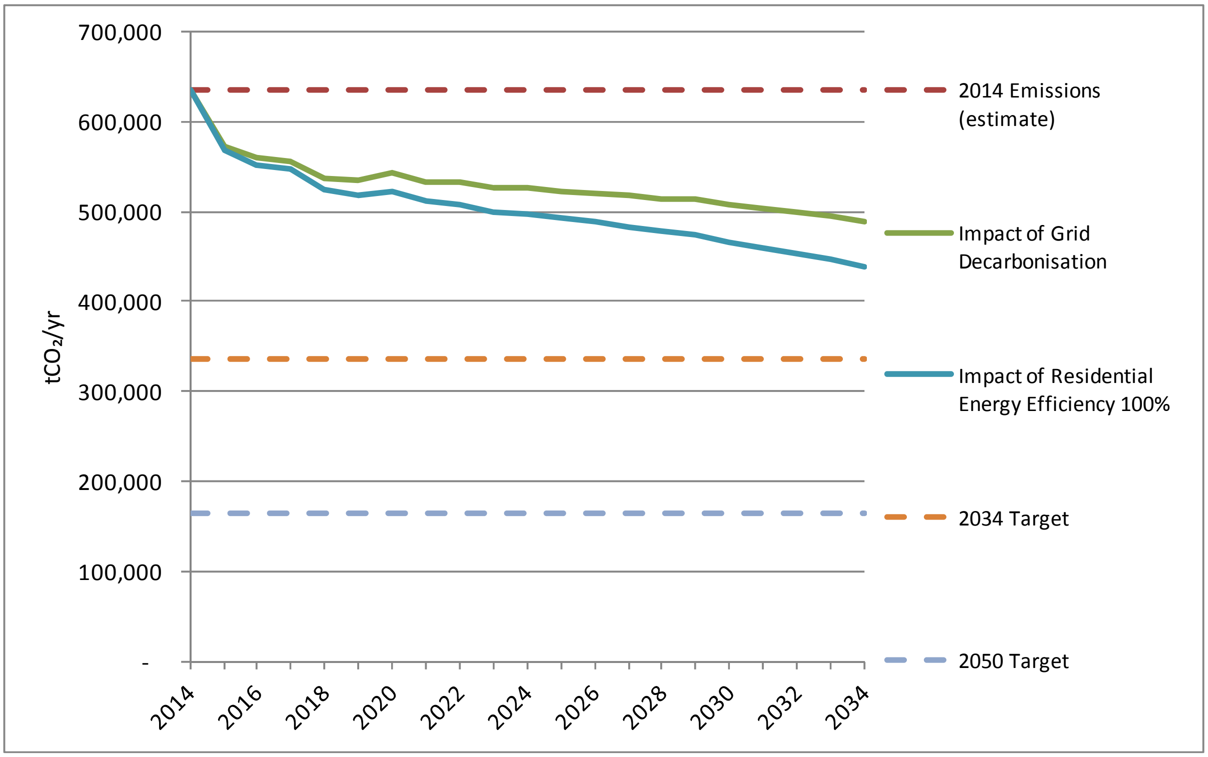

Figure 11: Relative potential carbon savings from 100% uptake of potential domestic retrofit efficiency measures

3.4 Off grid fuel switching to biomass

In addition to the potential for reducing carbon emissions by upgrading boiler performance, switching the fuel source used to heat off grid properties would also provide significant carbon savings such as natural gas or biomass. Around 60% of the 19,353 use coal, petroleum based fuels or manufactured fuel for heating. The remaining 40% use electricity which are more difficult to convert to. As such, the scenario below highlights that the carbon saving potential from converting the properties that use coal, petroleum and manufactured fuel to biomass would be around 51,854tCO_2/yr. If these properties were converted to the gas mains they would save around 3,100tCO_2/yr. The potential of biomass resources is examined in more detail in section 5.

Table 7: Fuel switch potential

	% Properties assumed to have potential	No. of Properties with Potential	Installations per year to 2034 if all with potential implemented	Total Potential tCO_2 saved/yr in 2034
Fuel switch - assumed half to biomass, half to gas	32%	11,721	587	51,854

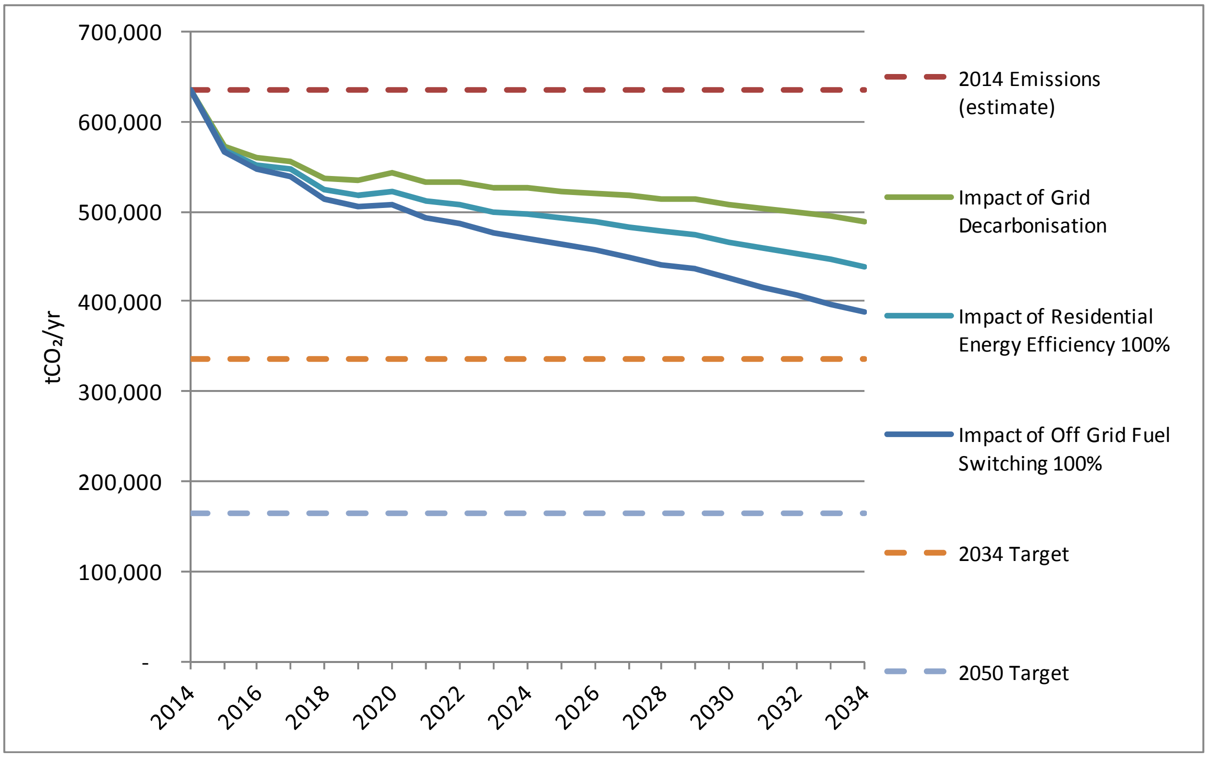

Figure 12: The relative carbon saving from switch of 100% of off grid properties to lower carbon heat supplies.

3.5 Testing uptake rates

It is however unlikely that 100% uptake of most measures would be achieved - for example it would be difficult to reach every home and technical difficulties (e.g. access issues) might prevent some of the potential being realised. Traditional buildings within the SDNP are likely to need a sensitive approach to retrofit – recent work on this issue includes the Sustainable Traditional Building Alliance's *Responsible Retrofit of Traditional Buildings* report, produced September 2012. Barriers to action will include the capital costs of measures and owner willingness to act. We have therefore developed two indicative scenarios for uptake of measures – one showing 'low' and one showing 'high' uptake, to give a range of what might be possible.

The low uptake scenario makes the following assumptions:

- Cavity walls: 40% of total potential insulated (pushed further due to concerns that the total potential may be underestimated)
- Solid walls: 10% of total potential insulated
- Lofts: 40% of total potential with <50mm insulated, 30% of loft top-up potential insulated (pushed further due to concerns that the total potential may be underestimated)
- Windows: 25% of total potential replaced

- Boilers: 50% of total potential replaced
- Fuel switching: 10% of total potential fuel switch for coal, solid fuel and LPG - 5% to gas, 5% to biomass
- Smart meters: 100% installed in line with government plans

The high uptake scenario makes the following assumptions:

- Cavity walls: 100% of total potential insulated (pushed further due to concerns that the total potential may be underestimated)
- Solid walls: 60% of total potential insulated
- Lofts: 75% of total potential with <50mm insulated, 75% of loft top-up potential insulated (pushed further due to concerns that the total potential may be underestimated)
- Windows: 60% of total potential replaced
- Boilers: 75% of total potential replaced
- Fuel switching: 40% of total potential fuel switch for coal, solid fuel and LPG - 20% to gas, 20% to biomass
- Smart meters: 100% installed in line with government plans

Both scenarios are indicative only; to give an idea of the relative increase in effort needed to make higher carbon savings from domestic energy efficiency and fuel switching measures.

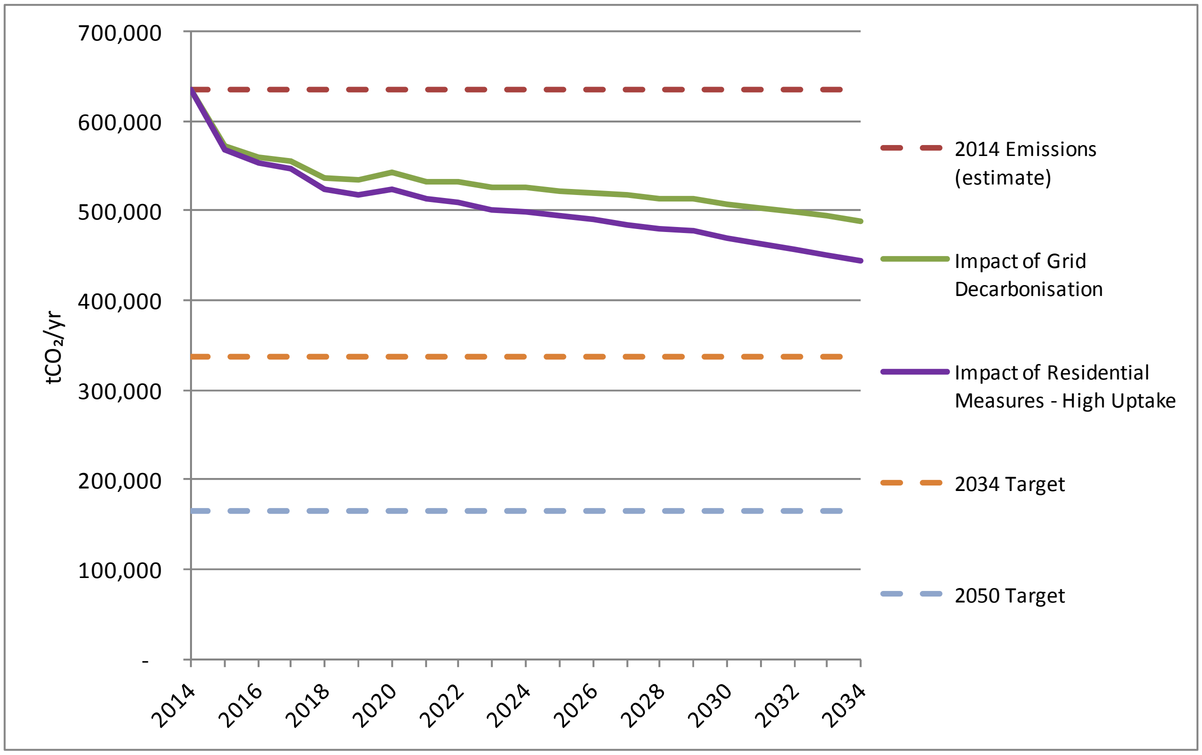

Figure 13: Potential carbon savings from high uptake of potential domestic retrofit efficiency measures and fuel switching

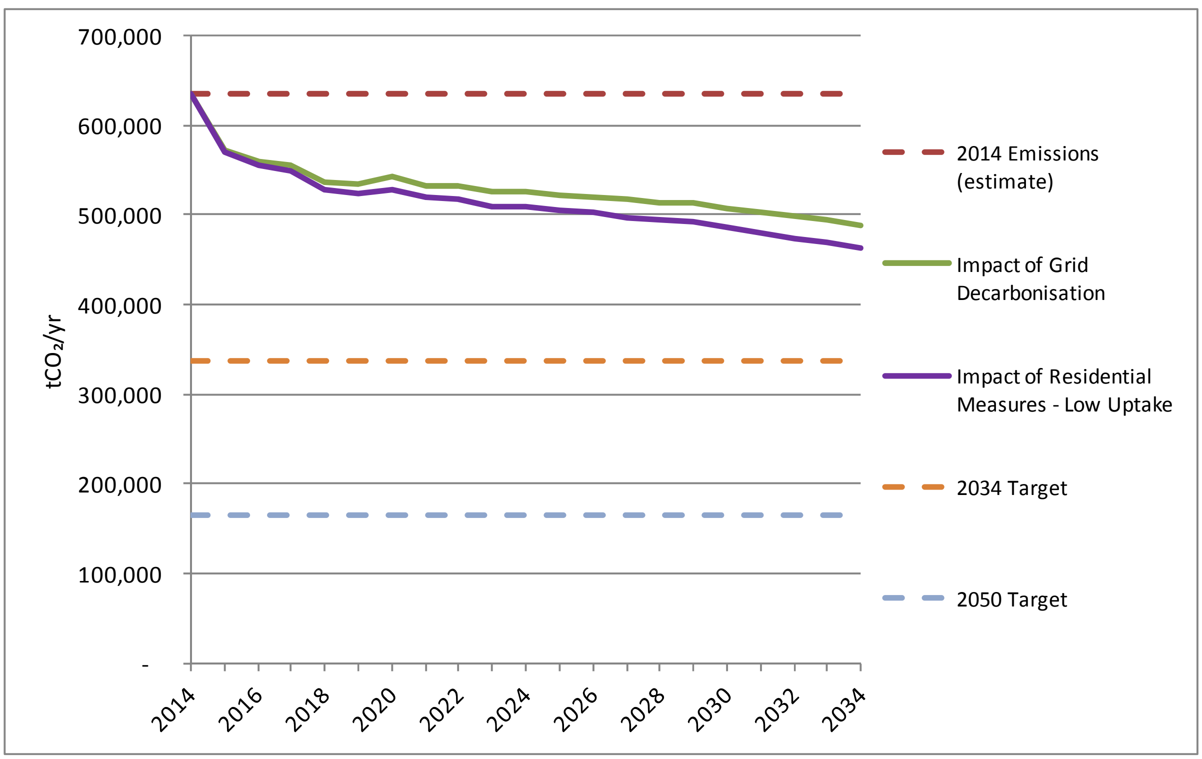

Figure 14: Potential carbon savings from low uptake of potential domestic retrofit efficiency measures and fuel switching

3.6 Energy Efficiency Potential – non-domestic buildings

The potential for energy efficiency measures in existing non-domestic buildings has been estimated based upon the energy consumption and number of existing non-domestic buildings in the SDNP. Due to data limitations, the estimate of the potential for non-domestic energy efficiency is based on a high-level assumption of a certain percentage of carbon savings made in this sector over the period to 2034. The Carbon Trust report, 'Building the Future, Today', on the non-domestic sector states a 35% reduction against 2005 can be achieved by 2020 for the UK as a whole. For illustrative purposes, a fairly conservative estimate of 25% against 2010 levels by 2034 is shown on the graph below, allowing for variation between national averages for building use proportions and those in the SDNP and for progress already made since 2005, although this study covers a longer time period. However, it is recommended that further work is undertaken to understand the particular capacity for individual measures in non-domestic buildings in the SDNP. As energy efficiency in the non-domestic sector has not been broken down into individual measures, it has not been possible to assign costs to non-domestic energy efficiency.

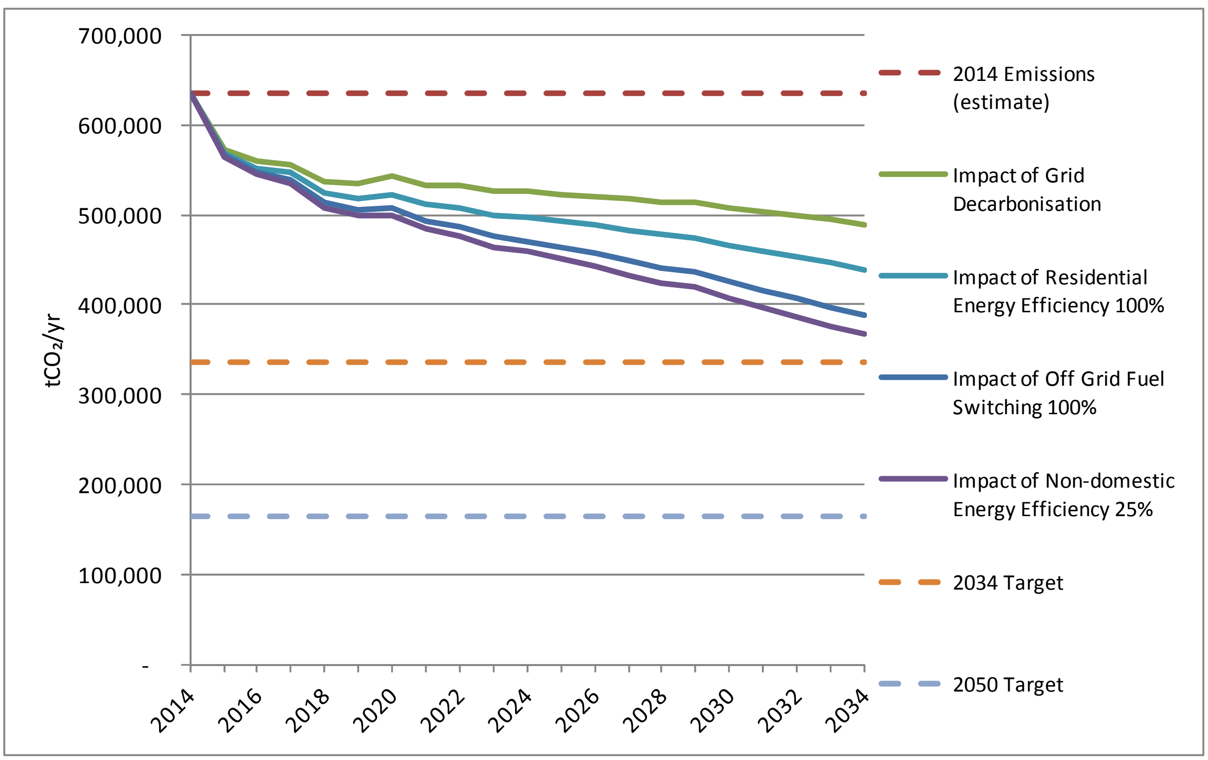

Figure 15: Additional potential carbon savings from a 25% uptake of efficiency measures in non-domestic buildings

Public buildings

With SDNP spanning across three counties and twelve local authorities, there are a number of publicly owned buildings, each with an energy demand that has an impact on the total greenhouse gas emissions for the South Downs National Park Authority. Using publicly available data from the Centre for Sustainable Energy, all public buildings across the UK were mapped and filtered to include only those located within the National Park's boundary. The result was 182 public buildings, which have been assessed to provide an understanding of opportunities for improvement.

Comparing the heat and electricity demand of public buildings in South Downs National Park against public buildings across the UK shows their demands are similar. As figure 16 shows, on average (per building), South Downs public buildings demand slightly more heat, and slightly less electricity than the rest of the UK.

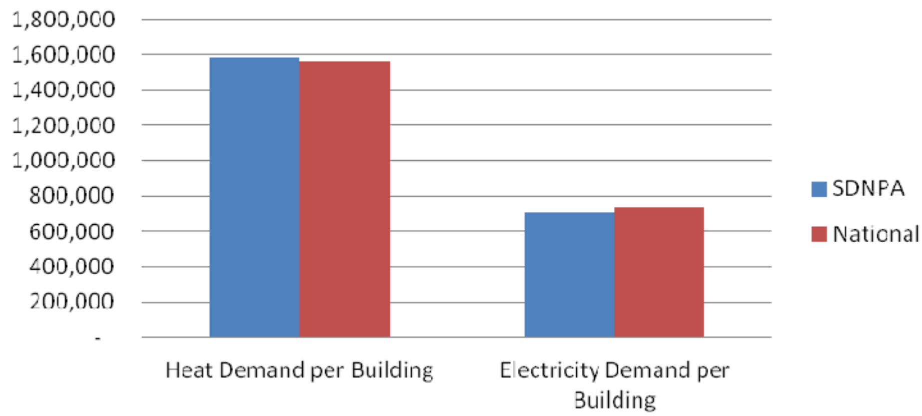

Figure 16: Energy demand (kWh) of public buildings in the UK and South Downs National Park

Rating the energy efficiency of buildings is another means of providing insight into how public buildings in South Downs National Park compare with those across the UK. As can be seen from Figure 17, the percentage of public buildings rated as A – the most efficient rating – is higher than across the UK. This is true for rating bands B and C. While it is positive that there are fewer than average which fall under ratings D, E, and F, South Downs has 2.5% more public buildings that have the lowest energy efficient rating. This may be the result of poorly insulated older buildings. These buildings represent an opportunity for the SDNPA to work with partner authorities to improve their energy use, and ultimately greenhouse gas emissions. On the whole, however, per building CO_2 emissions are somewhat lower, with the average in SDNP amounting to 693 tCO_2 compared to 793 tCO_2 nationally.

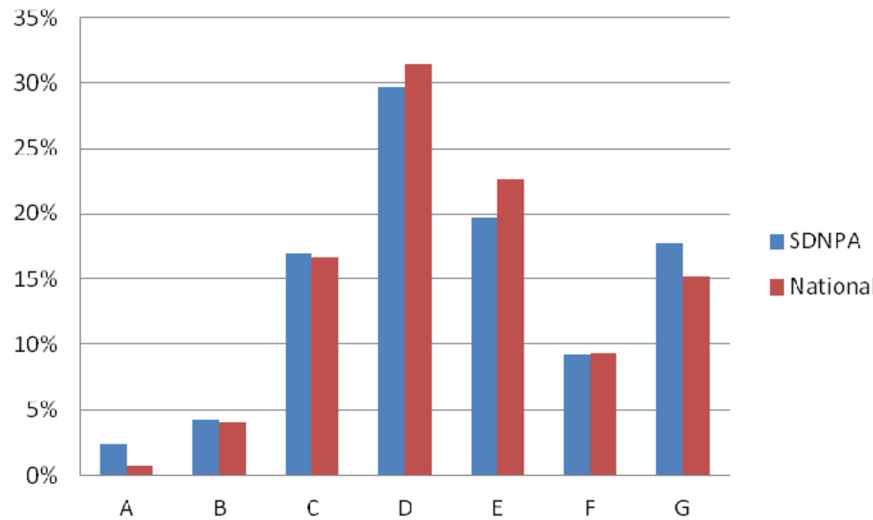

Figure 17: Energy rating of public buildings in SDNPA compared to public buildings nationally

Given the number of public buildings in South Downs with a poor Display Energy Certificate rating, retrofitting these existing buildings will be important to reducing carbon emissions. Non-domestic buildings are all different with their own energy demand profiles and effectively retrofitting them will require considering each building's uses. However, the list below outlines some of the most effective and cost efficient solutions that should be the considered first:

- Ensuring an energy efficient boiler is installed – Often the source of excessive heat demand is an old and inefficient boiler. Replacing these with a more efficient boiler can be one of the best ways to improve energy efficiency.
- Variable speed drive ventilation – Older ventilation systems often mean the system uses more energy than required. Ventilation which is able to operate at different speeds prevents more power being used than is necessary.
- Space heating controls – Thermostats allow users to establish automated, energy efficient behaviours
- Widen the "dead zone" – Programming heating controls to allow for a wider range of internal temperatures means there is less time heating or cooling systems need to be switched on, resulting in less energy demand.
- Window replacement – While somewhat costlier, installing double glazed windows, is an effective strategy to reducing heat lost in buildings.

All of the above strategies, except window replacement, have a payback period less than five years, and are therefore eligible for interest free loans made available through Salix Finance. A full list of strategies to improving energy efficiency in buildings can be found in the *CIBSE Guide F* document, *Energy Efficiency in Buildings* (2004).

3.7 Energy Efficiency Delivery mechanisms

Potential delivery mechanisms for energy efficiency measures include private funding (e.g. from homeowners, RSLs, estate owners) and funding through the Green Deal. This is a government initiative which launched in January 2013 and aims to enable private firms to offer energy efficiency improvements to home and building-owners at low or zero upfront cost, and to recoup payments through the savings in energy bills. Unlike traditional loans, the loan is attached to the property rather than to the individual. For all Green Deal measures, the expected financial savings must be equal to or greater than the repayment costs attached to the energy bill; this is known as "the golden rule". The 2011 Energy Bill, which made provision for the Green Deal, also provided for an Energy Company Obligation (ECO) to replace the current CERT and CESP schemes which oblige energy companies to contribute to the costs of installing energy efficiency measures in homes. The ECO focuses on subsidising measures which do not meet the Green Deal's golden rule - in particular solid wall insulation – and a proportion is targeted towards thermal energy efficiency measures in vulnerable homes. The Green Deal will also be open to private non-domestic building owners although this sector might be less attracted by the long-term repayment structure.

3.8 Onsite-microgeneration opportunities – Residential

The potential for building-scale renewable energy generation on domestic buildings has been estimated using the methodology followed in DECC's *Renewable and Low-carbon Energy Capacity Methodology for the English Regions*, 2010, and in the South East Renewable Energy Capacity Study.[21] The following technologies have been considered: PV, solar water heating (SWH), air source heat pumps (ASHP), ground source heat pumps (GSHP) which have permitted development rights even in a National Park[22]. The maximum capacities for are shown in the table below (rounded figures), along with associated carbon savings and costs (assuming 100% theoretical estimated capacity implemented):

Table 8: Maximum Capacities for Renewable Technologies in the Domestic Sector in SDNP based on DECC methodology

	% Properties assumed to have potential	No. of Properties with Potential	Installations per year	Total Potential tCO_2 saved/yr in 2034	Estimated Capital Cost (£k)
Domestic PV (assumed 3kWp per property)	25%	7,562	378	6,750	£51,100
Domestic Solar thermal (assumed 4sqm per property)		7,562	378	3,400	£25,500

[21] SEPB, *Review of Renewable & Decentralised Energy Potential in South East England*, 2010. The DECC methodology does not separate solar technology potential into PV/SWH nor heat pump potential into ASHP/GSHP so these have been split 50/50 for illustrative purposes. The methodology makes fairly broad assumptions.

[22] The Town and Country Planning (General Permitted Development) (Amendment) (England) Order 2011

	% Properties assumed to have potential	No. of Properties with Potential	Installations per year	Total Potential tCO_2 saved/yr in 2034	Estimated Capital Cost (£k)
Heat pumps	75% semi/detached, 25% flats	27,897	1,395	28,700	£297,000

It should be noted that the heat pump potential estimated by the DECC methodology appears high. This is due to an optimistic assumed viability of installing heat pumps in 100% of off-grid existing homes and 75%, 50% and 25% for detached/semi detached, terrace homes and flats respectively. In estimating the potential for carbon reductions from domestic microgeneration (shown on the graph below), 100% uptake has not been assumed as again it is not likely that this will be reached – the following assumptions have been made:

- PV and SHW 100 installations of each per year
- Heat pump 50 installations per year, assumed half ground source, half air source

It can be seen that the majority of potential savings are assumed to come from energy efficiency measures and fuel switching. Clearly this is an ambitious scenario and would require significant effort and finance to deliver, although there is still potential to push some measures further. It is important to note that savings from renewable energy sources which use or generate electricity are affected by assumptions on future grid decarbonisation – i.e. if the electricity grid decarbonises more this increases the carbon saving benefits of heat pumps which use electricity, but reduces the relative carbon saving benefits of PV compared to electricity from the grid.

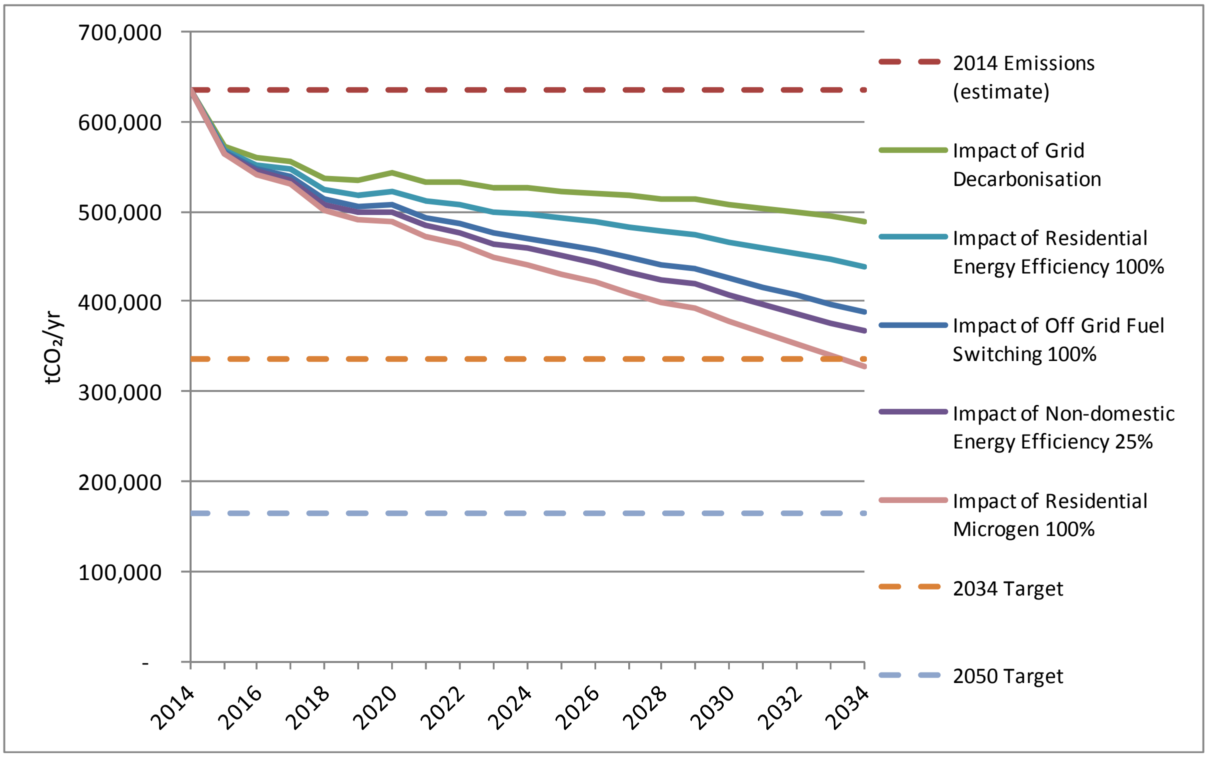

Figure 18: Additional predicted potential carbon savings from 100% uptake of microgeneration on residential properties

Although microgeneration offers great potential, the review of microgeneration uptake through the Feed-it-Tariff (FiT) in the next chapter highlights there is little appetite to install these technologies in the South Downs National Park. Furthermore, consideration needs to be given as to the cumulative impact the delivery of microgeneration on this scale would have on the nature of the South Downs landscape.

3.9 Onsite-microgeneration opportunities – Non-domestic buildings

The potential for microgeneration measures in existing non-domestic buildings has also been estimated, based upon the total numbers of non-domestic buildings in the SDNP and the methodology set out in DECC's *Renewable and Low-carbon Energy Capacity Methodology for the English Regions*, 2010. These estimates are summarised in the table below, with estimated carbon savings and costs given assuming 100% of the estimated potential is realised (and a 25% energy efficiency saving).

Table 9: Potential for mirogeneration form non-domestic properties

	% Properties assumed to have potential	No. of Properties with Potential	% of Total Potential Assumed Implemented	Installations per year	Total Potential tCO_2 saved/yr in 2034	Estimated Capital Cost (£k)
Non-domestic energy efficiency	100%	12,470	25%	n/a	21,000	Unknown
Non-domestic PV	40%	2,494	100%	125	7,500	£50,300
Non-domestic SWH	40%	2,494	100%	125	5,700	£35,000
Non-domestic Heat pumps	10%	1,247	100%	62	19,200	£88,000

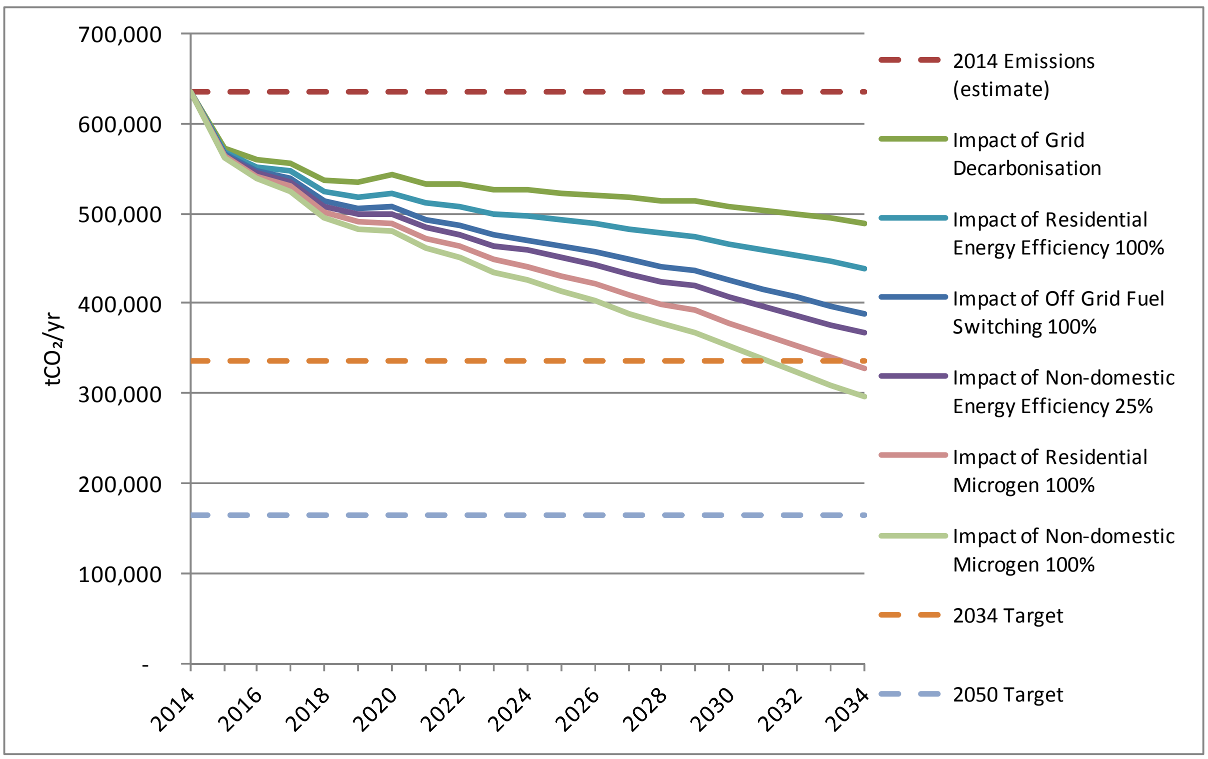

Figure 19: additional predicted potential carbon savings from 100% uptake of microgeneration from non-domestic properties

Again, uptake of microgeneration has been limited within the South Downs. Installation on non-domestic buildings might however be more attractive than on residential development as these buildings are less likely to be in sensitive areas, and be of sufficient size to benefit from economies of scale of infrastructure delivery. Larger scale renewable infrastructure will require planning permission and as such, up take is likely to be limited in the National Park where planning is perceived to be more restrictive.

3.9.1 Delivery mechanisms

Potential finance mechanisms for microgeneration measures include the Feed In Tariff (FIT). Launched in April 2010, FITs provide a financial incentive for the uptake for renewable electricity generating technologies. Payments are made over time based on electricity generated and are available for a range of technologies – currently including PV, wind, micro CHP, hydro and anaerobic digestion. The latest tariffs are published on DECC and Ofgem's websites. However up-front capital will still need to be provided. The Renewable Heat Incentive (RHI) was launched in 2011 for the non-domestic sector and provides a financial incentive for the uptake of renewable heat generating technologies. It is due to be fully launched for domestic buildings in summer 2013.

3.10 Workshop findings

An energy workshop was hosted by the SDNPA on 23 November 2012; the aim of the workshop was to inform policy development for both the South Downs Management Plan and Local Plan by presenting the analysis of energy data undertaken by this study and testing the appetite for potential delivery mechanisms to reduce the carbon footprint of building-related energy emissions.

One objective of this workshop was to refine our understanding of the main retrofit opportunities in the SDNP, in terms of the potential for different measures and for using existing and anticipated funding arrangements. The workshop was intended to help define and set appropriate targets for efficiency improvements and to help the SDNPA to consider its possible roles in delivery of these measures.

An overview of current findings on the potential for energy efficiency and microgeneration measures for existing buildings in the SDNP was given, and the Green Deal and ECO delivery mechanisms were outlined. The resulting discussions were extensive and detailed, but the key discussion points are summarised below:

- **Review of analysis of the HEED data which gives an estimate of the potential for different energy efficiency measures.** Comments were made which echoed AECOM's concerns that the potential for solid wall insulation may be underestimated in HEED. This may partly be due to the skewing of HEED towards cavity walls, as a key source of data for HEED is the record of CERT installations which have targeted mainly cavity wall and loft insulation. It was agreed that West Sussex would review the HEED data and compare it to the data they are gathering for their Green Deal programme, as their data cannot yet be shared.
- **Are there other data sources available locally?** As noted above, West Sussex County Council is working with the EST and Markman Consulting to gather their own data at postcode level for their area, which covers a large part of the SDNP. They are drawing upon HEED data but also undertaking some further analysis. However this data could not be shared at the moment[23]. Various concerns were raised with the HEED data – for example that traditional wall constructions such as stud walls are recorded in HEED as cavity walls, and that it has been found that when properties are visited

[23] Note that since the workshop West Sussex County Council have provided high level findings from their work to assess the potential for retrofitting residential properties in the County. Although data was not made available for publication, it did support the hypothesis that HEED data underestimates the potential for loft and cavity wall insulation.

their characteristics are different from those suggested by HEED. It was recognised that all available data sources are flawed – the best way of getting accurate data is surveying every home but clearly it is not feasible to do this. The level of data needed is also determined by the planned use for the data – more accurate data is needed for targeting particular homes, streets or areas for particular measures; less accurate data is needed to get an overview of the potential opportunities at local authority/SDNP scale. Some Local Authorities are asking national government to make EPC data available to them (at present there are limits on the number which can be downloaded per day) in order to facilitate Green Deal targeting and local authorities' responsibilities under the Home Energy Conservation Act. It was suggested that the SDNPA could also ask government for this. Overall attendees were keen to see recommendations on how to improve the sourcing and sharing of data.

- **What are likely barriers to uptake?** Concerns were raised around internal solid wall insulation with some participants being concerned about its application in traditional houses (e.g. create moisture issues, and that their current thermal performance levels may be underestimated in rdSAP which could mean that Green Deal assessments overestimate potential savings); however others believed it could be applied well if approached with knowledge. Recent guidance has been produced by the Sustainable Traditional Buildings Alliance (STBA), *Responsible Retrofit of Traditional Buildings*, 2012. Concerns were also raised over landlord, tenant and owner occupier barriers to uptake (interest rates, incentives to act) and it was suggested that further incentives/regulation are likely to be needed to secure the high levels of uptake necessary to make the significant carbon savings required. Attendees felt it was essential to market the Green Deal at key trigger points – e.g. when extensions/improvements are undertaken, at sale of properties.
- **How might this change with the introduction of Green Deal/ ECO?** There was concern expressed on the levels of consumer demand which would materialize for the Green Deal, particularly in comparison to previous grant schemes such as CERT and CESP.
- **What progress has been made on plans for accessing these funds and creating delivery mechanisms?** Different organizations were at different stages of planning. West Sussex County Council is in the process of gaining internal approval to procure a Green Deal provider in 2013-14, and to finance the Green Deal in their area using West Sussex County Council finance. Other Local Authorities in the area, including Arun DC, are planning to act with West Sussex and to be named on their tender documents. East Sussex are considering their options and are in discussions with West Sussex as well as considering other possibilities, for example working with Kent County Council on their Green Deal partnership model. The housing providers present were either looking to choose a preferred Green Deal provider or to act themselves. The SDNPA is currently considering its potential roles as part of this energy study and wider work.
- **What is the potential for the SDNPA or other authorities to be involved and what roles might they take in delivery?** A group exercise was undertaken focusing on the various stages of the Green Deal/ECO, to identify which roles participants thought were most appropriate for the SDNPA, Councils and Green Deal providers, and which roles would need to be shared. The results of this exercise are shown below:

RESPONSIBILITY	COUNCIL	GREEN DEAL PROVIDER	SDNPA
Marketing and customer engagement – domestic	✓	*(input on experience of delivery)*	✓
Marketing and customer engagement – non-domestic	✓		✓ *(Seen as having particularly high influence)*
Assessment		✓	
Installation and aftercare		✓	
Supply chain engagement – installers, manufacturers	✓		✓ *(promotion of local business)*
Selection of installers, manufacturers and products	✓	✓ *(depends on model chosen)*	
Manage business systems			
Authorisations	✓ *(Planning consents where needed)*	✓	✓ *(Planning consents where needed)*
Delivery of additional economic benefits e.g. training and employment	✓	✓ *(lead)*	✓
Secure and spend ECO	*(Provide info for targeting)*	✓	*(Provide info for targeting)*
Secure Green Deal finance and take finance risk	✓ *(potentially)*	✓	✓ *(potentially)*
Manage public stakeholders	✓		
Risk of lack of demand	✓ *(if provider or procuring provider)*	✓	
Risk of brand, reputation	✓	✓	✓
Risk of default on finance	✓ *(depending on model, if putting in finance)*	✓	

3.11 Implications for the Management Plan, Local Plan and Next Steps

This section illustrates the technical potential carbon savings from measures associated with the existing building stock. It highlights that to make proportionate progress to the Climate Change Act 2008 target of reducing carbon emissions by 80% by 2034 that all these measures would need to be exhausted. Even with dramatically improved uptake rates it is highly unlikely that carbon savings on this scale will be achievable. What is evident, however, is that there is a great deal of potential carbon saving to be achieved by improving the energy efficiency of existing building stock. The greatest overall savings are likely to come from boiler replacement and fuel switching, although the most cost effective measures are improved loft insulation and smart metering (which will be rolled out anyway). Green Deal offers an opportunity to improve the efficiency of existing properties in a cost effective way. However, focusing on only the cheaper measures, as in Green Deal, leads to the risk that harder to reach measures will go untouched. Once inside a property, through Green Deal for instance, there would be a lost opportunity cost of not delivering more difficult measures as it might be hard to get back inside the property in the future. As such in targeting energy efficiency improvements the SDNPA could consider leveraging additional funding through ECO or allowable solutions to focus on these harder to reach measures.

Furthermore, although the role of planning is limited in influence over existing development, the move towards localism and the NPPF, and support from the Committee on Climate Change, have highlighted the opportunities for local authorities to influence the energy performance of properties when applying for planning permission for a new extension – this is sometimes known as consequential improvements.

Submission by owners for 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. It is recommended 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 since adoption in 2005, which have also been well received by households. While the results stemming from this policy have never been empirically verified, by 2008 they had reportedly influenced approximately 1,400 extensions so far, and the estimated savings from measures required as a result are £72,600 and 398tonnes of CO_2 per year.

Microgeneration also offers significant potential, yet uptake rates are limited and unlikely to improve without stimulus. However, widespread uptake of residential scale renewable development might lead to cumulative impacts that are unacceptable. The SDNPA may wish to review their position on the permitted development of residential renewables. Larger non-domestic properties might offer more potential for larger scale uptake of microgeneration.

As such, in developing the Local Plan and Management Plan the SDNPA should consider:

- Establishing an approach to attracting Green Deal funding, perhaps in collaboration with emerging procurement arrangements with West Sussex County Council. Focus for retrofit should be off grid properties.
- Seek to leverage ECO or other funding (perhaps through allowable solutions) to target harder to reach measures to be delivering alongside Green Deal.
- Developing a 'consequential improvements' policy to require property owners seeking to extend their property to make additional energy efficiency improvements to the rest of their property.
- Reviewing the position on microgeneration to actively support uptake, for example on large warehouses, but limited in more sensitive locations. This might need to be through an Article 4 directive to alter permitted development rights.

The Energy Performance of New Buildings

4. The Energy Performance of New Buildings

4.1 Future growth

The SDNPA currently do not have specific domestic and non-domestic development growth targets. The South Downs National Park Housing Requirements Study (2011) does however highlight the need for greater supply of affordable family housing. To meet this need based upon a mix of 50% affordable housing and 50% market housings would require 380 homes per annum to be built. Achieving this level of growth is however likely to be challenging given that historic build out rate since 2010 equates to around 250 homes per annum. To estimate the additional energy demand and associated carbon emissions resulting from this new housing it has been assumed that this trend will continue. The mix of dwelling types has also been assumed to remain similar to the current housing mix of 45% detached, 40% semi-detached, 10% terraced and 5% apartments and that the energy performance of these new buildings meets the expected carbon compliance standards of proposed for the 2016 revision to Part L of the Building Regulations.

The South Downs National Park Employment Land Review (2012) highlights that there is sufficient employment land available and that there is unlikely to be significant demand for new non-domestic development. As such, it has been assumed that there will be no net increase in non-domestic buildings. Any improvement to the energy performance of non-domestic buildings over the local plan period is captured in the next chapter which looks at potential efficiency improvements. The graph below shows that the anticipated increase in carbon emissions associated with future growth is minimal, c13,053 tonnes.

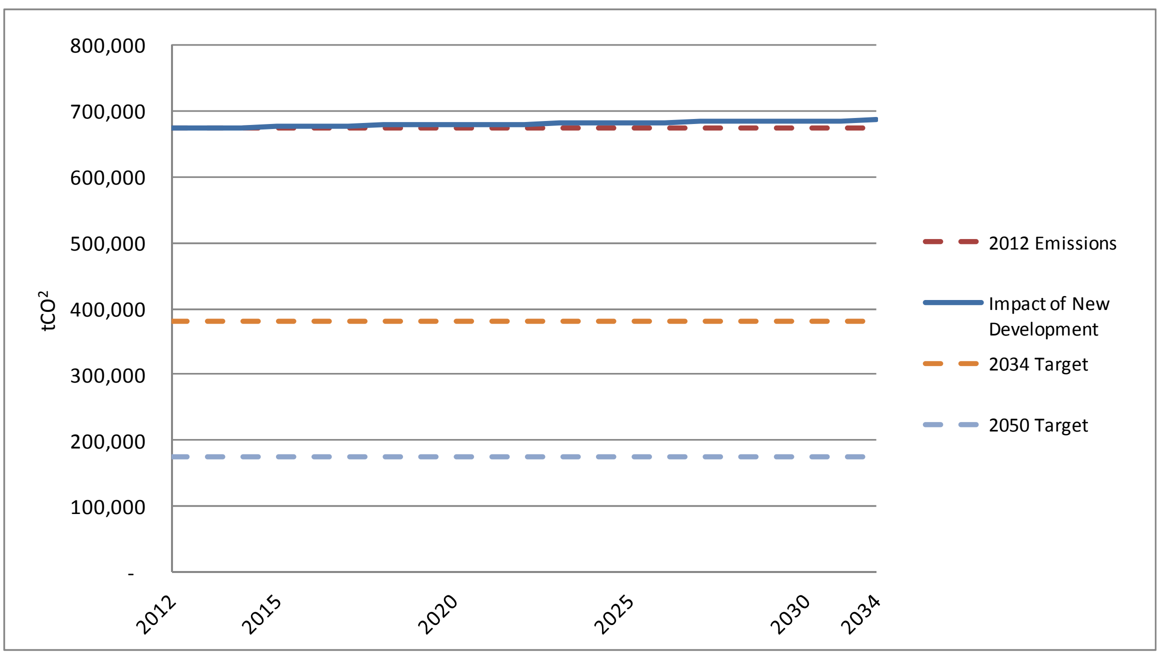

Figure 20: increase emissions due to new development

4.2 Building Regulations and path to Zero Carbon

Following consultation, in July 2007 the Government's Building a Greener Future: Policy Statement[24] announced that all new homes should be zero carbon from 2016 with non-domestic buildings following from 2019. The expectation is that this policy will be implemented through changes to Building Regulations.

As of March 2011, the Government defined zero carbon to include the 'as-built performance' of the building, including carbon emissions from heating, fixed lighting and hot water (regulated emissions)[25] Unregulated emissions from cooking and 'plug-in' appliances are no longer covered by the policy.

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

- 2013: 25% reduction in regulated emissions (relative to 2010 levels), corresponding to the carbon reduction requirements of Level 4 of the Code for Sustainable Homes.
- 2016: 'Zero carbon'; note however that unlike the 2009 version of Level 6 of the Code for Sustainable homes, this does will not include unregulated emissions[26] (see below).

Following further consultation on proposals for Part L 2013, which closed in March 2012, the overall carbon reduction targets were proposed to reduce by 8% rather than 25% relative to the 2010 levels. Further information regarding the expected route to achieving these savings was proposed in the consultation documents including;

- Fabric Energy Efficiency Standards (FEES) of 39 - 43 kWh/m²/yr for apartments and mid-terrace, 46 – 52 kWh/m²/yr for end-terrace, semi-detached and attached properties.
- There is more emphasis on limiting the heat gains in summer including the need to insulate circulation pipes for domestic hot water to prevent overheating.
- Regulatory energy demand targets for heating and cooling.

Government has yet to confirm the findings from the consultation or to publish the proposed improvements for 2013 Building Regulations which were originally expected to come into force in October 2013.

Despite the expected downgrading of the interim 2013 target, the Government has previously confirmed its commitment to implementing 'zero carbon' policy in 2016 for domestic properties and 2019 for non-domestic properties. However, the way in which 'zero carbon' is to be met has yet to be defined. The Zero Carbon Hub, an independent body advising the Government on the development of zero carbon policy highlights that the planned revisions to the Building Regulations Part L and move towards 'zero

[24] *Building a Greener Future: policy statement*, July 2007, Wetherby: Communities and Local Government Publications. Department for Communities and Local Government (DCLG) (2007a)

[25] 'The Plan for Growth'. HM Treasury. March 2011. ISBN 978-1-84532-842-9

[26] It is a common misconception that all aspects of Code levels will be required under the government proposals, but in fact it is just the CO_2 targets of the Code that will be applied and are mandatory through Building Regulations (the energy category is one of nine different categories in the Code).

carbon policy' are aimed at providing meaningful steps to significant reductions in carbon emissions whilst minimising the cost impact on developers. As such it is recognised that there are diminishing returns from attempting to mitigate for a buildings carbon emissions on site as in previous planning based approach such as the Merton Rule, requiring a proportion of renewable energy infrastructure onsite. These policies were impacting on development viability for limited improvements on performance. As such, the current proposals for 'zero carbon policy' includes three steps. Figure 21 summarises the Government's hierarchy for achieving 'zero carbon'.

- Step 1 - requires a minimum energy efficiency standard such as the proposed FEES to be achieved though material selection, construction methods, and building layout. This is likely to account for approximately 20-25% reduction in carbon emissions.
- Step 2 – a minimum level of onsite 'carbon compliance' to be reached through a range of measures including additional energy efficiency and low carbon energy supply. Carbon compliance levels are yet to be fully defined. The Zero Carbon Hub have recommended to Government that targets are based on as built performance and have suggested targets which equate to 25% / 41% / 47% reduction in regulated emissions compared to 2010 for flats / semis and terraces / detached homes respectively[27]. If adopted by Government these would deliver overall savings in the region of 40-70% depending on building type.
- Step 3 – once carbon compliance has been achieved onsite, further CO_2 reduction can be made either on-site, or by paying a contribution towards approved offsite carbon reduction measures known as 'allowable solutions'. The [Government's] framework for allowable solutions is still being developed, however it is likely that local planning authorities will be required to identify a pipeline of approved allowable solutions. This study will help to identify these measures.

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 should be embedded in policy and administered. A key aspect of allowable solutions would be for the local planning authority (LPA), such as Lewisham, to collect allowable solutions as a financial contribution from developers to mitigate for the residual emissions not reduced onsite. This would provide local councils with the ability to create policy which could determine how funds can best be used to meet government standards in a way that suits local circumstances. In the absence of local policy, developer contributions would be delivered through a national list of allowable solution projects, the Zero Carbon Hub recommend that LPAs prepare for future allowable solutions by developing policies for contribution/collection and identify potential allowable solution projects.

[27] Zero Carbon Hub, Carbon Compliance: Setting an Appropriate Limit for Zero Carbon Homes - Findings and Recommendations, Feb 2011

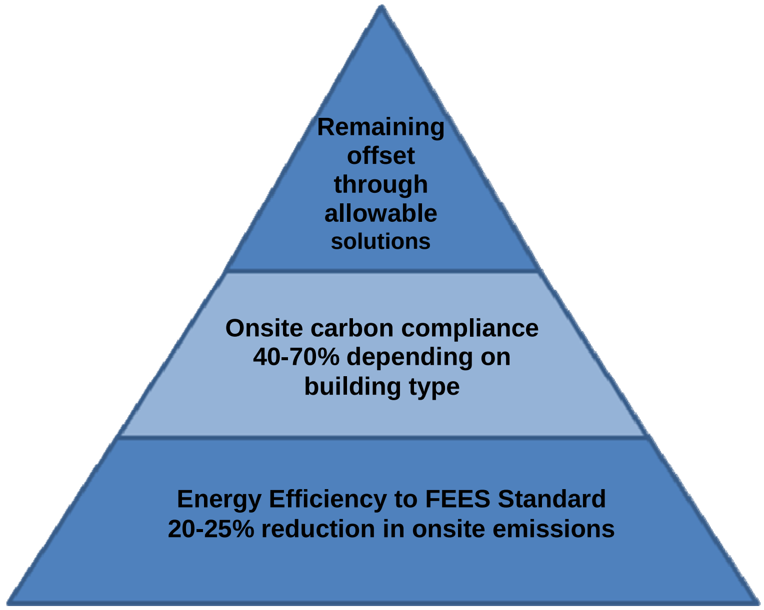

Figure 21: The Government's hierarchy for achieving 'zero carbon' development

Furthermore, it is worth noting that zero carbon in this definition only relates to 'regulated emissions' i.e. the emissions from energy consumption provided by the fixed building services, including heating, cooling, ventilation and lighting. The definition of zero carbon in the Code for Sustainable Homes level 6 also includes 'unregulated emissions'; the emissions associated with use of small appliances and power plug loads such as IT equipment. As such unregulated emissions can be difficult to evaluate as they are linked to personal choices and behavioural attitudes; however total regulated and unregulated emissions is often estimated at around 170% of regulated emissions.

The proposed move towards tighter Building Regulations also shifts the emphasis away from planning to regulation for setting targets for reducing emissions. However, it is important in this regard not to lose sight of the importance of effective planning in supporting low carbon development by delivering appropriate infrastructure and the strategic responses and the related economies of scale that planning can coordinate.

4.3 Onsite carbon reduction measures

4.3.1 Fabric efficiency

Reducing the demand for space heating and/or cooling is perhaps the primary opportunity for reducing building related carbon emissions. It is possible to achieve substantial savings through improving the fabric efficiency of building envelopes. This is the core focus of the voluntary Passivhaus standard, which seeks a similar improvement in energy performance as 2013 Building Regulations and Code for Sustainable Homes level 4 primarily through an airtight building envelope with high levels of insulation. Delivering the low U values to meet Passivhaus requires significant skill and expertise and there has been a lot of debate about the additional costs associated with focusing so heavily on fabric performance.

The Government's approach to setting FEES standards has been one of balancing improvements in the fabric efficiency with the relative return in carbon savings from the additional investment need; recognising that there are diminishing returns beyond a certain point. The Zero Carbon Hub has set out in the *Fabric Energy Efficiency for Zero Carbon Homes* guidelines to help inform the development of Building Regulations 2016. The idea behind this more 'flexible performance standard' approach is that although the overarching emissions reductions required is similar, FEES provides a backstop fabric performance. Further improvements to the fabric can be made if the developer believes this to be the most cost effective way. If not then saving needs to be delivered through other carbon compliance routes. The table below reproduces the Zero Carbon Hubs FEES recommendations and anticipated uplift in build costs.

Table 10: Uplift in cost to meet FEES

	Dwelling FEE performance (kWh/m2/year)	**Cost uplift over Part l 2010**
Detached	46	£3,900
End of terrace / semi detached	46	£1,300
Terraced house	39	£700
Apartment	39	£0

4.3.2 Carbon compliance under Building Regulations and other energy improvement standards

As highlighted above, it is proposed that future Building Regulations will be met through a combination of fabric efficiency and onsite carbon compliance after which remaining emissions will be allowed to be offset through 'allowable solutions'. To advance carbon savings, however, other more stringent targets could be used within planning policy to encourage higher levels of performance. Two commonly used rating systems are the Code for Sustainable Homes for domestic buildings and BREEAM for non-domestic buildings. Although both these rating systems require action across a range of sustainability criteria, they both include energy / CO_2 performance standards that require a greater level of carbon compliance onsite.

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.

The table below outlines specific requirements to achieve different levels of the Code. November 2010 brought updates to the Code. 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 11: Performance required to meet Code levels.

	Minimum entry requirements		
Code Levels	Energy Improvement over TER	Water litres/person/day	Total points score out of 100
Level 1 (★)	10%	120	36
Level 2 (★★)	18%	120	48
Level 3 (★★★)	25%	105	57
Level 4 (★★★★)	44%	105	68
Level 5 (★★★★★)	100% reduction in regulated emission through onsite measure[28]	80	84
Level 6 (★★★★★★)	Zero Carbon[29] – both regulated and non regulated emissions on site	80	90

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-domestic buildings. Like the Code, 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

[28] Note that this is more onerous than the Government's current definition of zero carbon which allows for Allowable Solutions to be off site.
29 Note that this is even more onerous than the Government's current definition of zero carbon which only includes regulated emissions.

- 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.

The different levels of performance

The table below ranks the relative carbon performance requirements from Building Regulations, the Code for Sustainable Homes and BREEAM based on their onsite carbon compliance requirements.

	Domestic		**Non Domestic**
Proposed Building Regulations (2013) **Based on CLG, 2012 consultation on changes to the Building Regulations in England (preferred options)**	Aggregate 8% reduction over 2010	**Proposed Building Regulations (2013)** **Based on CLG, 2012 consultation on changes to the Building Regulations in England (preferred options)**	Aggregate 20% reduction over 2010 [1]
Code for Sustainable Homes level 4	25% reduction over 2010 Building Regulations in regulated emissions onsite (no allowable solutions)		

[1] Other options are proposed, ranging between 8% - 20% aggregate reductions for non-domestic buildings. The 20% scenario has been taken as the preferred option. Disaggregated targets have been applied to different building types where these are given in the consultation stage impact assessment. Aggregate targets are proposed in recognition of the fact that it is harder to make carbon reductions within certain building types compared to others.

Proposed Building Regulations (2016) **Based on Zero Carbon Hub recommendations which have not yet been adopted in policy by Government.**	25% / 41% / 47% carbon compliance compared to 2010 for flats / semis and terraces / detached on site Plus equivalent of a total of 100% reduction in regulated emissions through allowable solutions.	**Proposed Building Regulations (2016)** **CLG, Zero carbon non-domestic buildings Phase 3 final report, July 2011 - high scenario[3]**	Aggregate 25% over 2010
		BREEAM Excellent	25% reduction in regulated emissions (no Allowable Solutions)
Code for Sustainable Homes level 5	100% reduction in regulated emissions onsite (no allowable solutions)	**Building Regulations (2019)**	100% reduction in regulated emissions; 32% through carbon compliance
Code for Sustainable Homes level 6	100% reduction in regulated AND 100% reduction in unregulated emissions (equivalent to 150-190% reduction in regulated emissions) onsite (no allowable solutions)	**BREEAM Outstanding**	40% reduction in regulated emissions (no allowable solutions)

Table 12: Carbon reduction targets within Building Regulations, Code for Sustainable Homes and BREEAM

4.3.3 Testing the cost impact of meeting different targets – Case Study

Although work is continuing within the SDNPA to understand potential development sites within the South Downs National Park, it is expected that the majority of growth will be delivered through a handful of larger developments of around 200 homes, smaller development sites and in-fill development. As there are likely to be the widest range of options associated with more strategic scales of development, the different performance targets described above have been tested by developing potential development scenarios for a more strategic development including:

[3] The high scenarios have been chosen for non-domestic buildings in 2016 and 2019 as they align best with the preferred option in the 2012 Building Regulations consultation; however these do not reflect government preferences, which have not yet been stated. Although both are proposed to be aggregate targets, i.e. varied across different building types, they have been presented at a fixed level for all building types due to the uncertainty around the disaggregated levels for different building types at this stage.

- 100% residential = 200 units @ 30 dwelling per hectare
- 80% residential and 20% office = 160 units and 20,000 sq m of 2-storey office
- 60% residential and 40% office = 120 units and 40,000 sq m of 2-storey office
- 40% residential and 60% office = 80 units and 60,000 sq m of 2-storey office
- 20% residential and 80% office = 40 units and 80,000 sq m of 2-storey office
- 100% office = 100,000 sq m of 2-storey office

Given the low density of the development expected, the residential units have been assumed to be a mix of semi-detached, detached and terraced houses. Carbon emissions associated with the development would vary depending on the amounts of different building types and the Building Regulations period under which the development is undertaken. For the purposes of this case study, carbon emissions are given at current carbon emission factors (it would be expected that they would be lower if future emission factors were used, as the electricity grid is expected to decarbonise in the future).[30] The baseline energy demands assumed for the different building types and the results of the analysis are shown in the tables below.

Table 13: Baseline energy demands

Building Type	Baseline Energy Demands 2010 (kWh/sqm/yr)			
	Space Heating	Domestic Hot Water	Regulated Electricity	Unregulated Electricity
Domestic: Mid-Terrace	39	30	7	44
Domestic: Semi-Detached	49	30	7	44
Domestic: Detached	57	21	5	36
Non-domestic: Office	13	3	44	44

Table 14: Estimated total CO2 from each development scenario

Development Scenario	Total Estimated CO_2 Emissions from Development (tCO_2/yr)		
	2013	2016	2019
100% residential = 200 units	760	430	430
80% residential and 20% office = 160 units and 20,000 sq m of 2-storey office	1460	1180	790

[30] Defra/DECC, *2012 Guidelines to Defra/DECC's GHG Conversion Factors for Company Reporting*, April 2012.

Development Scenario	Total Estimated CO_2 Emissions from Development (tCO_2/yr)		
	2013	2016	2019
60% residential and 40% office = 120 units and 40,000 sq m of 2-storey office	2160	1940	1160
40% residential and 60% office = 80 units and 60,000 sq m of 2-storey office	2860	2690	1520
20% residential and 80% office = 40 units and 80,000 sq m of 2-storey office	3560	3450	1880
100% office = 100,000 sq m of 2-storey office	4250	4200	2250

Based on the technologies considered to be potentially applicable to a development at sites of this scale, the following scenarios have been modelled to test the potential for meeting different carbon reduction targets. The list of solutions above does not cover the full range of possible approaches that could be delivered on site. We have applied a range of reasonable scenarios but there are numerous other options that could potentially be applied:

- Gas Boilers (Part L 2010 Compliant Base Case)
- Gas Boilers
- Gas Boilers & PV 25% (i.e. 25% of max potential on a typical roof)
- Gas Boilers & PV 50%
- Gas Boilers & PV 75%
- Gas Boilers & PV 100%
- Air Source Heat Pump
- Air Source Heat Pump & PV 25%
- Air Source Heat Pump & PV 50%
- Air Source Heat Pump & PV 100%
- Air Source Heat Pump & Solar Hot Water & PV 50%
- Ground Source Heat Pump
- Ground Source Heat Pump & PV 25%
- Ground Source Heat Pump & PV 50%
- Ground Source Heat Pump & PV 100%
- Ground Source Heat Pump & Solar Hot Water & PV 50%
- Solar Hot Water
- Solar Hot Water & PV 50%
- CHP District Heating
- CHP District Heating & PV 25%

- CHP District Heating & PV 50%
- CHP District Heating & PV 100%
- Biomass Heating (either district heating or individual systems)
- Biomass Heating & PV 100%
- Biomass Heating & PV 200% (where appropriate – roof design optimised for solar PV)

Houses are assumed to have pitched roofs, which determines the limit for the maximum '100%' roof area available for PV. The 200% PV option goes beyond this so would require building or roof design to increase the amount of suitable roof area, for example by using a mono-pitched roof, and/or more efficient panels.

The technology combinations above are mainly building-level solutions with the exception of the district heating options. Potential strategic scale renewable energy development could potentially deliver the requisite carbon savings, however to make them viable they would need to supply a larger demand. If there is a larger demand, potentially from existing development, then there might be economies of scale in using strategic renewable energy infrastructure.

The resulting carbon emission reductions from the different technology scenarios are compared to expected future Building Regulations in 2013, 2016 and 2019.

4.3.4 Cost implications of the carbon reduction targets

The graphs on the following pages examine the relative cost of various potential technology options that could be used to achieve improvements in the CO_2 emissions in the different development scenarios considered above relative to Building Regulations Part L 2010. For each building type, the first graph shows the improvement in carbon emissions and cost against the CO_2 reductions targets expected to be required by:

- Building Regulations 2013-2016,
- Building Regulations carbon compliance requirements (recognising that a proportion of emissions can be offset offsite –discussed further below),
- Meeting a 100% reduction in regulated emissions on site (equivalent to meeting Building Regulations 2016/2019 without offset through allowable solutions and Code for Sustainable Homes level 5
- Meeting the highest standards in the Code for Sustainable Homes (level 6, 100% reduction in regulated and unregulated emissions) and BREEAM (Outstanding).[31]

The second graph shows the improvement achieved per £1,000 additional spend over and above a standard build.

[31] Note that this modelling only assesses the increased cost in meeting the energy credits of the Code for Sustainable Homes and BREEAM. There are likely to be other costs associated with meeting the mandatory and voluntary credits relating to other sustainability topics. DCLG's *Code for Sustainable Homes: A Cost Review* provides some guidance on the expected uplift in costs of these measures. It highlights that the greatest costs are associated with meeting the energy and the water credits.

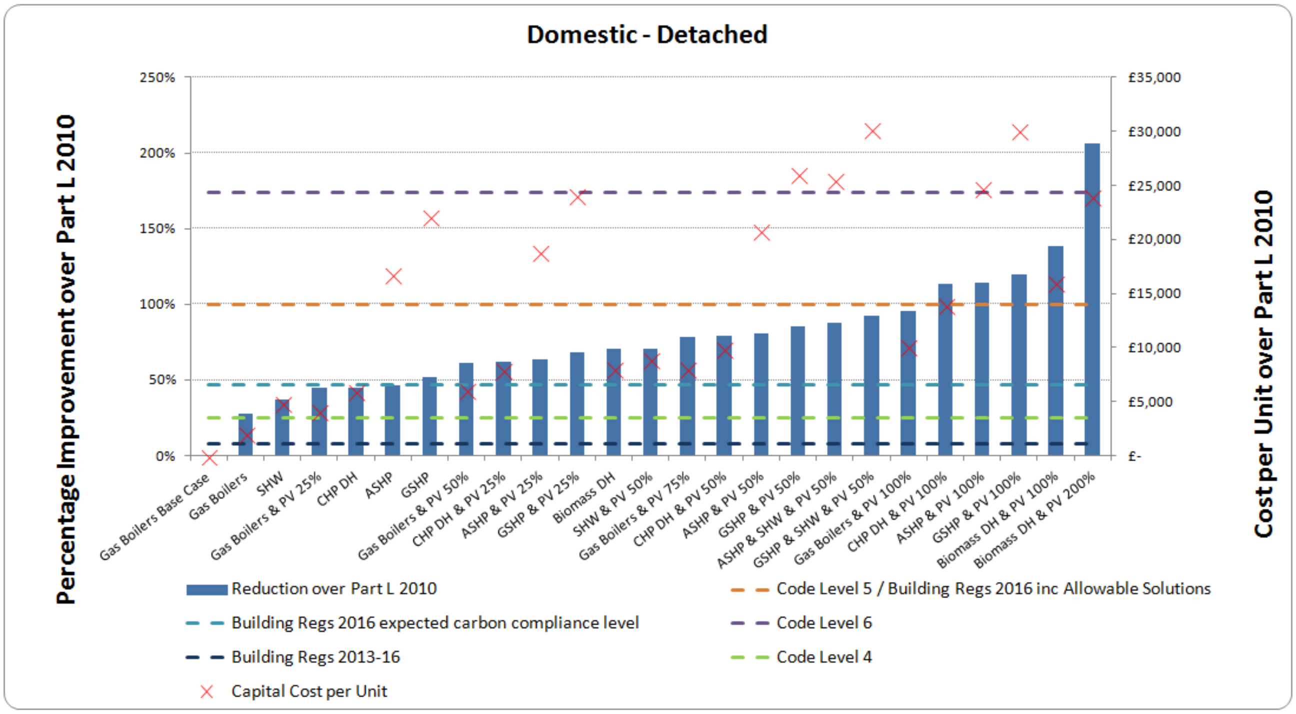

Figure 22: Carbon saving potential of different carbon reduction strategies against cost and targets for new build detached homes

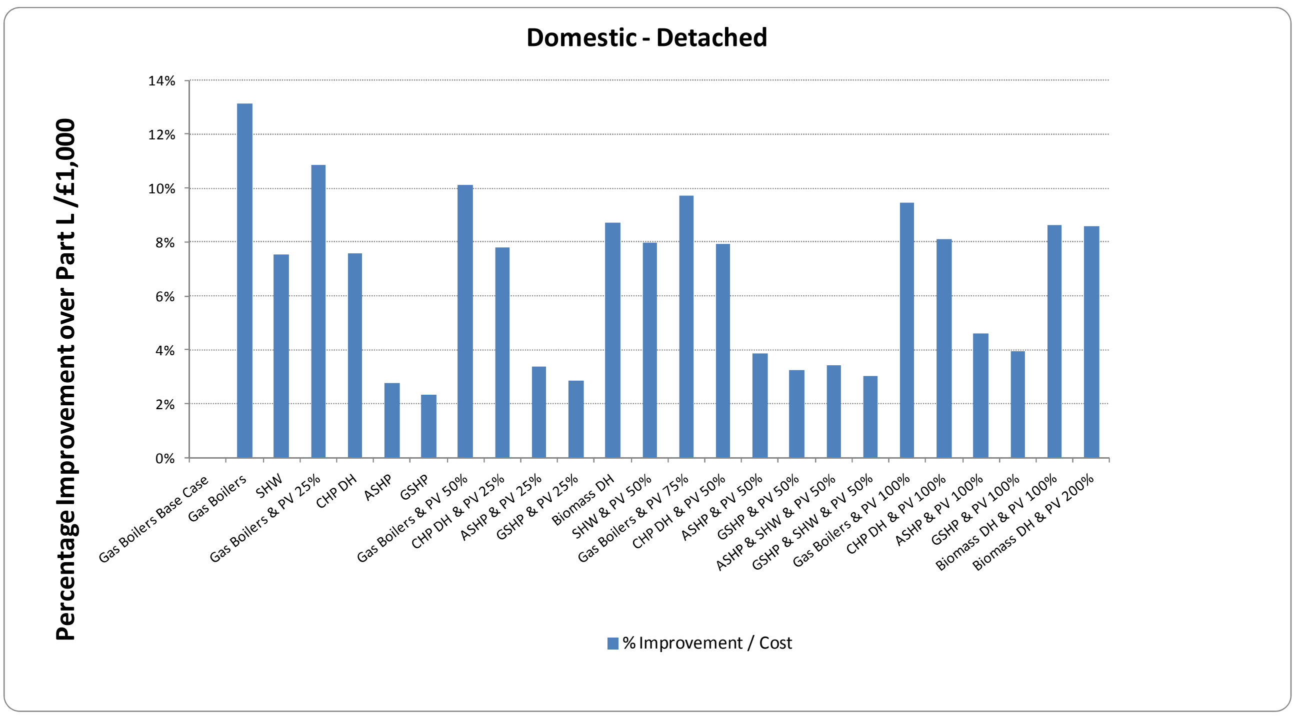

Figure 23: Carbon saving potential per £1,000 additional spend over and above a standard new build detached home

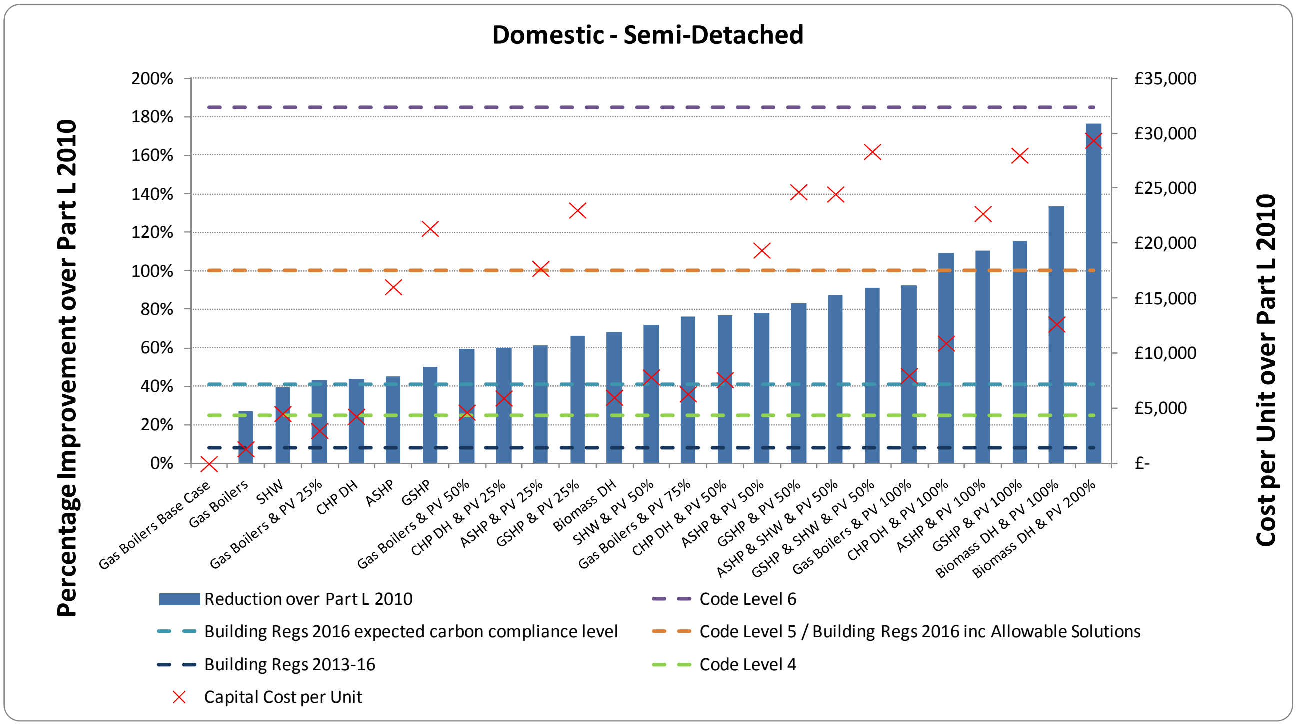

Figure 24: Carbon saving potential of different carbon reduction strategies against cost and targets for new build semi-detached homes

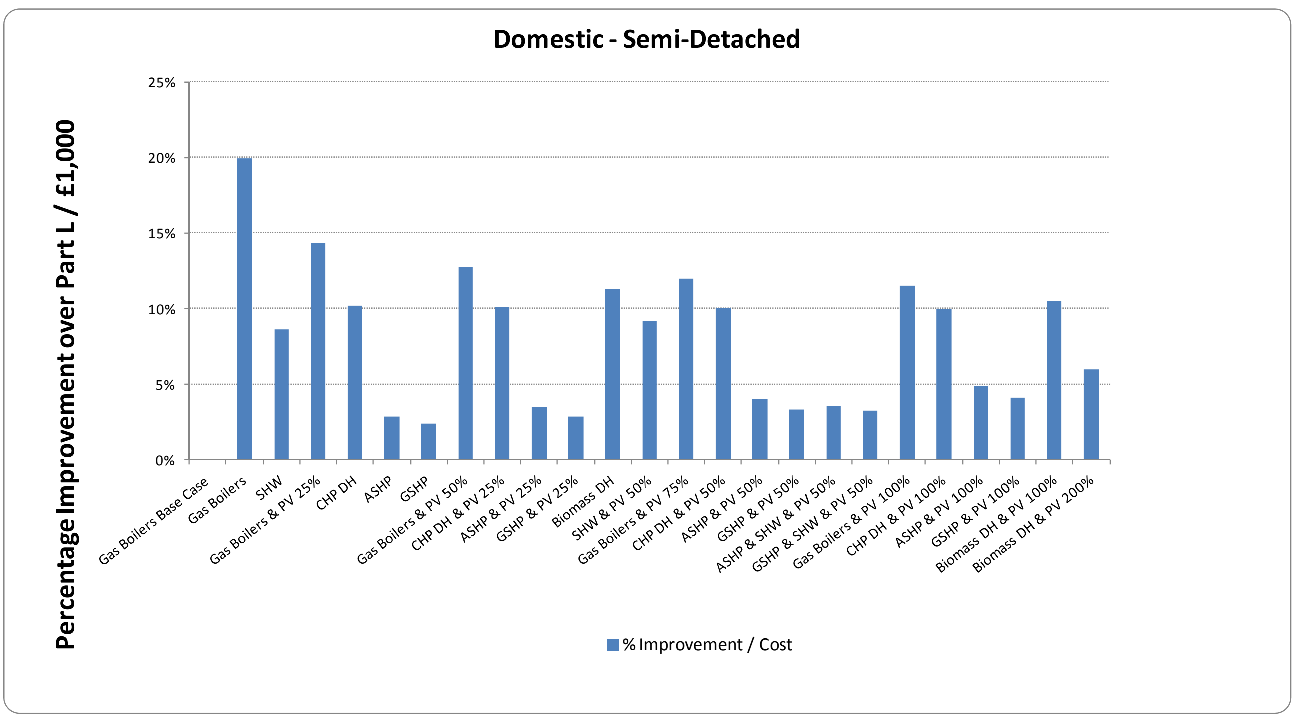

Figure 25: Carbon saving potential per £1,000 additional spend over and above a standard new build semi-detached home

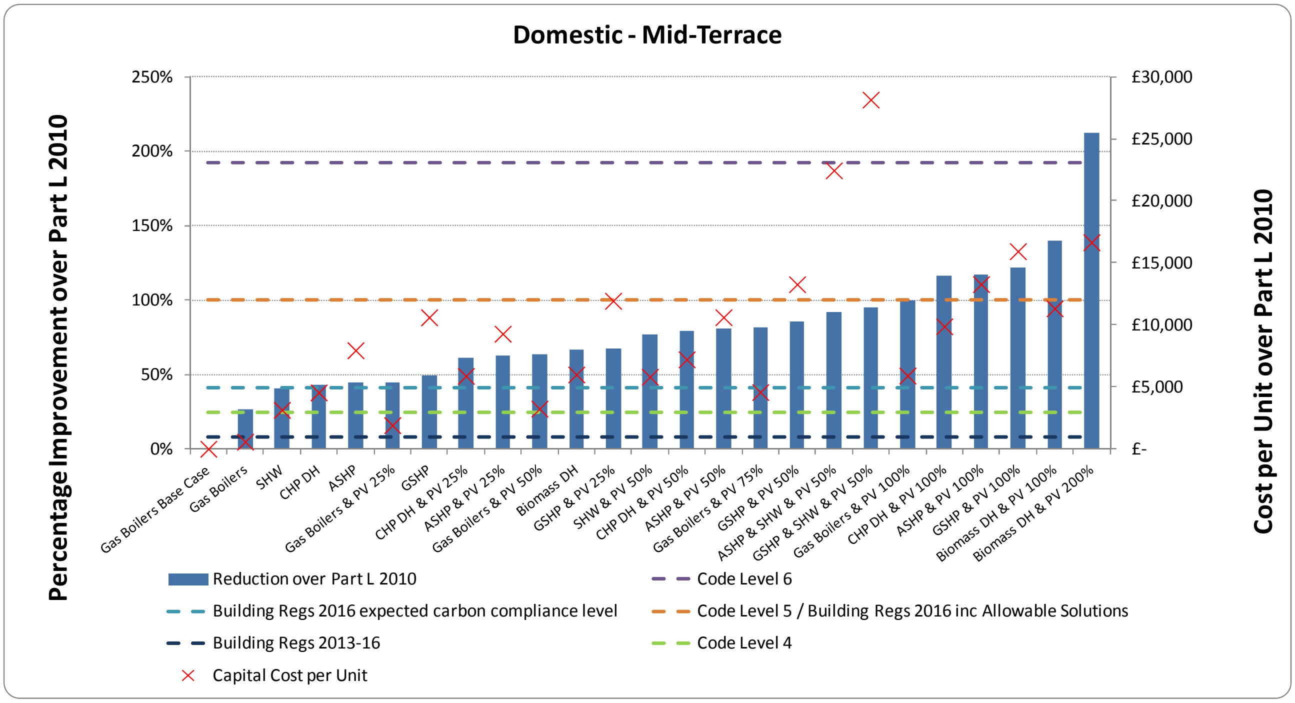

Figure 26: Carbon saving potential of different carbon reduction strategies against cost and targets for new mid-terrace homes

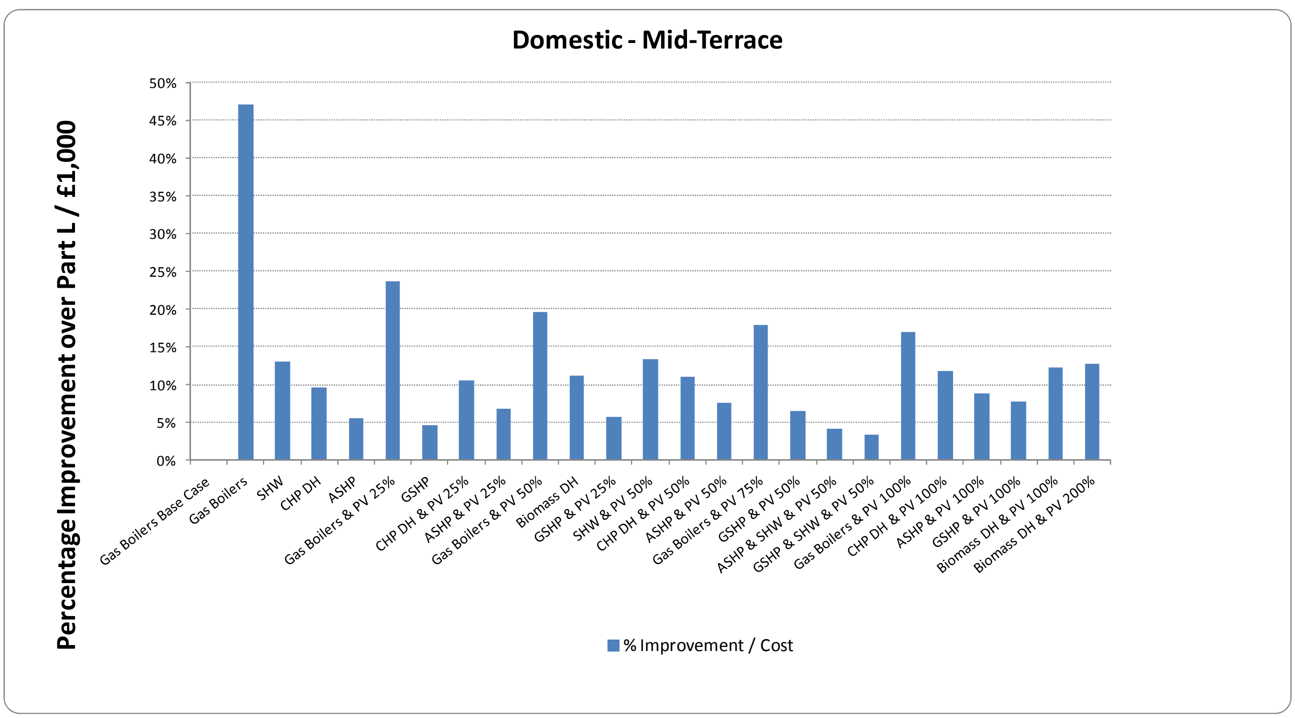

Figure 27: Carbon saving potential per £1,000 additional spend over and above a standard new build mid-terrace home

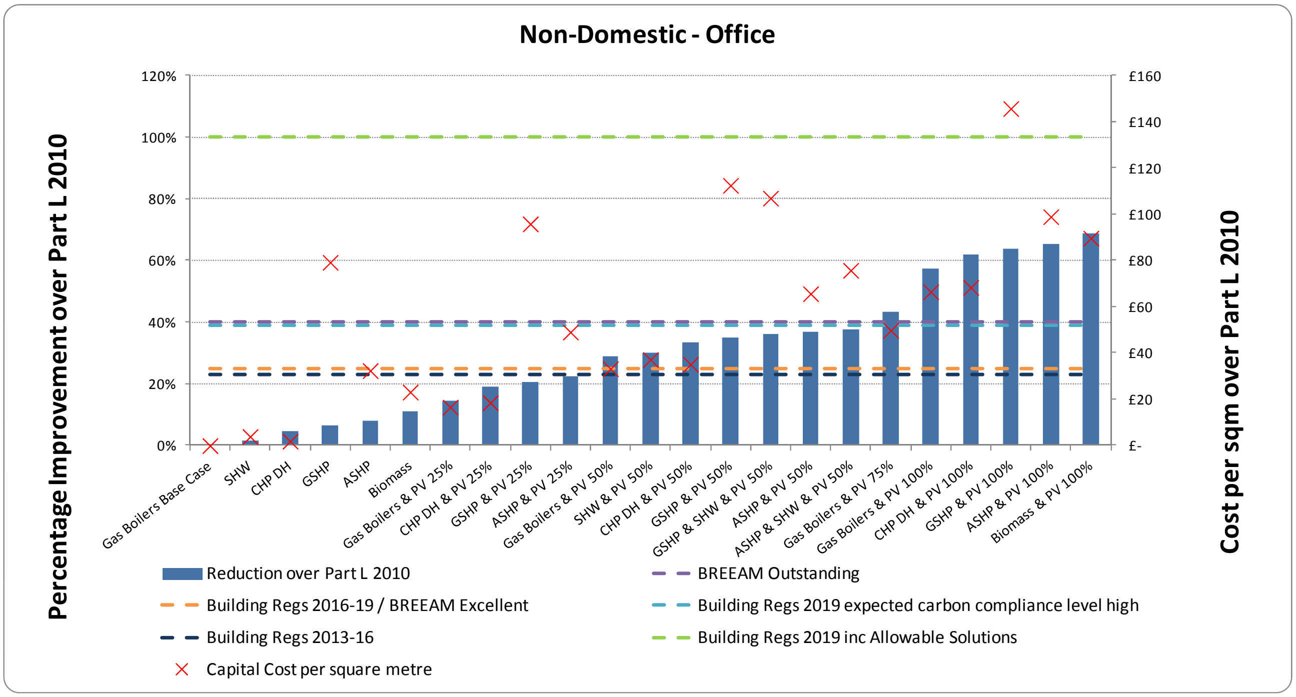

Figure 28: Carbon saving potential of different carbon reduction strategies against cost and targets for new build non-domestic buildings

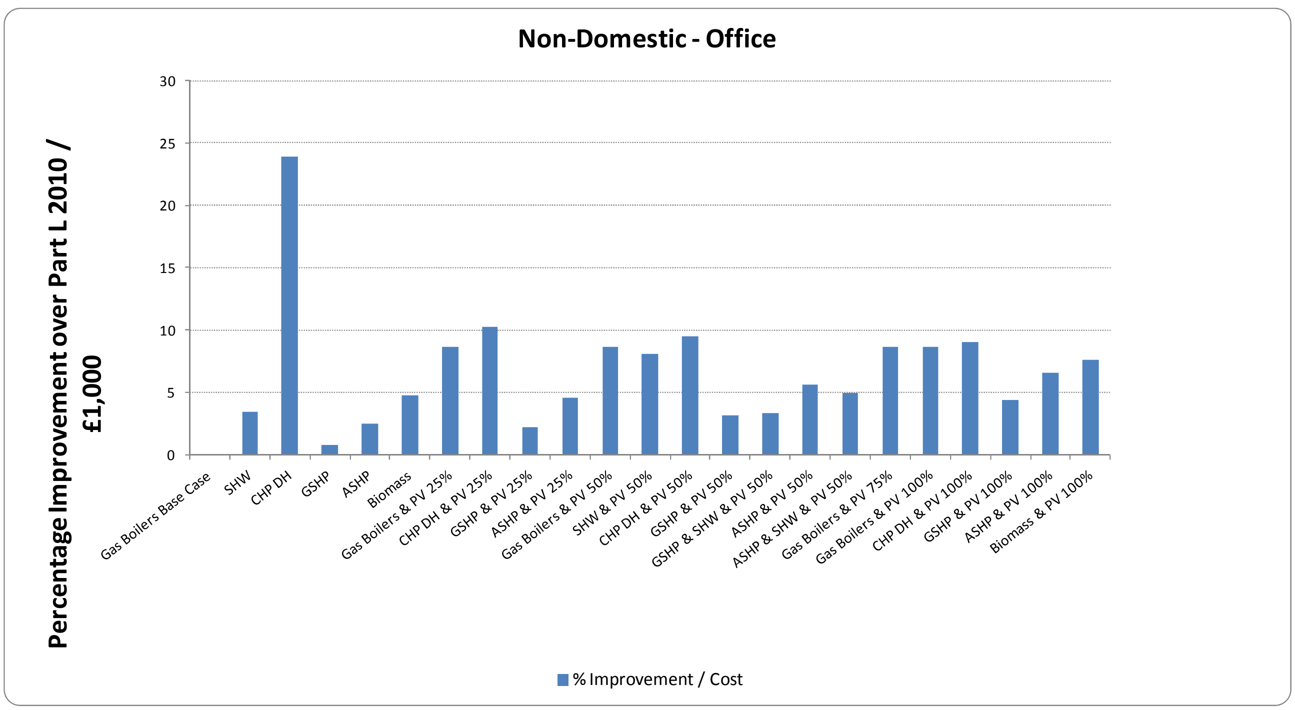

Figure 29: Carbon saving potential per £1,000 additional spend over and above a standard new non-domestic building

Conclusions – Residential / Domestic

The modelling suggests that there are a range of technology options which could potentially achieve expected future Building Regulations targets in 2013 and 2016 (carbon compliance) for domestic properties, although this will depend upon the final targets set by government.

However, fewer of the technology solutions tested were shown to meet the CSH Level 5 target of a 100% on-site reduction in regulated emissions without allowable solutions. Air or ground source heat pumps or biomass heating or CHP combined with PV covering 100% of the roof area (assuming standard roof design) were identified as potential solutions which could potentially meet this target.

Meeting the requirements for Code Level 6 (as it is currently defined) is likely to be more difficult and our analysis only shows one potential solution to this target, the use of biomass and a PV array maximised through the design of the roof.

This target could be technically possible if there is sufficient space on site for the application of these technologies, in particular for the application of design adaptations to increase the available roof space. Similar solutions have been used in existing examples of Code Level 6 houses which have been delivered elsewhere, including the Kingspan Lighthouse at the BRE Innovation Park, Upton in Northampton, Stoneham Green in Southampton and Greenwatt Way in Slough.

Clearly there will be cost implications for all the technology options and the relative scale of these is indicated in the capital cost estimates shown on the graphs – however their overall impact on the viability of delivering development needs to be tested through an open book appraisal of real development options.

Conclusions – non-domestic

The non-domestic modelling suggests that there are a range of technology options which could potentially achieve carbon reductions equivalent to Building Regulations targets in 2013 and 2016, and the Ene1 target required by BREEAM Excellent, and some options for meeting the expected carbon compliance level in 2019, although again this will depend upon the final targets set by government. However it should be noted that in the calculation methodology for non-domestic buildings the '% improvement' is calculated relative to a 'notional building' that uses a set specification in which the same heating system is applied to both. This means that there is no improvement in Building Regulations Part L for using low carbon heating, such as a biomass boiler or gas CHP, systems in place of gas boilers, since the same system is applied to the notional building as well. Our results have shown improvements for different heating systems relative to a gas boiler as we have assumed that this will be calculated and accepted for the purposes of demonstrating CO2 reductions for planning, but for Building Regulations compliance and credit Ene1 in BREEAM, which uses Building Regulations outputs, these savings will not count.

Our modelling identified a limited number of options which might meet the BREEAM Outstanding mandatory Ene1 credit requirement of a 40% reduction over Part L 2010 (currently effectively excluding offsite solutions), or the 39% carbon compliance aggregate reduction over Part L 2010 derived from the high scenario of the CLG's Zero carbon non-domestic buildings Phase 3 final report, July 2011, which is the latest report on future non-domestic Building Regulations beyond 2013. Given the large amount of roof space which could be available for PV options involving 100% PV might meet the target although it should be noted that no development has yet achieved a BREEAM 2011 Outstanding rating in practice.

The fact that it tends to be more difficult for certain types of non-domestic building to meet % reduction targets than for others is intended to be recognised in future non-domestic Building Regulations through setting varied targets for different building types. It is likely that as more work is undertaken to support the future revisions of the Building Regulations for non-domestic buildings in 2016 and 2019 that government will provide further guidance on the application of specific targets to different non-domestic building types.

4.3.5 Offset / Allowable solutions

As highlighted above, the proposed 2016 Building Regulation allows for residual emissions to be offset through a range of potential 'allowable solutions' once FEES and onsite carbon compliance levels have been met. Although the range of 'allowable solutions' and their cost per tonne of carbon saved are yet to be defined the most recent Government impact assessment for the Zero Carbon Homes policy[32] has estimated that the cost to developers of Allowable Solutions would be £46 per tonne of CO_2 per annum, totalled over 30 years. This figure is in present value terms, and assumes, in effect, that this is the cost that the developer would pay upfront on completion of each new dwelling. The Zero Carbon Hub has estimated the potential cost to developer (or revenue generated to pay for offset/allowable solution measures) for different building types based on their relative carbon compliance levels.

Table 15: summary of potential costs for Allowable Solutions for different dwelling types

Building type	Total cost of Allowable Solutions@ £46/tCO2 over 30 yrs, regulated energy only
Detached	£1627
Semi detached	£1159
Terraced house	£1159
Apartment	£1,055

The level of funding that will arise from Allowable Solutions is unknown but it is possible to estimate the approximate level of Allowable Solutions which may be raised from the Local Plan area through future development, based on the numbers above.

Using the growth housing mix assumptions set out above from 2016 through to 2034 (the end of the proposed Plan period) there would be 4000 homes requiring their residual emissions offsetting, generating 341,386 per annum or just over £5.46m over the plan period.

Table 16: Predicted allowable solutions revenue raised

	Houses per annum	Total across from 2016 to 2034	Cost of residual emissions	Revenue per annum	Total revenue raised over 18 year period.
Detached	113	1808	1627	£183,851	£2,941,616
Semi detached	100	1600	1159	£115,900	£1,854,400

[32] CLG, Zero Carbon Homes, Impact Assessment, May 2011

Terrace	25	400	1159	£28,975	£463,600
Apartment	12	192	1055	£12,660	£202,560
Total	**250**	**4000**		**£341,386**	**£5,462,176**

There are three probable ways in which Allowable Solutions might be managed:

- *Local Authority Approved List* – Local authorities could identify and approve a discreet list of measures, projects and activities for reducing carbon. These could be identified by the authority based on an assessment of local opportunities, or they could request local delivery partners to come forward with projects they would like to deliver and support those that are deemed suitable. If this is the preferred approach, then this should be set out as a local policy.
- *Local Authority Managed* – Local authorities may elect to manage the collection and spending of Allowable Solution Money, allowing funding to accrue to a level high enough for delivering strategic or priority infrastructure. Setting out that policy for a local carbon fund would enable this approach to be safeguarded.
- *National Allowables pot* – In the event that local authorities are not in a position to approve or manage Allowable Solutions, the money will be paid into a national pot from which national priority projects can be funded.

In lieu of any other charging mechanism that might be brought in as part of zero carbon policy associated with proposed changes to Building Regulations in 2016, the only legal mechanism open to local authorities to charge developers a variable rate dependent on the level of residual emissions that require offsetting is through Section 106 (s106) payments. The Community Infrastructure Levy (CIL), the other mechanism for charging developers, is not appropriate as it applies a fixed tariff that cannot take account of the variable rates of residual carbon emission to be offset.

It should be noted that the price/cost of £46 per residual tonne of residual carbon does not necessarily mean that there will be sufficient funding generated to offset one tonne of carbon for every one residual tonne generated. At present, this figure is only likely to cover the retrofit of basic efficiency improvements in existing homes, which means that it is potentially competing with other funding sources such as the Green Deal. It is likely that this figure will change in the future depending on the scale of local offset opportunities. To broaden the economies of scale to spending allowable solutions revenue, the SNDPA may wish to work with the partner Local Authorises in leveraging spending that can have more of an impact. The importance of partnership working is crucial to the SDNPA which, unlike other Local Authorities is not a housing authority.

4.4 Stakeholder workshop feedback

Discussed below are the key themes raised at the stakeholder workshop relating to new development. The objectives of the workshop were to establish aspirations; discuss the implications [positive and negative] of setting performance targets for new development; identify barriers and opportunities associated with achieving such standards and recommend actions for the South Downs National Park to consider as part of the development of the 'development plan'.

- **SDNPA should set ambitious targets** – The group suggested that as the national parks have a remit to enhance and protect the natural environment, development should aspire for higher sustainability standards. As such, the group immediately suggested that the South Downs National Park Authority should be aiming for all new development to achieve the highest viable [evidence based] sustainability standard such as BREEAM Outstanding for non domestic buildings and Code for Sustainable Homes Level 6 for residential development. This was tempered however on consideration of the cost implications which are likely to restrict achieving higher levels of code. Similarly, to achieve higher targets more strategic renewable and low carbon infrastructure might be required which may not fit with wider landscape / environmental aspirations.

- **Opportunities should be sought to use development standards to leverage wider social and economic benefits** – There was strong recognition that new development could act as a catalyst for new 'green' business opportunities across the region. As such if higher performance standards were achieved on new development, knowledge and experience gained from delivering buildings to such standards could empower and contribute to wider social and economic regeneration across the national park.
- **Focus on clustered development** - Following a discussion regarding future predicted performance standards and potential measures required to achieve such standards [see attached] the group focused the discussion on 'clusters' of new development, rather than on 'individual' buildings, and what appropriate standards should be considered. It was agreed by all parties that it is critical that the 'highest' sustainability standards should be set with regards to 'clusters' of new development. Clusters of development are more likely to be able to achieve higher sustainability standards as wider energy strategies can be employed to address anticipated performance standards. Similarly it was also discussed that a wider energy strategy associated with clusters of new development could also expand to evaluate potential connectivity and improvements to existing development within the immediate vicinity.
- **District heating potential** - District heating opportunities were widely praised as a solution that should be seriously considered for both new development sites and also as a means to regenerate/enhance the performance of an existing area. However, the group considered that the perception of district heating was currently associated with 'social housing' and of buildings that have problems with heating due to lack of occupant control. Communication on modern district heating solutions was identified as a means to overcome existing perception. In addition, it was recognised that the opportunities associated with district heating are likely to be limited in areas of the national park that have low density, detached housing. Potential district heating opportunities include connection to existing farm estates, and the use of biomass to fuel off grid areas.
- **Communication and support** - Throughout the workshop the issue of clear communication from the national park was discussed. It was recognised that in order for the national park to reduce its overall carbon emissions then a proactive and clear communication strategy must be in place. Advice on how performance targets can be achieved, and why performance targets should be set should be clearly communicated to all stakeholders. A proactive approach should assist the national park in achieving a high level of 'buy in' from stakeholders and developers. As such a clear message should be developed from the national park with regards to ambition and direction of policy.

- **Variable standards based on development scale** - The viability of performance standards was discussed in further detail by the group. It was recognised that the performance standard that could be achieved would depend on the size and experience of the developer. The group suggested that larger developers, particularly of non domestic schemes should be expected to achieve higher standards, whilst smaller developers, such as an individual house builder would not necessarily have the resource available to achieve higher standards. As such a blanket standard was unlikely to work in practice. To address this it was recognised that the national park planning officers should have the knowledge, experience and evidence to set sustainability standards according to the development type, whilst be able to promote and support the uptake of higher performance targets though clear communication across the national park authority.
- **Developers may require incentivising** - The group highlighted that in order for higher standards to be achieved there may need to be incentives to the developer. Incentives could either be a 'carrot' or a 'stick' approach or a combination of both. Whilst, not a policy that the South Downs National Park could implement, one suggestion included reducing VAT on schemes that delivered higher standards.
- **Developing bespoke standards** - Finally, the group discussed whether the national park could develop its own sustainability standard rather than rely on existing BREEAM and Code for Sustainable Home assessment methods. Should any standard be developed then consideration should be given to wider sustainability issues, not just focusing on energy reduction, such as water and waste consumption, social and economic regeneration. Any standard should also base decisions on life cycle costs rather than simply capital costs.

4.5 Implications for the Management Plan, Local Plan and Next Steps

Given the environmental protection and management remit of the SDNPA, it is only right that policies for new development should meet the highest reasonable standards of sustainability. This however needs to be balanced with a wider remit to support economic and social prosperity; particularly in regard to delivering more affordable housing and not restricting the viability of development.

The above analysis highlights that Building Regulations are set to become increasingly stringent, but are being designed to offer a flexible way to reduce total carbon emissions through a combination of building energy efficiency, on site carbon compliance and a suite of allowable solutions on or off site (depending on what offers the most cost effective way of reducing emissions overall). Meeting the carbon compliance requirements of Building Regulations is relatively straightforward; no more onerous than meeting Code for Sustainable Homes Level 4 for residential development which is now a standard expectation.

Options to meet a 100% reduction in regulated emissions onsite (equivalent of Code for Sustainable Homes level 5 or meeting 2016/2019 Building Regulations without using Allowable Solutions offsite) is however increasingly limited and expensive. For the average detached property the modelling suggests that this would add around c£15k to standards build costs[33]. Furthermore, there is an increasing need for more strategic infrastructure to meet these higher standards which require equally strategic scales of

[33] Note that these costs are just for meeting the energy and there are likely to be additional costs for meeting other sustainability topic credits.

development to benefit from economies of scale to warrant investment and are likely to have a more significant impact on the landscape. Code for Sustainable Homes level 6 is even more constrained by limited options and cost. Similarly, some non-domestic uses are likely to struggle to meet the 2019 Building Regulations carbon compliance and even less BREEAM Outstanding.

The proposal for the use of offsite ‘allowable solutions’ is therefore designed to achieve an equivalent level of carbon savings through other measures i.e. retrofitting existing properties. The Government has tested a figure of £46 per tonne of residual carbon over a 30 year building life (i.e. £1,380 per tonne) to pay for allowable solutions. Although this cost of carbon is not fixed and should be defined based on local opportunities, it would ideally deliver one tonne of carbon saving for every one tonne of residual emissions i.e. £46 would pay for a one tonne saving elsewhere. As the types of measures that can deliver a one tonne saving for £46 is limited to basic measures such as loft insulation, the ability to achieve a one tonne saving for every tonne of residual emissions is restricted to the scale of carbon reduction measures available i.e. how many lofts can be insulated. The above analysis shows that there is significant potential for carbon savings through basic measures and allowable solutions could offer a mechanism to pay for these. However, this would put the allowable solutions revenue in the same market as the Green Deal, which is also designed to pay for basic energy efficiency measures. To avoid competition, the allowable solutions could pay for harder to reach measures. These, however are more expensive and as such to achieve a one tonne saving for every residual tonne the cost of carbon would increase, or the SDNPA would have to accept a lower offset ratio than one to one.

As a result, it would be difficult for the SDNPA to justify a carbon reduction target significantly higher than that proposed by Building Regulations. More cost efficient carbon savings should be sought through the development of locally defined allowable solutions to work in conjunction with the Green Deal.

Determining the potential and evaluating the appropriateness of strategic renewable and low carbon resources

5. Determining the potential and appropriateness of strategic renewable and low carbon technologies

5.1 Introduction

The analysis in the previous chapters evaluates the scale of potential carbon reduction measures from the existing buildings within the South Downs National Park. It highlights that to make proportionate progress towards meeting the Climate Change Act's target of 80% reduction in emission by 2050 over the Local Plan period to 2034 then all opportunities to retrofit efficiency measures, switch off-grid fuel sources and utilise micro-generation would need to be realised. Given current uptake rates, this is highly unlikely even with new funding through the Green Deal and ECO. Furthermore, even if all these measures could be delivered, there would still be a significant shortfall from meeting the overall 80% reduction target of around 172,000tCO_2/yr.

Once opportunities for demand reduction are exhausted, further carbon reduction can only be achieved through lowering the carbon content within the energy supply. This section therefore draws on DECC's Renewable and Low-carbon Energy Capacity Methodology for the English Regions (2010) to estimate the total theoretical potential for low carbon and renewable energy supply drawn from resources within the South Downs National Park. However, while the SDNPA has a responsibility to protect the special nature of the South Downs from potential threats such as those posed by climate change, these longer term risks need to be balanced with the need to protect the character of the area. As such, this chapter also presents some of the key issues in assessing the appropriateness of different technologies within different areas across the South Downs National Park. First however, is an audit of the renewable and low carbon technology already installed within the National Park.

Unlike energy use which is reported in terms of energy use over time (kWh), renewable and low carbon energy infrastructure is reported in terms of installed capacity (i.e. kW). The energy output from these installations is dependent on their efficiency in generating energy and the way in which they are used. Where possible, efficiency factors have been included here to show the potential output.

5.2 Audit of existing renewable and low carbon technology in the SDNP –

Unfortunately, there is no comprehensive up-to-date database for renewable energy installations in the UK. To develop an accurate picture for South Downs National Park required drawing on a number of resources. The databases consulted include:

- Renewable Energy Statistics for the UK (RESTATS)
- RenewableUK
- International Small Hydro Atlas

Records for micro-generation installations are imprecise as most can be installed as permitted development and do not require planning permission. However, it is possible to estimate the amount installed in South Downs National Park.

While uptake of renewable energy has been modest, it has increased substantially since the introduction of the feed-in tariff incentives in April 2010. The FiT database[34] provides an accurate portrait of the amount of renewable energy installed since its introduction for each local authority area. Because SDNPA's borders cut across portions of 15 different local authorities, the amount of micro-generation installed in the national park had to be estimated based on population. Similarly, the number of installations before the introduction of FiTs, a similar population-based estimate was used to break down the estimated 100,000 national installations to local authority level.[35] Similarly, biomass heating is difficult to assess. As such, an estimate is based on local intelligence.

Table 17: Renewable Energy Installed Capacity in South Downs National Park

Renewable Energy Type	kW Capacity
PV Farm	200
Wind-(onshore)	850
Microgen (FiT)	3,033
Biomass (heat)	c1,500
Total	**5,583**

5.3 Renewable and Low Carbon Energy Resource

This assessment uses an adapted version of the Energy Capacity Methodology for the English Regions (2010) to provide a theoretical maximum energy generation from the South Down's resources. There are also a number of existing studies, including:

- Review of Renewable and Decentralised Energy in South East England (2010)
- West Sussex Sustainable Energy Study (CSE/LUC, 2009)
- Brighton and Hove Renewable and Sustainable Energy Study (AECOM, 2012)
- Eastbourne Renewable Energy Potential Study (AECOM, 2009)
- Lewes Renewable Energy and Low Carbon Development Study (AECOM, 2010)

Although these studies provide useful context on which this study can draw, their geographical coverage is defined by local authority boundaries; as such, they are not wholly representative of the South Downs. This study provides an update specific to the spatial coverage of the South Downs National Park.

[34] Ofgem E-serve FiT database (2012) https://www.renewablesandchp.ofgem.gov.uk/Public/ReportManager.aspx?ReportVisibility=1&ReportCategory=0

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

5.3.1 Wind – Large Scale

DECC[36] typically classify wind turbines as either commercial scale [between 600 kW and 2,500 kW installed capacity[37]] or small scale [less than 100 kW]. The industry standard for planning applications associated with commercial scale wind farms is however typically at least 2.5 MW installed capacity. Turbines of this capacity typically range from 100m to 165m in tip height, with an average of 135m. For comparison, the wind turbine at Glyndebourne is an 850kW turbine and stands 67m tall.

A single large 2.5MW turbine will save around 3,4160tCO_2/yr[38]. As such, to mitigate for the remaining 172,000 tCO_2/yr required to achieve an 80% reduction in emissions by 2050 would require 50 large turbines to be installed. Alternatively an 850kW turbine will deliver around 1160 tCO_2/yr saving, requiring 148 turbines to mitigate for the remaining emissions.

The theoretic maximum potential wind resource for a given wind turbine size can be determined by an understanding of the available wind resource [i.e. suitable wind speed], existing environmental including historic constraints, and physical constraints to development [i.e. proximity to roads and buildings]. Once the theoretical maximum potential wind resource has been established, consideration should then be given to potential landscape and visual impacts associated with potential development. A brief summary of each of the above issues is given below.

Available Wind Resource

The available wind resource is determined by the total area of land within the South Downs National Park that is considered to have a commercially viable average wind speed. The definition of a commercially viable wind speed depends on the size and type of wind turbine. DECC[39] typically classify wind turbines as either commercial scale [between 600 kW and 2,500 kW installed capacity[40]] or small scale [less than 100 kW].

The industry standard for planning applications associated with commercial scale wind turbines is typically at least 2.5 MW installed capacity. Turbines of this capacity typically range from 100m to 165m in tip height, with an average of 135m. The benchmark used for the minimum commercially viable average wind speed varies between 5m/s and 7m/s at 45m above ground level (agl). However, in practice, most developers currently consider sites with wind speeds of over 6m/s at 45m agl.

The table below confirms the total available area of land that is considered to be viable for 'commercial' scale wind energy technologies.

[36] Renewable and Low-carbon Energy Capacity Methodology - Methodology for the English Regions, January 2010
[37] For instance the turbine at Glyndebourne is 850kW
[38] 2.5MW turbine with a load factor of 30% (A Low Carbon Revolution - The Welsh Assembly Government Energy Policy Statement, Appendix 1) using a carbon factor of 0.52037
[39] Renewable and Low-carbon Energy Capacity Methodology - Methodology for the English Regions, January 2010
[40] For instance the turbine at Glyndebourne is 850kW

Table 18: Available Wind Resource at 45m agl

	AAWS greater than 6m/s	AAWS greater than 7m/s	AAWS greater than 8m/s
Available wind resource [km^2]	552	187	22

The maps below illustrate the location of available wind resource for 'commercial' scale wind turbines. The average annual wind speed map for commercial scale wind turbines confirms that the majority of area covered by the South Downs National Park Authority has sufficient average annual wind speed for commercial scale wind energy generation. The greatest available wind speeds, i.e. greater than 8 m/s are as expected, located on the highest areas of the South Downs. The areas that do not have sufficient average annual wind speed for commercial scale wind energy generation are located to the leeward side of the South Downs, e.g. the low lying land between Petersfield, Midhurst and Marehill. Similarly the low lying areas associated with the River Arun and the River Ouse do not have a suitable average annual wind speed for commercial scale wind energy technology.

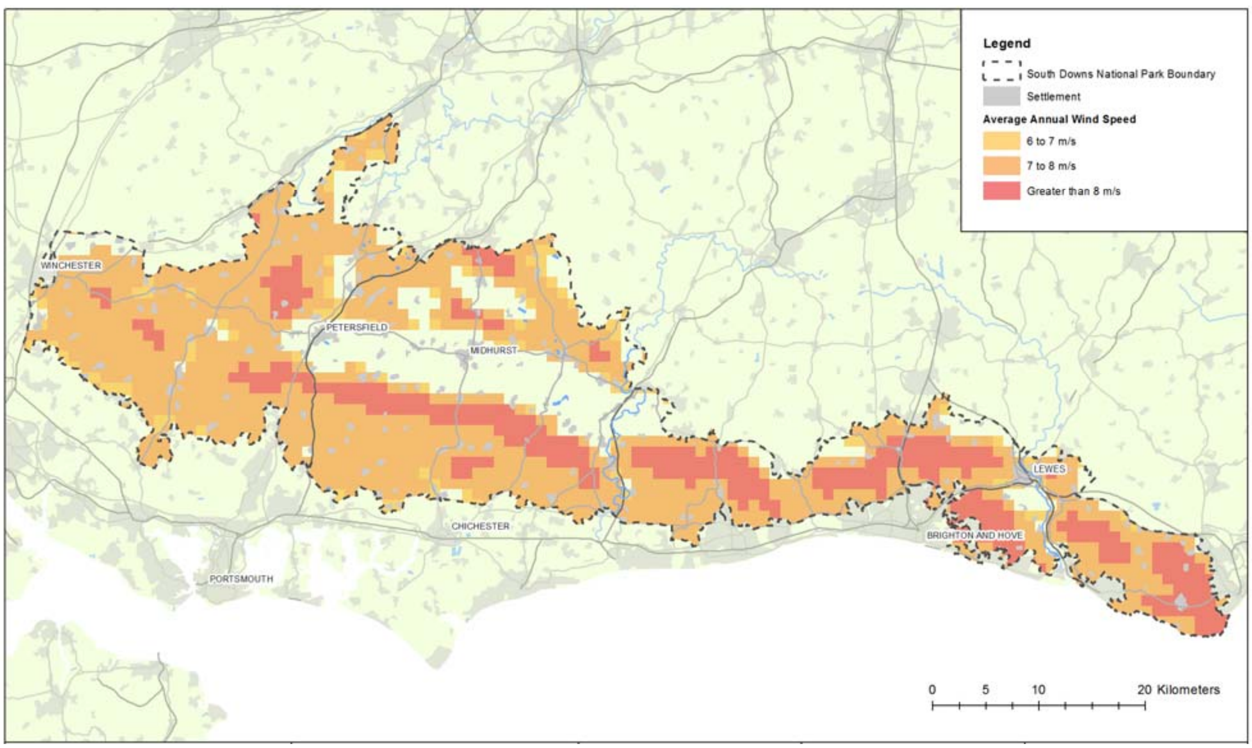

Figure 30: Windspeed at 45m

Ecological and Historic Constraints

Wind energy development is unlikely to be permitted in areas where that have been designated for their ecological or historic interest. For the purpose of this study, and in accordance with the DECC methodology[41] the following ecological and historical designated sites are considered to be areas where no wind turbine deployment can be made.

- Ancient Woodland
- International and national nature conservation designations [including National Nature Reserve; RAMSAR Site; Special Area of Conservation; Special Protection Area; and Site of Special Scientific Interest]
- Sites of historic interest [including Listed Buildings; Scheduled Ancient Monuments; Registered Park and Gardens; and Registered Historic Battlefields]

It is recognised that there are likely to be additional ecological and historic constraints, such as Country Parks and bat fly-lines which may also exclude deployment of wind energy technologies. However, this study has considered only those 'constraints' that are identified within the DECC methodology.

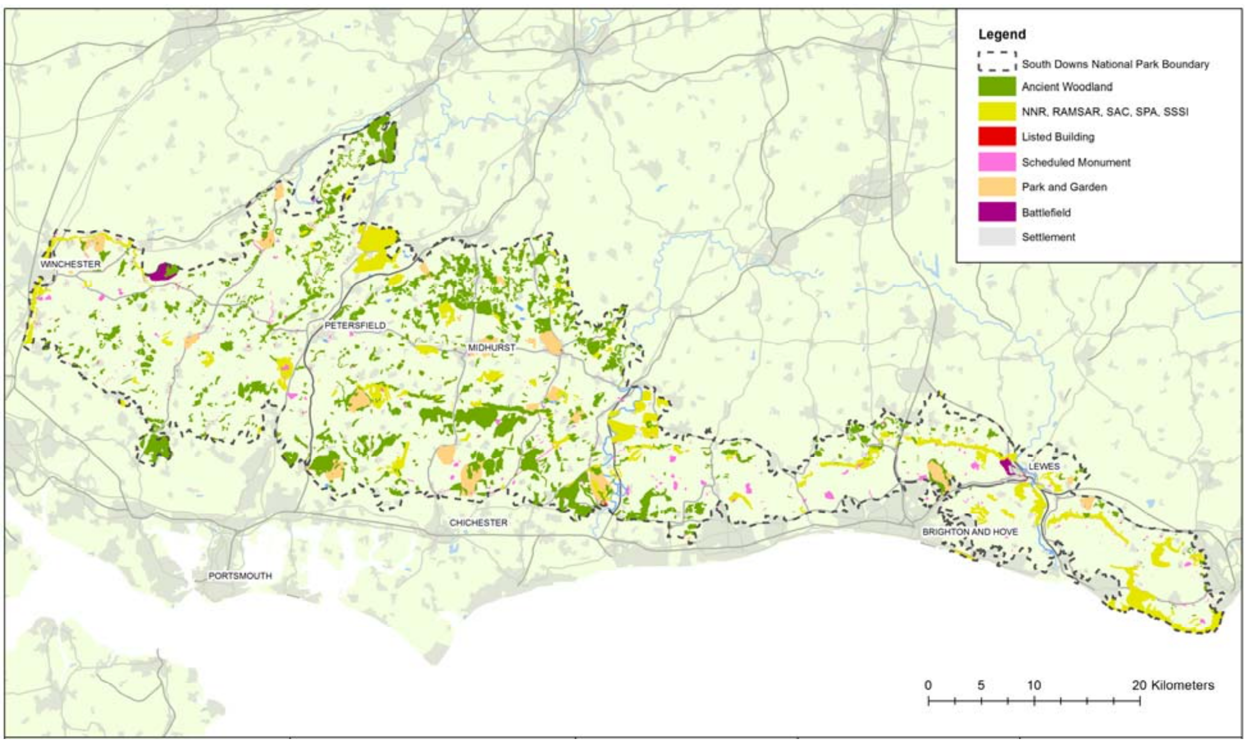

Figure 31: Ecological and Historic Constraints

Physical Constraints

The final set of constraints that have been considered here are associated with identifying the potential theoretic maximum wind resource associated with physical constraints. Physical constraints will depend

[41] Renewable and Low-carbon Energy Capacity Methodology - Methodology for the English Regions, January 2010

on the size of turbine, for example, a turbine should not be deployed within the ‘topple distance’ of major road and rail infrastructure, or within proximity to existing electrical transmission lines.

Physical constraints consider the potential noise impact to residential properties associated with wind turbines. The extent of the exclusion area varies from 400 to 600m. In practice, the minimum distance required between a wind farm and residential property is site-specific, dependant on the proposed turbine and ambient background noise. There is no definitive guidance on this issue. However, the DECC methodology suggests that the minimum buffer distance that is required for a 2.5MW turbine (to take account of safety and noise constraints) is 600m.

A summary of physical constraints associated with a commercial scale wind turbine is listed below.

A map illustrating the geographical extent of ‘physical constraints’ associated with commercial scale wind turbines is given below.

Table 19: Physical Constraints

	Exclusion Zone
Proximity to Civil Aviation Aerodrome	5 km
Proximity to Electrical Transmission Lines	300 m
Interference with Air Traffic Control Radar	Height of turbine [140m]
Proximity to Transport Network	150 m
Proximity to Water Courses	Boundary of Water Course
Potential Noise Impact to Dwellings	600m

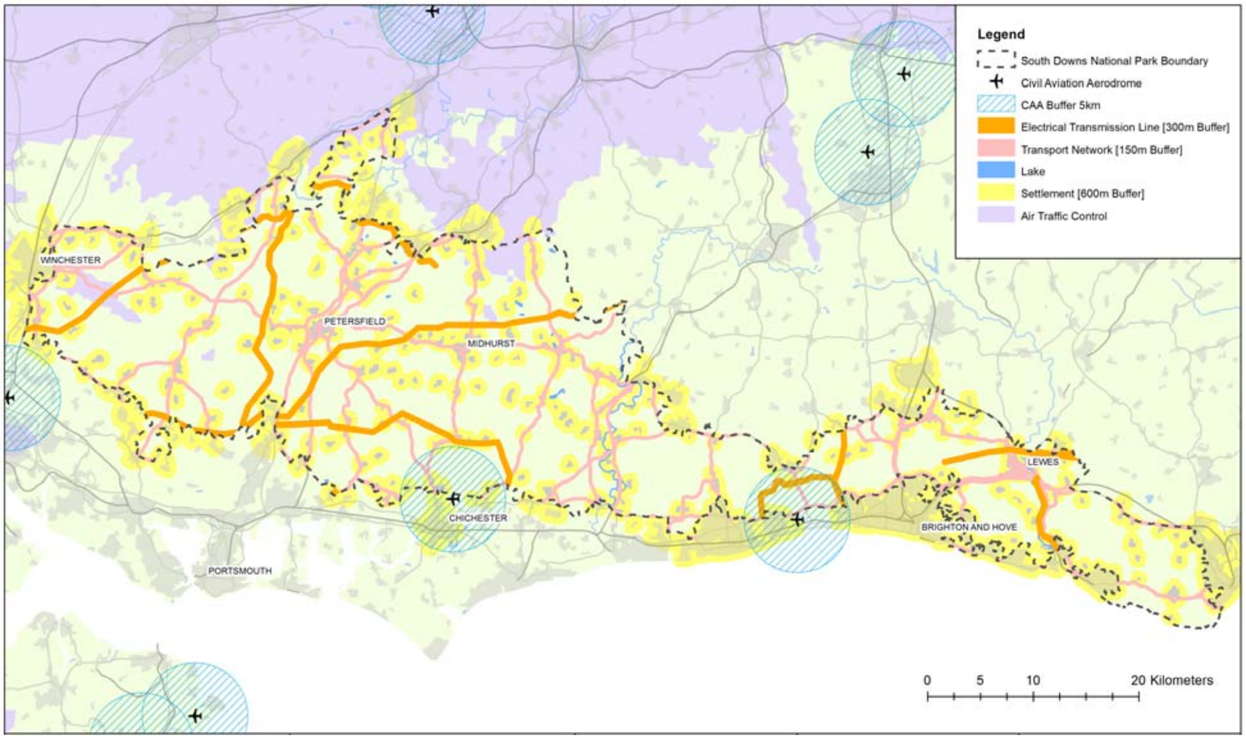

Figure 32: Physical Constraints

Theoretical maximum potential wind resource

The map below illustrates the geographical extent of the theoretical maximum potential wind resource associated with commercial scale wind turbines.

The theoretical maximum potential wind resource takes into consideration the minimum average annual wind speed, existing ecological and historic constraints and physical constraints associated with individual wind turbine sizes.

Table 28 confirms the theoretical maximum potential wind resource [km^2] for 'commercial' scale wind energy. The DECC methodology assumes a maximum installed capacity per km^2 of 9 MW of a 'commercial' scale wind turbine.

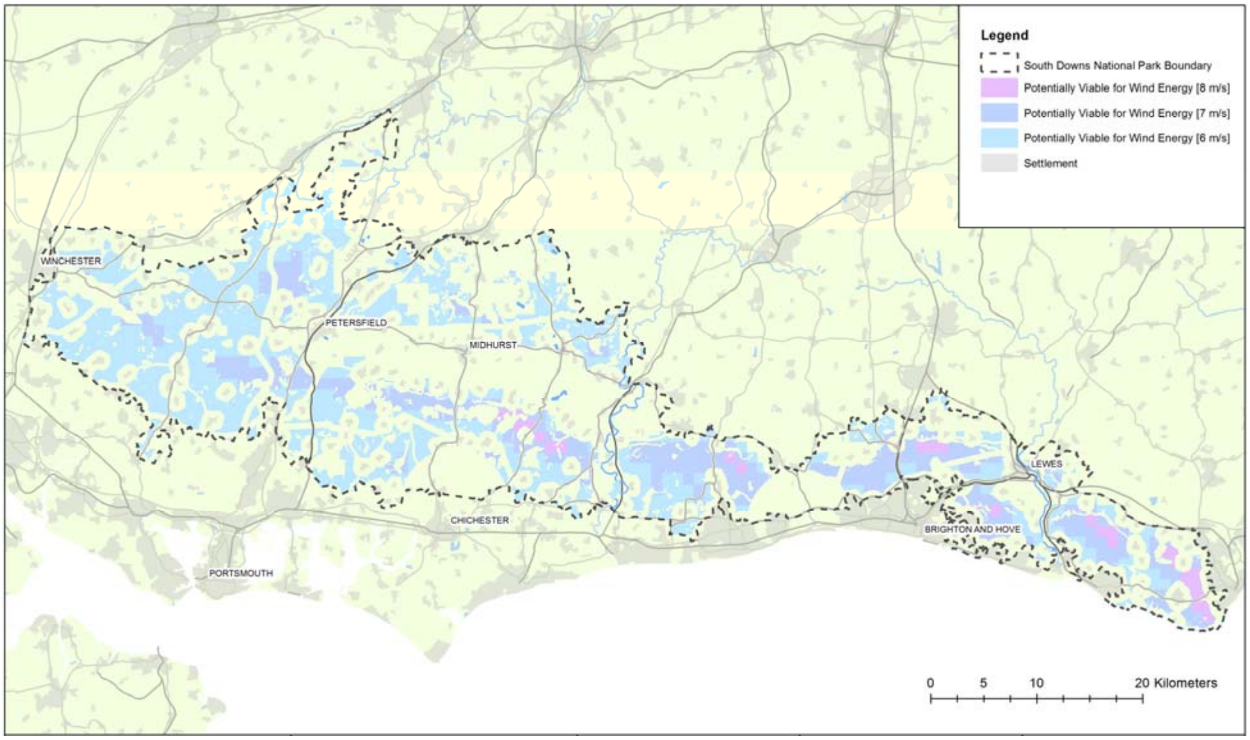

Figure 33: Theoretical practical wind resource for large turbines

Table 20: The theoretical maximum potential wind resource – Commercial Scale

	AAWS greater than 6m/s	AAWS greater than 7m/s	AAWS greater than 8m/s
Potential Area	552 km^2	187 km^2	22 km^2
Installed capacity per area	9 MW	9 MW	9 MW
Installed capacity	**4,968 MW**	**1,683 MW**	**198 MW**
Hours Operational	8,760	8,760	8,760
Capacity Factor	10%	10%	10%
Energy Generated	**4,351,092MWh**	**1,474,308MWh**	**173,448MWh**

Landscape Character and Visual Sensitivity

Although landscape character is not included in the DECC methodology, as by nature it includes a level of subjectivity, it is central to the debate around wind development. The Countryside Agency Guidance on Landscape Character Assessment (2002) advises that in such circumstances relating to subjective elements, it is important that judgements are made in a transparent and systematic manner.

The South Downs Integrated Landscape Character Assessment (2011 Updated) follows the Landscape Character Assessment: Guidance for England and Scotland methodology which sets out the best practice approach to providing a clear hierarchy of assessment and links to existing character. Although it provides a thorough analysis of the character and highlights that some areas are more sensitive to change than others, it does not provide an assessment of the landscape's capacity for change (other than accepting that climate change is likely to increase pressure for renewable infrastructure including wind development.

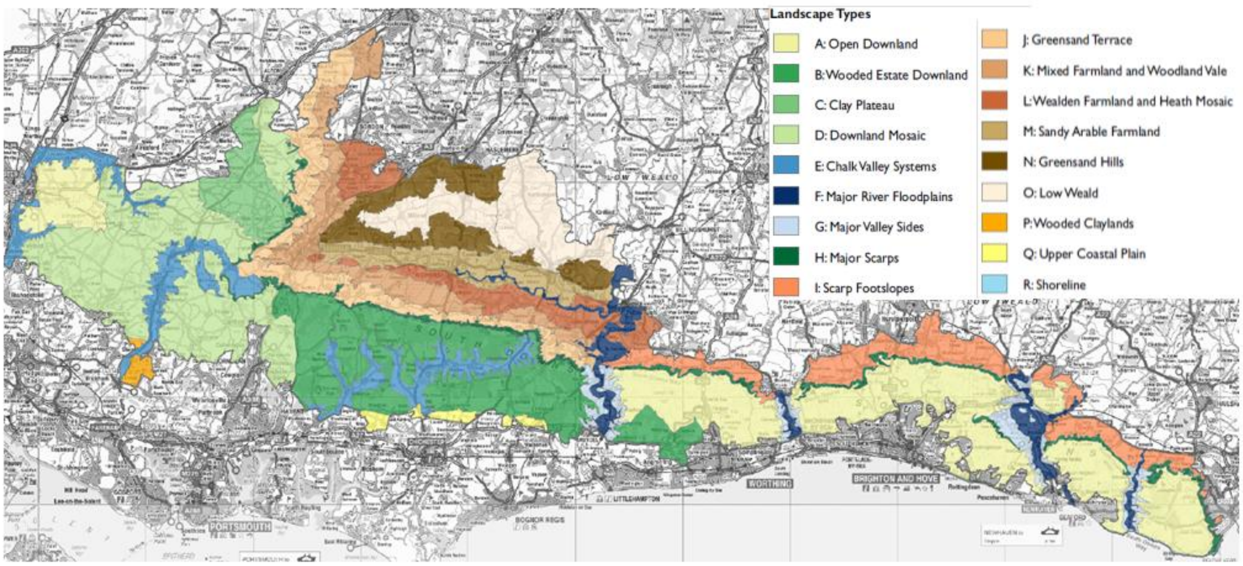

Figure 34: The landscape character of the South Downs

The visual impact associated with the deployment of a commercial scale wind turbine is highly subjective and typically depends on a variety of factors including the size, number, type, and location of wind turbines. However, to provide an indication as to the 'visibility' of a commercial scale wind turbine a 3D model of the SDNPA was developed to calculate the number of locations that could 'view' each area at 135m agl. Thus areas that were on the whole visible from a greater number of locations across the whole of the SDNP are highlighted as a being more sensitive than those that were visible from a smaller number of locations. This information is illustrated in the context of 'potentially available wind resource areas'. It should be noted that this is a spatial representation as to where turbines could be viewed from to give an indication of the overall impact on the South Downs rather than taking into consideration the number of potential viewers.

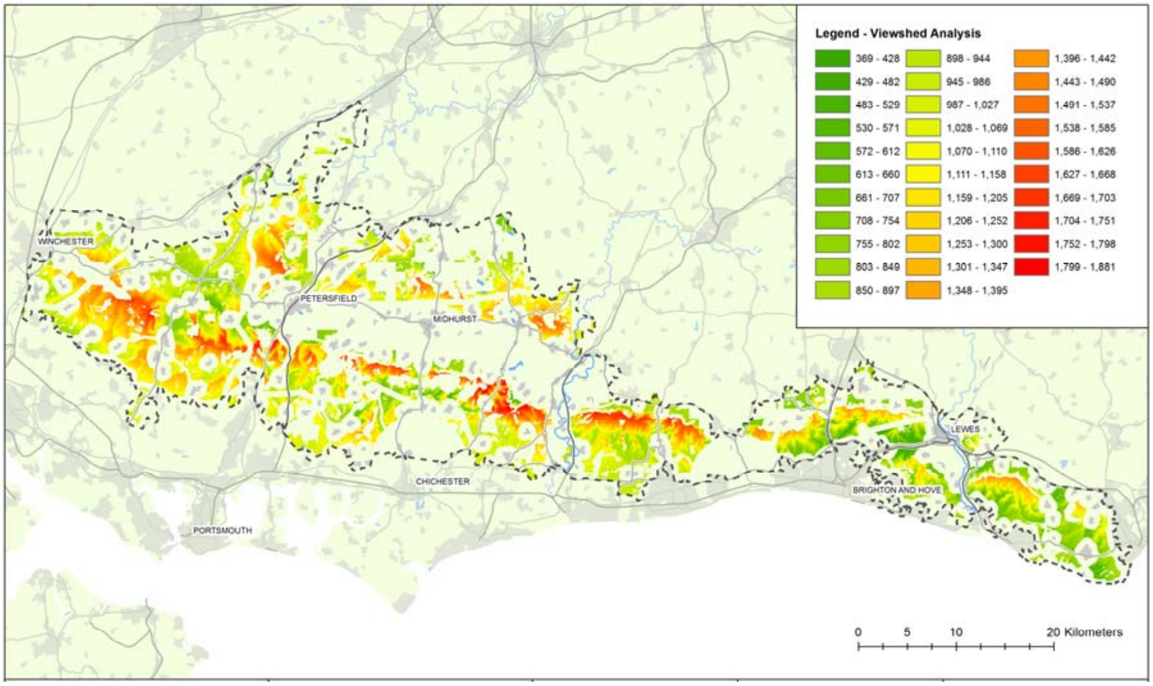

Figure 35: Relative visual impact for large wind turbines

Other Practical Considerations

Large scale wind presents by far the greatest opportunity for renewable energy generation in the Local Plan area. The practical wind resource plan highlights at a broad level that there is significant opportunity for deployment throughout the Local Plan area. Although these areas present preferential areas for exploration, further detailed feasibility studies would have to consider a number of additional locational constraints before any site could be confirmed, including the issues below. The NPPF refers to the issues cited in the National Planning Statement for renewable energy, which sets out all considerations in some detail.

- **Local Wind Resource Survey** - This study is not a sufficient evidence base for the actual positioning and delivery of wind turbines, but it gives a high level assessment of potential capacity areas to investigate 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.
- **Aeronautical and Defence Impacts** – Wind turbines may interfere directly with the operation of aeronautical and defence equipment. Whilst safeguarded areas have been taken into account for all operational civilian and military airfields, consultation will have to be undertaken with MoD and nearby airport authorities to determine particular constraints in the area and possible mitigation strategies.
- **Grid connection and Sub Station Requirements** – While this study has not identified any strategic infrastructure constraints, 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 location aspects and additional infrastructure. This may require developers to consider sites which are close to the existing infrastructure, or methods of mitigation (such as building underground sub stations and connections). UK has now moved to a 'connect and manage' approach to offering transmission connections to generators. This means that National Grid is obliged to offer connection within a set period of time (currently 3 years). As such, grid capacity is less of an issue/risk for developers than it has been in the past. *Quantification of constraints on the Growth of UK Renewable Generating Capacity* (SKM 2008) highlights that connection and transmission remain viability constraints, although planning is potentially the main barrier to enabling development. Furthermore, *Growth Scenarios for UK Renewables Generation and Implications for future Developments and Operation of Electricity Networks* (SKM, 2008) includes growth scenarios for different renewable technologies - including a high wind scenario – in which it suggests that each of the 17 critical network boundaries identified in National Grid's Seven Year Statement have capacity for additional wind resource.

- **Flood risk –** As with all development, flood risk needs to be a key consideration.
- **Blade Glint Modelling** – Blade glint is the reflection of light from a turbine 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; its effects have not been specifically considered in this study. 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 and where this may be an issue. Mitigation usually takes the form of suspension in operating hours for offending turbines. 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[42].
- **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 around the site.

[42] Erickson, Wallace P.; Johnson, Gregory D.; Young, David P. Jr. 2005. A summary and comparison of bird mortality from anthropogenic causes with an emphasis on collisions for the US Forestry Service.

- **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 proposed 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.
- **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** – Whilst designated archaeological sites have been considered, any impacts on archaeology in the area would have to be assessed through 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.
- **Noise implications** - Concerns over noise can be related to perception rather than actual experience[43]. 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.

In addition to these practical constraints, there are a number of social and political concerns over the deployment of wind turbines. To ensure wind energy development is delivered appropriately, SDNPA and the partner Local Authorities should work with developers to make sure wind turbines are well placed.

5.3.2 Wind – Small Scale

Small scale wind installations are defined as having capacity of less than 100 kW and typically comprise single turbines. A 100 kW turbine could be expected to save around 140tCO_2/yr. The majority of small scale wind installations are ground-based developments, with only few that are building integrated [on top of roofs]. Small scale ground-based turbines, by their nature have lower hub/tip heights of about 15m agl and are viable at lower wind speeds [4.5 m/s at 10m agl]. They are typically installed on-site and supply the on-site demand first before spilling the excess to the grid and therefore they are by definition located on or next to buildings where there is a sufficient ongoing demand. This means that they can extend the deployment of wind capacity into areas where larger wind developments are likely to be significantly constrained.

For the purposes of this renewable and low carbon energy study, we have assumed that any area with an average annual wind speed of greater than 4.5 m/s at 10m agl, and that is located outside of an

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

ecological or historical designation [see Wind Constraints – Commercial Scale] is considered to be suitable for a 'small scale' wind turbine. The map below confirms the area of land across the SDNPA that is potentially viable for small scale wind energy deployment.

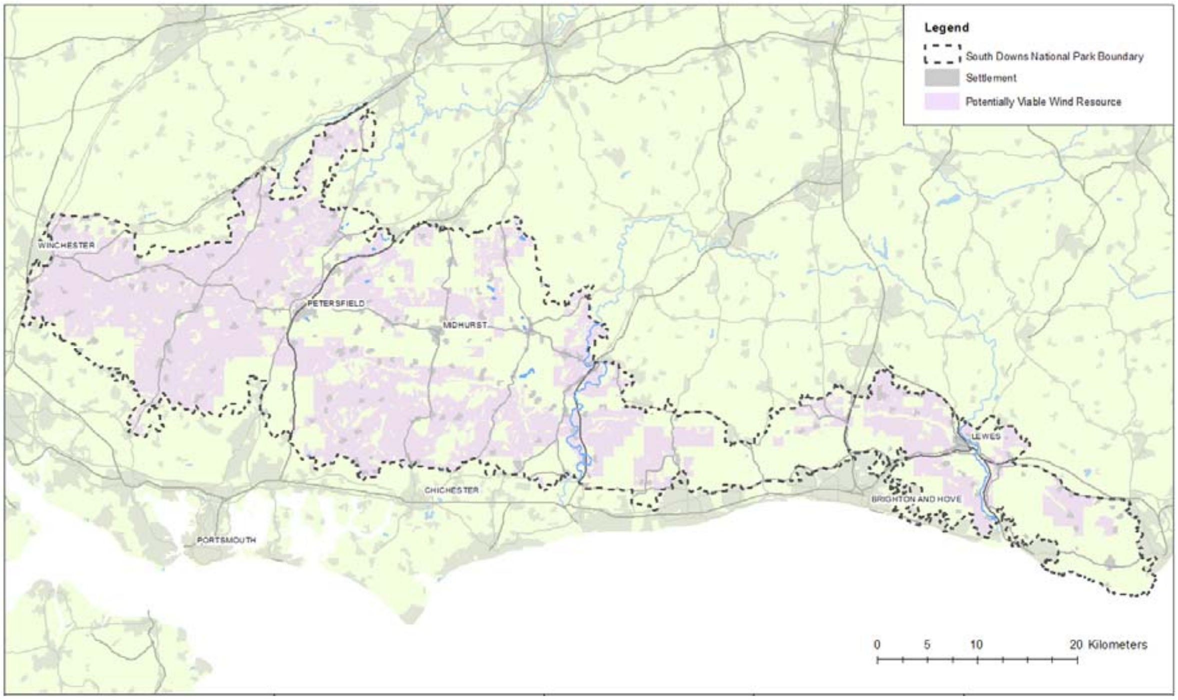

Figure 36: Theoretical practical wind resource for small turbines

Landscape Sensitivity

The visual impact associated with the deployment of a small scale wind turbine is highly subjective and typically depends on a variety of factors including the size, number, type, and location of wind turbines. However, to provide an indication as to the 'visibility' of a small scale wind turbine the 3D model was used to calculate the number of locations that could 'view' each area at 15m agl. Thus areas that were on the whole visible from a greater number of locations across the whole of the SDNPA were highlighted as a being more sensitive than those that were visible from a smaller number of locations. This information was illustrated in the context of 'potentially available wind resource area'.

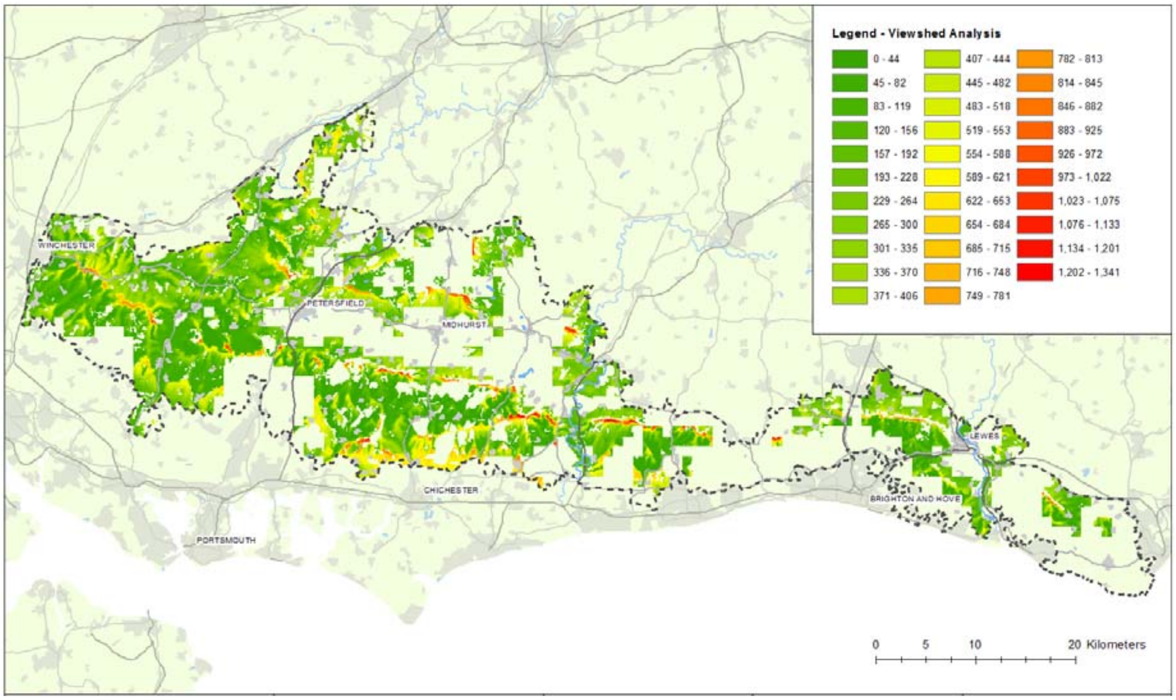

Figure 37: Relative visual impact for small wind turbines

Landscape and Visual Impact - Workshop findings

The focus of this session was to explore the relationship between the delivery of strategic renewable and low carbon energy infrastructure and the special landscape character of the SDNP. To assist in the discussion, participants had access to 'viewshed' mapping which shows the relative visibility of different areas of the Park and environs. The discussions and conclusions arrived at by the group are summarised below:

- **Do the special, intrinsic characteristics of the National Park justify lower carbon reduction targets?**
  In order to meet an 80% reduction in carbon emissions based on 1990 levels by 2050 it was acknowledged that strategic renewable and low carbon infrastructure would need to form part of the mix of solutions. This prompted a debate as to whether, in the context of the statutory designation of the National Park, the SDNPA should emulate at a local level the central government climate change reduction target of an 80% reduction on 1990 carbon emissions by 2050; related to this was the question of whether it should seek a less ambitious target or more ambitious target. Although it was unanimous that the National Park should be a beacon of 'sustainability', there was some concern that renewable and low carbon infrastructure might have an impact on landscape character and should be limited. Conversely, the argument was made, and supported, that areas such as the South Downs, which have considerable potential to generate low carbon energy compared with surrounding built up areas, should take on a greater share of the responsibility for reducing emissions. The overall verdict was that the National Park could accept some strategic renewable infrastructure and should aim, as a

minimum, to deliver its share of an 80% reduction in carbon emissions relative to level of carbon emitted within the SDNP area.

The debate was considered further at a Members' workshop on 18th December following which a minute was drafted that summarised the commitment to Climate Change arrived at through consensus.

1. The response to climate change in the South Downs Management Plan (SDMP) will take as its starting point the UK targets and level of ambition, i.e. we should be looking to make our contribution to an overall reduction in CO2 emissions of 80% by 2050.

2. The SDMP document will show positive leadership in inspiring people to contribute to this level of ambition in ways appropriate to the National Park purposes and duty.

3. Our response will set out the range of levers that are available - e.g. the Planning system, advice, communications and funding – and how we will deploy them in relation to climate change and emissions reductions.

4. We will report every five years on the contribution that the SDMP in general, and the NPA in particular, has made to emissions reductions within the National Park.

5. We will promote informed public debate, and champion the positive benefits of an ambitious approach to emissions reductions to the communities and economy of the National Park.

6. The SDNPA will aspire to a leadership role with respect to other LAs and local organisations/businesses.

7. As with other aspects of the SDMP, our approach to climate change and emissions reductions should be based on a 2050 trajectory but with actions split into clear, deliverable, five year achievable programmes.

- **Viewshed analysis** - The viewshed analysis highlighted that there are some areas within the National Park that are relatively less viable than others but could still support strategic renewable infrastructure such as wind turbines. This, combined with an understanding of the locations of population centres and important views, helps to add context to how many views are made, and their relative level of importance. This divided opinion as to whether this kind of infrastructure should be kept, by-in-large, out of sight or not. The overarching conclusion was that if strategic renewable infrastructure was in the least visible places, it is likely to have greatest impact on the rural nature of the landscape and biodiversity assets. On the other hand, accepting greater impacts on views / number of viewers meant that there was relatively less impact on the range of ecological and landscape sensitivities of the National Park. As such, immediate proximity ecological and landscape considerations are seen by the majority to be more important that the impact on views. This prompted debate around the acceptability of wind turbines around the A23 and A27; areas where windspeeds could support large wind turbines. Views are largely restricted but there are likely to be numerous viewers due to the proximity to Brighton and as a key gateway into the park. An opposing argument deemed this unacceptable due to the level of viewers; however, others believed that this would reduce impact on the wider South Downs and sent a powerful message of the SDNPA's commitment to sustainability.

- **Landscape character** - Continuing from the analysis of the viewsheds, debate turned to landscape character. It was agreed that the landscape is not entirely natural and has to evolve. The idea of 'relative wildness' was suggested as a way of directing strategic renewable infrastructure away from the most sensitive areas and a level of change should be accepted in the least 'wild' areas.

- **Community renewables** – There was a strong emphasis on the need for greater community involvement in planning renewable and low carbon infrastructure. Similarly, it was seen as important that people's relationship with energy use and infrastructure requirements was more overt. As such if strategic scale renewable and low carbon infrastructure is to be supported it should have a direct and tangible benefit for the community within which it has the most impact. For instance, if a wind turbine is developed next to a village then that community should be compensated through reduced electricity bills.

- **Permitted development** – Debate concluded by considering the cumulative impact of small scale renewable development on and within the curtilage of existing buildings. Although building scale renewable and low carbon infrastructure was widely supported, particularly PV on larger industrial and commercial roof spaces, there was concern that permitted development could blight rural villages. Taking measures to reduce permitted development rights was muted.

Other Practical Considerations

Although permitted development rights to effectively allow 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 3.8m^2 came into effect in 2011 they were excluded from Article 1(5)[44] land which includes National Parks. As such, unlike small scale PV, small wind turbines will still require planning permission. In forming policy on small scale wind there are also a number of other factors to take into consideration:

- **Farmers –**The South Downs has a significant area of farmland which means that much of the land has potential for small scale wind power. On sites for which large scale turbines are inappropriate or where it is unlikely that they can be commercially delivered, smaller scale turbines could be viewed as an alternative. For farmers small scale turbines can provide the benefit 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.

[44] As defined in The Town and Country Planning (General Permitted Development) Order 1995

- **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 organisations. 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 is therefore more suited to large scale commercial installations. For smaller installations, FITs provide a larger revenue stream due to the higher tariff levels.

5.3.3 Solar Farms

The potential from building mounted solar power has been completed in relation to existing buildings in section 4 (as per the South East Study). As the whole of the South Downs has the potential to generate electricity from solar power, it has not been possible to estimate a theoretical potential for installation of strategic scale solar farms. Despite reductions in the FiT available for larger solar farms, the reduction in the cost of panels means that strategic solar installations remain attractive to energy developers. There have been a small number of planning applications for solar farms both within the National Park and adjoining Local Authorities. Annex A of circular 02/99 on Environmental Impact Assessment states that EIA is unlikely to be required for smaller (less than 50MW) solar farms. As with the wind development, the sensitive nature of the South Downs landscape increases the risk for energy developers and as such, this may influence them to focus their attention to areas where there is less perceived risk. Notwithstanding this, in terms of energy output, solar farms are likely to present a significant opportunity for the South Downs National Park if they can be integrated without detriment to the special character of the area.

A 5MW solar farm would save around 2,275tCO_2/yr. As such, to achieve the 172,000tCO_2/yr saving required to meet the 80% reduction target would require 75 solar farms of this scale. A 5MW solar farm would typically take 3.5ha. As such, this would require a land take of around 262.5ha.

5.3.4 Hydropower

The Environment Agency identified potential hydropower sites across England and Wales[45]. This data has been reproduced for sites across the SDNPA. There were approximately 89 sites identified by the Environment Agency that could be developed for hydropower. Assuming that the average power output

[45] Opportunities and environmental sensitivity mapping for hydropower in England and Wales, Annex – Wales and Regional Data Part B

of a potential hydropower site as reported by the Environment Agency is 10kW [small scale hydro] this would equate to a potential hydropower resource of 890 kW or circa 0.9 MW. This would deliver a carbon saving of around 1,026 tCO_2/yr. Given the low potential output, and generally remote nature of locations where hydropower might be feasible, significant hydropower development is not envisaged for the SDNP.

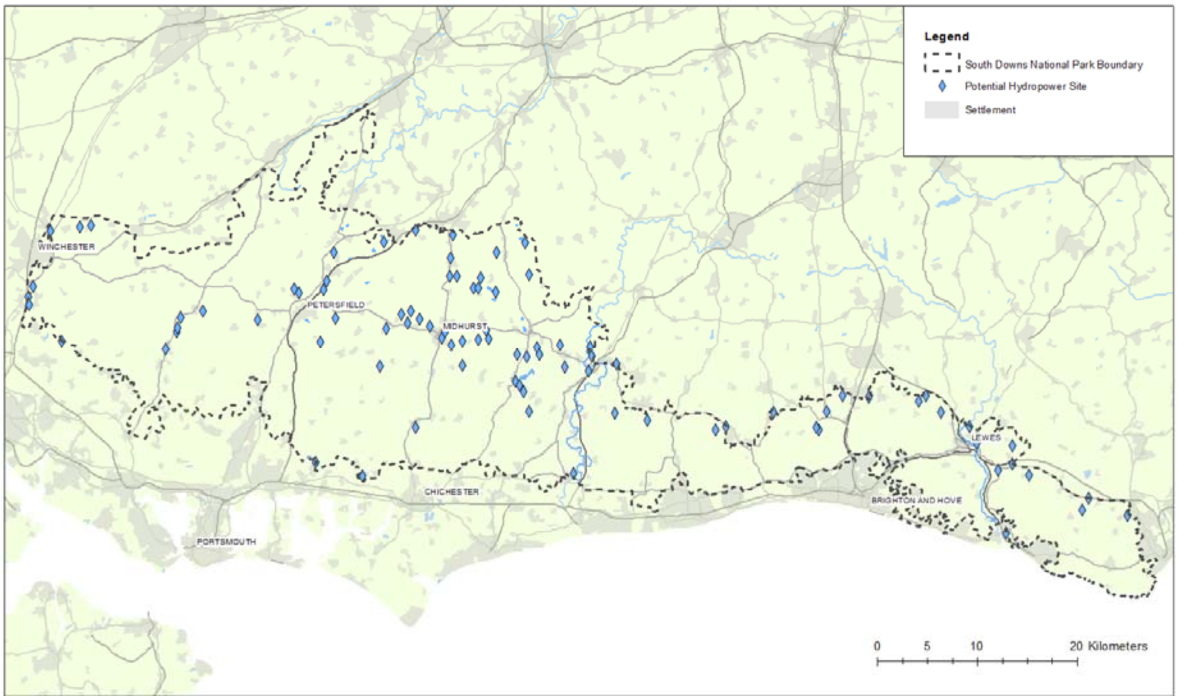

Figure 38: Potential locations for hydro power

5.3.5 Biomass

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 the 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 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. Biomass fuels include:
    - Waste wood from domestic, construction and industrial uses

- Forestry residues
- Fuel crops including miscanthus and short rotation coppice such as willow
- Straw

- 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. They include by-products from:
  - Pig and poultry farming sectors
  - Meat and Poultry Processors
  - Brewing
  - Water industry

Although it is likely that the Local Plan area could generate a significant biomass resource, the sourcing of biomass is critical when considering resource potential and sustainability. There is concern that excessive specification of biomass technologies on a site-by-site basis will lead to either long-distance import of biomass material or the sacrifice of food-producing arable land to grow dedicated biomass crops. For these reasons, there is a need to take a region-wide approach to biomass sourcing and supply to ensure that biomass is available for energy use. Such use needs to be managed in a sustainable way with priority use targeting waste biomass sources. Therefore, although this study provides an assessment of the biomass resource from the Local Plan area, it is likely that this will feed into the wider biomass market. Conversely, developers seeking to utilise biomass resources are likely to consider availability of biomass from a wider area.

Woodfuel

The Forestry Commission (FC) has highlighted that there are significant wood fuel resources across the South Downs. Using on the National Inventory of Trees and Woodland (NITW 1995), which maps the tree species cover, the FC suggest that there was around 328km^2 of woodland cover across the South Downs. Modelling the potential woodfuel yields from this cover, they predict that this woodfuel would be capable of delivering 179,690MWh; heating for over 9,000 homes and saving over £8m if use instead of oil to heat homes.

A recent update to the NITW 1995 in 2011 showed that there is actually around 383km^2 of woodland cover. Although the new2011 NITW update is assumed to be more accurate in terms of coverage, it provides little detail of species. Overlaying the 1995 NITW with the 2011 NITW we are able to get a picture of the species for much of this area. For the areas where there was no recorded species cover, assumptions have been made based on the neighbouring species. These updated assumptions are set out in the table and map below.

Table 21: Area [km^2] and type of woodland across the SDNPA

Woodland Type	Forestry Commission [km^2]	Non Forestry Commission [km^2]
Broadleaved	42	207
Coppice	1	30
Coppice with standards	0	13
Shrub	*7*	*19*
Unknown	3	61
Total	**53**	**330**

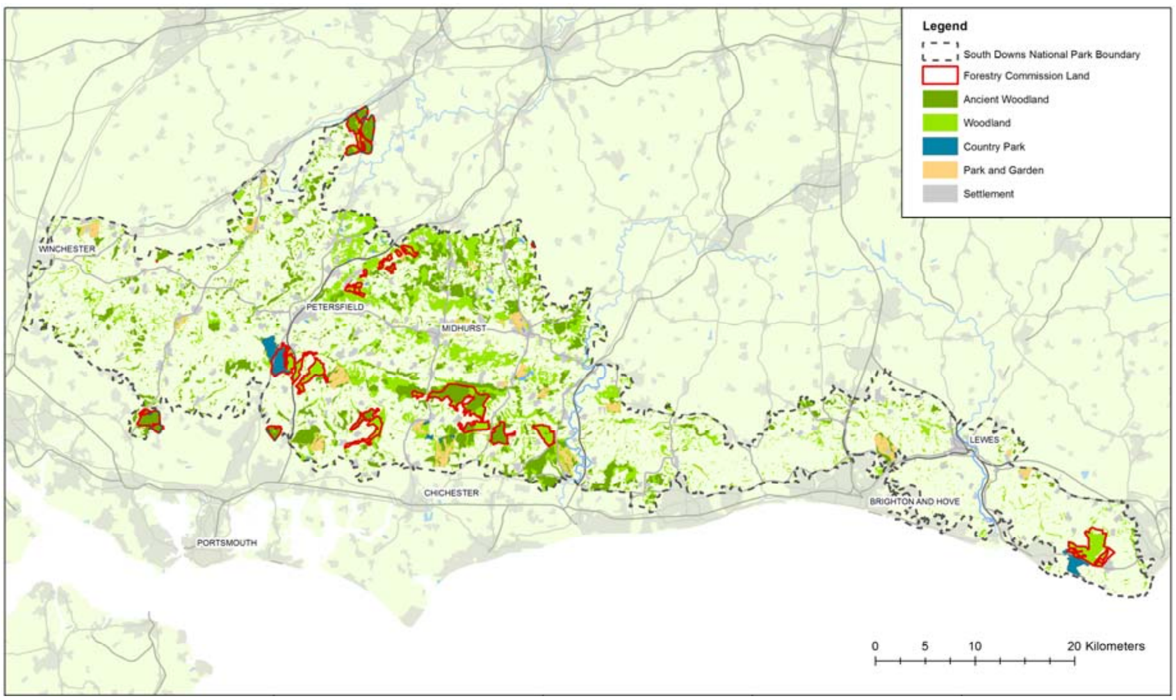

Figure 39: Woodland cover in the SDNP

Assuming that Shrub areas are unsuitable for woodfuel, and that 'unknown' areas are attributed according to the proportion of woodland type as identified in the NIWT, the revised usable wood fuel resource across the South Downs National Park can be calculated as follows:

Table 22: Area [km^2] and type of usable woodland for wood fuel across the SDNPA

Woodland Type	**Forestry Commission [km2]**	**Non Forestry Commission [km2]**
Broadleaved	45	254
Coppice	1	37
Coppice with standards	0	16
Total	**46**	**307**

Using the yield projection modelling developed by the FC, this study has rerun the analysis of wood fuel potential based on the larger area below.

Table 23: Energy value [MWh] of usable woodland for wood fuel across the SDNPA

Woodland Type	**Forestry Commission [MWh]**	**Non Forestry Commission [MWh]**
Broadleaved	40,500	171,450
Coppice	972	26,973
Coppice with standards	0	11,664
Total	**41,472**	**210,087**

In total biomass could theoretically deliver around 251,559MWh of heating. As highlighted in section 3, targeting those properties that use coal, solid fuel and petroleum to convert to biomass heating would save around 51,900tCO_2/yr. This would take the majority of the available biomass resource as these properties 214,766MWh. Converting those off grid properties that use electricity for heating to biomass is however significantly harder; and it is likely to be more cost effective to convert these properties to lower forms of electricity generation. The remaining biomass could be used to replace existing gas boilers, although the carbon savings will not be as significant as for those properties heated by coal, solid fuels and petroleum based fuels.

Unlocking the potential of woodfuel

Delivering carbon savings through the use of woodfuel is however challenging and complex. The Biomass Supply Chains in South Hampshire (PUSH 2009) and Woodfuel Supply and Demand in West Sussex (PUSH 2010) both provide an insight into these complexities in the locality. These main issues include:

- Developing the demand side – At present the potential supply of biomass far outstrips the demand. Although demand is set to rise, the reports recommend that support is needed to help increase this demand through:

- Encouraging major development sites to install biomass CHP. Although strategic scale development in the South Downs is likely to be limited, the SDNPA could support the development of the biomass market by supporting partner Local Authorities to encourage the uptake of biomass CHP.
- Using biomass to heat local authority buildings. As highlighted above, there is a need to improve the energy performance of public buildings across the South Downs. The SDNPA could play an important role in supporting the conversion of heating within these buildings to biomass.
- Support the development of a sub-regional Energy Service Company to provide a vehicle for delivery of biomass infrastructure.

- Developing the supply side – Although there is considerable supply potential, much work needs to be done to help bring this to market. Many of the woodlands need improved management to ensure a consistent, quality of supply is maintained. There is also a question of investment in the other supporting infrastructure. Covering the capital costs for the scale of chipping or pellet processing required to be commercially viable is often cited as the principal inhibitor.
- Competing markets – developing a wood fuel market is complicated by the surrounding market impacts. Wood fuel grown in the South Downs might not be used in the area and vice versa. This is further complicated by the different buying power of the major uses versus the domestic market.

Potential for organic waste suitable for use in 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 planning an AD scheme, that the disposal of the feedstock is considered alongside the availability of feedstock, the former being equally important.

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[46] 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 the end of this year, the goal is for all buses to run

[46] The Oil Depletion Analysis Centre and the Post Carbon Institute (2009) "Preparing for Peak Oil – Local Authorities and the Energy Crisis" ODAC

on a mix of one-third natural gas, two-thirds biogas. The biogas will be 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 will be 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 buses, 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.

Norfolk and 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.

The West Sussex Sustainable Energy Study predicted that across the 5 authorities covered in wet waste from agricultural processes, harnessing the biomass potential could contribute in the region of 110,459MWh. Collecting this waste on such a scale is a significant undertaking. As such, opportunities are likely to be much more limited and probably focus on farm scale anaerobic digestion.

Developing the biomass market – Workshop findings

The discussion focused on the potential of Biomass within the South Downs National Park (SDNP) and the perceived issues. The following is a summary of the discussion and the key points (Note: the expertise around the table was mainly focused on woodfuel, non-woodfuel options were discussed but only in brief):

- **Woodfuel** - In the discussion this was by far the most favourable and likely option for the SDNP. The Forestry Commission[47] has identified a potential of 141,000MWh per year of heat energy within our existing woodland. This is the amount which could be sustainably harvested from the woods if brought into active management. This amount is equivalent to £8.46million of heating oil[48]. The group noted:

  a. **Barriers to uptake**.
    - Lack of public confidence and awareness in what is still perceived to be new and untested technology.
    - At the domestic level there is also a lack of knowledge in the building and construction trade to include this technology in new builds.
    - High initial capital cost of installation and lack of advice on the most appropriate system.
    - Public concern over continuity of supply of wood chip.

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[47] Note that the Forestry Commission was based on an earlier 1995 version of the National Inventory of Trees and Woodlands. This dataset has been superseded by the 2011 inventory which shows a greater area of woodland coverage, but does not detail the woodland species as in the 1995 version. AECOM has used the Forestry Commissions methodology and woodland yield figures but with the 2011 NITW areas. AECOM made assumptions as to species type based on the 1995 mapping and for new areas, their proximity to known woodland types.

[48] The Biomass Energy Centre quote the average price per kWh of heating oil is £0.06.

- Other markets for timber remain strong. In particular the fire log market is attracting a higher price than woodchip. Woodland owners are always going to seek the best price for their wood/timber.

b. Potential Opportunities

- Domestic woodfuel may be a major incentive to woodland owners to bring their woods back into active management; this will have positive effects on biodiversity if managed correctly.
- There is an opportunity to educate the wider public that active woodland management for sustainable fuel is beneficial to biodiversity, tree health and will likely improve woodland access and amenity.
- It is a proven technology for estate heating systems. There is now the potential to expand to estate villages and sell heat on a wider scale.
- Becoming a registered energy provider/company is a potential diversification for some of the large estates/farms in the SDNP.
- There is a potential role for the SDNPA via partners to provide a central advisory service and education to the public on the benefits of woodfuel which may encourage wider uptake. The SDNPA can also advertise the benefits of village heating co-operatives through the use of proven case studies within the National Park.
- Increased use of woodfuel will foster a thriving local woodland economy. Best results and savings are achieved when woodfuel is locally sourced. This reduces transport costs and creates local sustainable jobs. Knowing where your fuel comes from also alleviates any concerns over continuity of supply.

c. Issues for planning and development.

- The boiler systems can be quite large and will be hard to site within the curtilage of listed buildings (of which there are a lot within the SDNP).
- The boiler flu is larger on woodfuel systems. It is key that planners understand the requirements and do not reject applications without full consideration.
- Planning officers may require training on the special and practical requirements of renewable heating systems.
- It may be beneficial to provide case studies to the public of designs for renewable systems that would be viewed favourably by the SDNPA.

- **Biogas and Anaerobic Digesters** - There was a general perception that this option was limited by the technology that is affordable. The majority of Anaerobic digesters within the SDNP are less than 30,000tn per annum of waste and as such the application of this technology within the SDNP is limited due to the lack of dairy herds. Other concerns centred around the increased commercial vehicle movements that supply this technology particularly on small rural roads and the potential longterm use of the technology. If a dairy farm fails and becomes arable, the digester will either be redundant or become a stand alone waste operation. A potential benefit of this technology was the option that spare heat could be used in village heat systems or be fed back into the mains (limited by access to mains gas).

- **Biofuel Arable crops** - Two forms of arable crops were considered

    - Maize - Usually a spring crop. Deep rooting so requires a fairly deep tilth, it may struggle on the shallow soils of the Downs. Concern was raised that as a spring crop there is an increased risk of soil erosion over the winter.
    - Biodiesel - Rape is commonly grown on the downs as part of an arable crop rotation. It is unlikely more will be planted for fuel because priority remains with food production. Small scale use by cooperatives of farms is more likely.
- **Short Rotation Coppice**
    - Myscanthus - Concern over small scale landscape change. The crop looks very different from arable crops. Although not that obtrusive. It is a deep rooting crop that may struggle on shallow soils. May require new farm equipment for harvesting. There was concern that there is no exiting market for the crop and that it burns less efficiently than wood coppice such as willow or poplar.
    - Willow/Poplar - Requires new equipment to harvest. Considerable landscape change from arable crops. However, there was general consensus that it has a role to play if sited correctly. In poor soils it can act as a stabiliser preventing run off. It may also be beneficial to water quality by reducing leaching into water courses. However the flip side of the coin is that in large quantity it can require a large water uptake and if sited badly will be negative for aquifer recharge.
    - The above points on short rotation coppice and Biofuel crops focused mainly on the technicalities of the crops. The main argument against these crops and the biggest reason why it is unlikely to be used on a wide scale within the SDNP is the current value of arable land and the price of grain. It is far more profitable to retain land as arable and the current price of wheat far outweighs any small gain from biofuels.

5.3.6 Heat networks and CHP

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 conventional 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 36 shows the CHP arrangement compared with traditional energy generation.

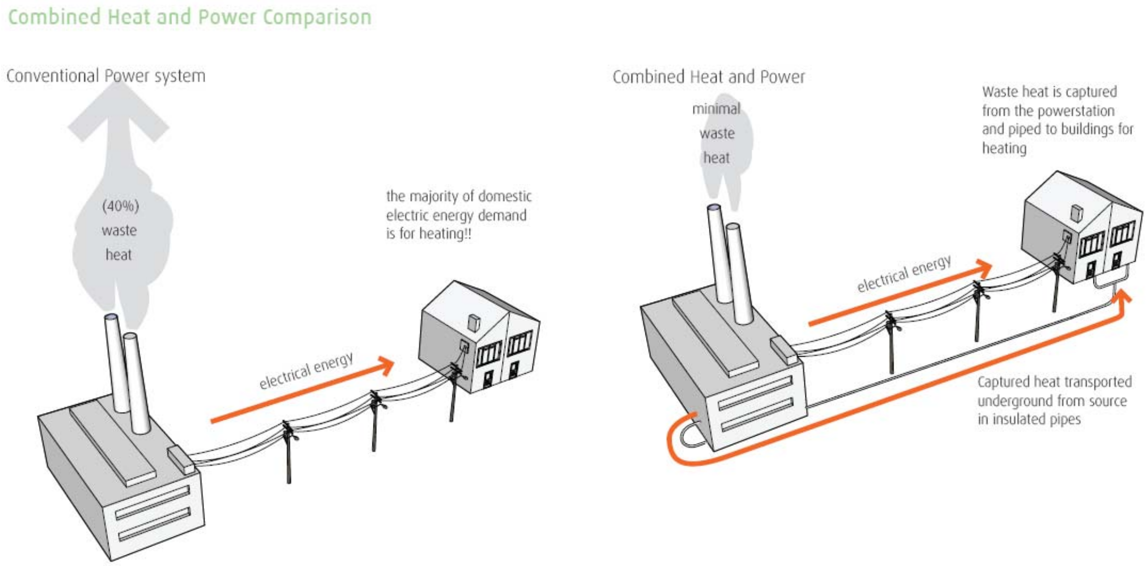

Figure 40: CHP comparison

To assess the potential for CHP/District Heating Network (DHN), this study has undertaken more detailed mapping to establish 'heat opportunity plans'. This section considers some of the issues associated with mapping opportunities for the utilisation of low carbon heat in District Heating Networks (DHNs). In reviewing the heat opportunity map we sought to identify locations with the most potential in the following areas:

- **Heat density -** The DECC residential gas consumption data at Lower Layer Super Output Area[49] (LLSOA)[50], can be used to locate areas within the district with the highest levels of heat density and interrogate these to determine which buildings were contributing most to the apparent heat density. In residential areas a heat density of 3 MW per km^2 (26.28 kWh per m^2) is considered to be a priority area worth further investigations[51].
- **Total heat demand -** The data presented in the DECC database, and supplemented with metered data from the Council owned buildings where available were used to estimate the total heat demand within a certain area. Assessing the total heat demand provided us with an indication of the size of revenue from the heat sales and therefore what level of initial capital investment could be supported.
- **Presence of key anchor loads -** Using the information provided by the SDNPA and partners, the locations of buildings with high and stable heat demands have been mapped. These types of buildings could include leisure centres with swimming pools, dense areas of social housing and council buildings. A cluster of anchor loads could provide the initial load in the creation of a wider

[49] Lower super output area is a geographic area used to improve the reporting of statistics by assigning data to smaller areas.
[50] DECC 2009 Energy Statistics on Residential Gas Consumption which was available at the lower level super output area [LLSOA]
[51] Note that the West Sussex Sustainable Energy Strategy also recommends an equivalent heat density of 3 MW per km^2 (as defined by the DECC methodology. However the West Susses report work is presented in kWh per m^2 rather than MW per km^2. Furthermore, they prioritise higher heat densities over 45 kWh per m^2. In the South Downs however, the maximum heat density is equal to 36 kWh per m^2

network. When reviewing the existing key anchor loads, consideration needs to be given to the likelihood of refurbishment or demolition that may be planned.

- **Building types** - Locations with building types which result in a good balance of heat demand profiles have been identified. For example a residential area will require heat in mornings, evenings and weekends, but there is less demand for heat in the daytime. If commercial buildings are also present, which have a daytime heat demand, the overall demand profile is more consistent and will enable the system to operate more efficiently.
- **Future plans** -As well as reviewing the existing heat demands and densities it is important to look at the future development plans within the area to see if there is potential for future development and expansion. Clusters that are close to one another also open up the opportunity for future expansion. Although it is not possible to consider these at this stage, they should be considered when a development is proposed.

The following plans show the priority areas within the main settlements within the South Downs National Park[52].

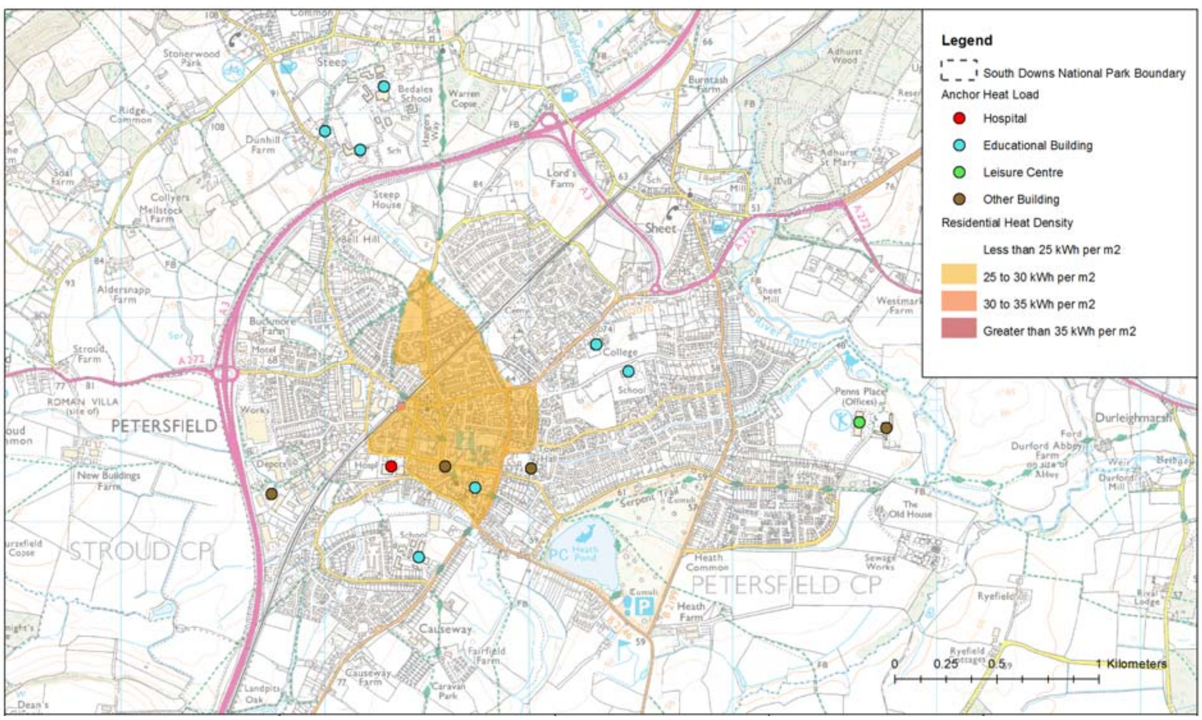

Figure 41: Pertersfield Heat Opportunity Area

52 Note that there is not sufficient heat density in Midhurst to be recorded

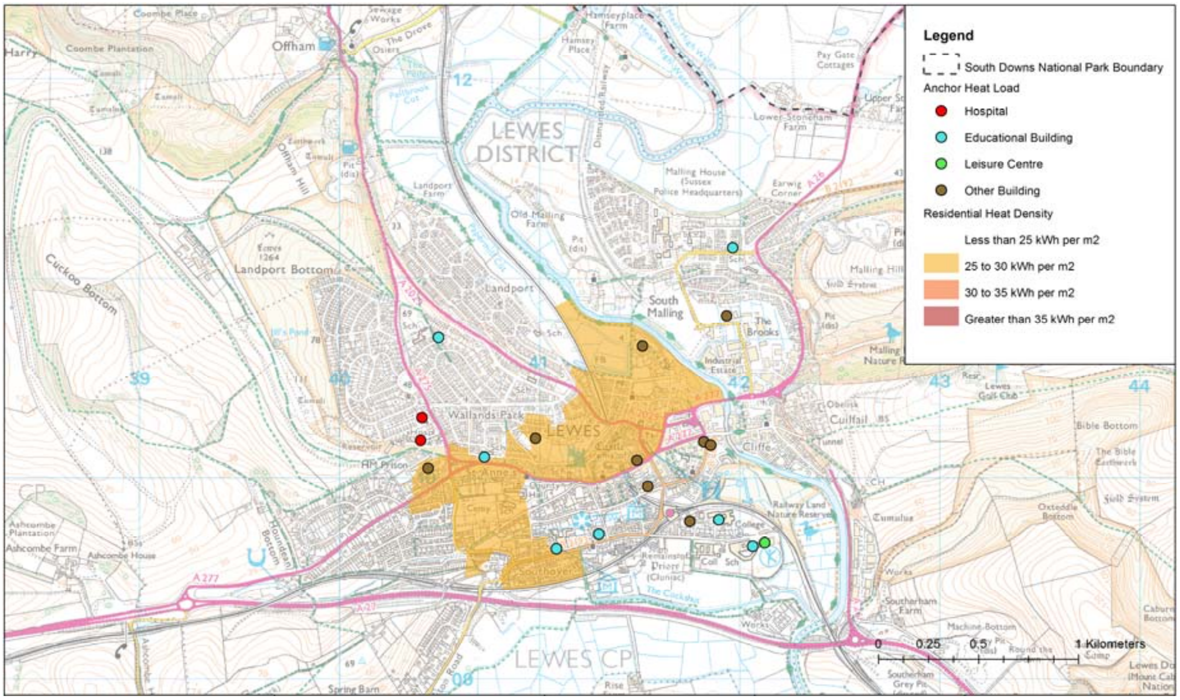

Figure 42: Lewes Heat Opportunity Area

Practical considerations

There are, however, a number of constraints to also take into consideration

- **Heat networks and existing infrastructure –** Because heat networks involve connecting buildings via underground piping, retrofitting established neighbourhoods with heat networks can encounter numerous obstacles and therefore can be expensive. Furthermore with increasingly more infrastructure being placed underground – including water, electricity and broadband – finding enough space to place heat piping can be one of the more pressing physical constraints. For this reason, it is important to include heating pipes as part of the underground infrastructure whenever possible, such as when road maintenance occurs, to make it more viable.
- **Low density developments and rural estates** – Generally, the lower the density of a development, the less economical a heat network becomes due to the additional piping and associated excavation required. However, this is not always the case as the small scale rural biomass networks on the Standsted and West Dean estates, and the village of South Carlton in Central Lincolnshire demonstrate. While district heating is normally only thought feasible in high density developments, and generally requires a key anchor load, these projects suggest that when other factors, such as carbon reduction, the price of alternative fuel sources and fuel poverty, provide the motivation, district heating networks can be feasible.

  In response to a need to upgrade its heating scheme, Burton Estates in South Carlton converted the properties from oil and electric-based heating to a district heating network, which partially uses local woodchip supply as its fuel. 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 can be 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.

- While developments that are not dense enough to support heat networks should be avoided, they can be feasible in reality. In these instances, individual biomass boilers are more viable.
- **Local authority owned properties** – To stimulate the development of heat networks many local authorities such as Woking and Sheffield, have had success by initially linking publicly owned assets and council housing.

5.4 Potential for district heating in rural estates - West Dean Case study

Appendix A sets out a case study comparing options for reducing the energy demands and CO2 emissions from the cottages on the West Dean College site using two alternative strategies:

1. Extension of the existing heating network to provide a low carbon source of heat to the cottages; and
2. Whole-house energy efficient refurbishment of the dwellings' fabric and services to reduce the energy demands and meet these demands in a way that results in lower carbon emissions.
3. This analysis indicates that in terms of both the relative carbon savings and the relative capital costs, the two strategies are likely to be fairly comparable. As such, the choice of which strategy to pursue is more likely to be influenced by the practical implications for the College and the residents of the dwellings and potentially the longer term financial implications.

The table below summarises the main differences between the two options and the relative advantages and disadvantages of each.

Table 24: Summary of the comparative advantages and disadvantages of the two options

	Heat Network Connection	Fabric and Energy Efficiency Improvements
Indicative CO_2 savings	Based on the assumption in our indicative calculations 230 tonnesCO_2 per year	Based on the assumption in our indicative calculations 190 tonnesCO_2 per year (although could be larger or smaller based on the extent of the improvements)
Indicative capital costs	The total capital cost could be in the order of £300,000 to 400,000 (assuming around 700m of pipework at £250/meter, installations of HIU's and heat meters to each property and an assumption of £100–200k for additional plant). However, the proposed upgrade of the existing system, which would involve the development of a new energy centre and potential improvements and upgrades to the existing plant and infrastructure, would add additional costs.	The total capital cost could be in the order of £600,000 to 700,000 (assuming an average cost of £30-35k per property for the basket of measures suggested). This option would allow some flexibility in that the capital costs could be higher or lower depending on the extent of the improvements made.
Operational costs	Should deliver a significant reduction in energy bills for residents (depending on the price charged for the heat) May deliver a return on the initial investment if the Renewable Heat Incentive can be obtained	Likely to deliver in the order of 50-70% reduction in energy bills for residents
Practical Implications	Potentially less direct implications for the residents in carrying out the works Would require additional biomass fuel to be obtained	Potentially extensive disruption to residents during the works
Other benefits	Could have a benefit for the operation of the heat network as a whole May enable the move to a new boiler house and upgrades to the flue and boilers	Should improve the value of the properties Could use Green Deal financing and may also be eligible for money from the Energy Company Obligations
Risks and constraints	Installing a heat main across the A286 could be difficult and would certainly be more expensive than the relatively easy network sections over soft ground. It would also require the approval and co-operation of the local authority and/or highways agency.	Would need to consider the implication on the appearance of the properties, particularly with regard to the use of external wall insulation and new windows

5.5 Implications for the Management Plan and Local Plan

The workshop on strategic renewable infrastructure highlighted that there is appetite for more strategic renewable and low carbon energy infrastructure in the National Park providing it is the right technology in the right place. Specifying the right location for renewable energy development is subjective and potentially contentious; some believe that the infrastructure should not be a visual intrusion and others believe that there are areas of the National Park already influenced by infrastructure (which is therefore less sensitive to wind / solar development) and advocate a visual connection with the sources of our energy. However, areas that are less sensitive to landscape change are also likely to be those closest to the most visual receptors.

The lack of clarity that this presents hinders the development of strategic renewable infrastructure. The capital investment made into strategic infrastructure pushes development towards areas with the lowest risk. As the sensitivity of the South Downs National Park creates significant risk for potential developers, it may deter developers from investigating areas to deliver strategic scale infrastructure. If the SDNPA wishes to encourage the uptake of strategic renewable and low carbon infrastructure it will need to:

- Develop a robust policy position on the types and locations where renewable energy developments may be appropriate, taking into consideration full landscape and visual impact assessment as well as public consultation.
- Develop the biomass / woodfuel market that will also play an important role in reducing the energy related carbon emissions across the National Park. Although woodfuel is potentially plentiful, both the supply side and demand side of the market need to be supported. Furthermore, it is important that in the development of the woodfuel market the wider services that woodlands provide are not damaged and, where possible, enhanced; these include water management, biodiversity, recreation and wider ecosystem services. As such, to encourage the uptake of woodfuel the SDNPA should consider:
    - Working with land owners and the Forestry Commission to bring more woodland in to active management for wood fuel.
    - Support for the uptake of woodfuel heating within new developments, off grid properties, publically owned and large institutional buildings and where possible wider heating networks. In particular, the SDNPA should investigate opportunities for working with the large rural estates as they are in single ownership and often off the national gas grid.

Summary of Key Issues for the National Park Management Plan and Local Plan

6. Summary of Key Issues for the National Park Management Plan and Local Plan

6.1 Summary of Findings

Chapter 2 of this report highlighted that the annual energy demand within buildings in the SDNP is around 2,287,271MWh. Given the current mix of fuel sources used, this contributes around 675,438tCO_2/yr. Taking into account savings already made nationally, to achieve an 80% reduction in CO2 emissions based on 1990 levels by, the SDNP would need to reduce building related emissions to 164,751tCO_2/yr. The majority of this demand comes from residential energy use. Energy use is generally higher per residential dwelling than it is in other parts of the country, reflecting the largely detached and semi-detached nature of the housing market. There are also a significant number of properties that are off the national gas grid. As such, these properties generally rely on more carbon intensive methods of space and water heating.

There is however significant potential to deliver carbon savings across the SDNP as illustrated in Chapter 3. The table below summarises the maximum potential carbon savings associated with different carbon reduction strategies.

Table 25: Summary of buildings scale carbon reduction potential

Carbon reduction strategy	Total carbon saving potential from measure	Running carbon saving potential by 2034
Baseline	675,438	675,438
National strategies to decarbonise the grid	186,140	489,298
Residential energy efficiency measures in the SDNP	50,024	439,274
Off grid fuel switching to Biomass	51,854	387,420
Non-domestic energy efficiency measures in the SDNP	21,018	366,402
Residential microgeneration measures in the SDNP	38,866	327,536
Non-Domestic microgeneration measures in the SDNP	32,405	295,131

Despite the significant potential carbon savings associated with building scale carbon reduction measures highlighted above, it still falls significantly short of the 2050 target. This challenge is further compounded by the fact that it is highly unlikely that this level of uptake of carbon reduction measures is deliverable;

particularly on recent evidence of uptake rates, coordination of numerous small scale measures and potential cumulative impacts.

New development will also generate an additional c13,050tCO_2/yr. This is relatively low, highlighting the low level of growth predicted; this figure assumes that the increasingly stringent proposed Building Regulations coming into force in 2013 and 2016 will be met.

The remaining shortfall carbon reduction would need to be met through strategic renewable and low carbon infrastructure. In addition, it is likely that strategic scale interventions will constitute a more cost efficient way of reducing emissions due to economies of scale.

The South Downs is rich in renewable and low carbon resources. Wind resources could theoretically deliver 4,351,092MWh of electricity (twice the total electricity demand in the South Downs) and biomass could theoretically deliver 210,087MWh of heating. However, it is the natural resources of the National Park with the potential to generate renewable energy that also contribute to its special character. An indiscriminate approach to delivering renewable and low carbon infrastructure would damage this special character and as such, a more sophisticated approach of identifying suitable areas and approaches needs to be adopted in planning policy and the SDNP Management Plan.

6.2 Issues for the National Park Management Plan and Local Plan

To improve the performance of the existing building stock the SDNPA should:

- Establish an approach to attracting Green Deal funding, perhaps in collaboration with emerging procurement arrangements with West Sussex County Council. The focus for retrofit should be off-grid properties.
- Seek to leverage ECO or other funding (perhaps through Allowable Solutions) to target harder to reach measures to be delivered alongside Green Deal.
- Develop a 'consequential improvements' policy to require property owners seeking to extend their property to make additional energy efficiency improvements to the rest of their property.
- Review the position on microgeneration to actively support uptake, for example on large warehouses, but limited in more sensitive locations. This might need to be through an Article 4 directive to alter permitted development rights.

In considering policies for new development the SDNPA should consider that:

- Given the proposed changes to Building Regulations Part L, the anticipated zero carbon policy and the additional cost associated with meeting high levels of the Code for Sustainable Homes, it would be difficult for the SDNPA to justify a carbon reduction target significantly higher than that proposed by Building Regulations. More cost efficient carbon savings should be sought through the development of locally defined Allowable Solutions to work in conjunction with the Green Deal.

To support the development of appropriate strategic renewable infrastructure the SDNPA should:

- Develop a robust policy position on the types and locations where renewable energy developments may be appropriate, taking into consideration full landscape and visual impact assessment as well as public consultation.
- Support the development of the biomass / woodfuel market. Although woodfuel is potentially plentiful, both the supply side and demand side of the market need to be supported. Furthermore, it is important that in the development of the woodfuel market the wider services that woodlands provide are not damaged and, where possible, enhanced; these include water management, biodiversity, recreation and wider ecosystem services. As such, to encourage the uptake of woodfuel the SDNPA should consider:
    - Working with land owners and the Forestry Commission to bring more woodland in to active management for wood fuel.
    - Support for the uptake of woodfuel heating within new developments, off grid properties, publically owned and large institutional buildings and where possible wider heating networks. In particular, the SDNPA should investigate opportunities for working with the large rural estates as they are in single ownership and often off the national gas grid.

Appendix A: West Dean College Case Study

West Dean Case Study

Introduction

West Dean College is located midway between Midhurst and Chichester in the heart of the South Downs National Park. It is located on a site of approximately 50 acres, within the wider West Dean Estate. The site comprises a number of different buildings, including educational spaces, offices and residential accommodation as well as greenhouses, workshops and other outhouses.

The main college buildings are connected to a heat network which delivers hot water via a network of buried pipes, which is then used to provide space heating and hot water within the buildings. The buildings currently connected to the network are shown within the red line boundary on the map of the site shown below in Figure 1. The heat network is served by a central boiler house which contains two biomass boilers which use wood chips that are produced on the West Dean Estate.

The College also owns a number of cottages located to the north of the main campus buildings. A few of these are located on the south side of the A286 and the others on the north side of the road. These are shown within the blue line boundary on the map in Figure 1. These cottages are not connected to the heat network and instead have individual heating systems that use a range of fuels but predominantly liquefied petroleum gas (LPG).

Main image Google Maps: Imagery©2013 Digital Globe, GeoEye, Getmapping plc, Infoterra Ltd & Bluesky, Map data©2013 Google
Inset image Google Maps: Map data©2013 Google

Figure 1: West Dean College and inset showing location relative to Midhurst and Chichester.

The cottages all vary in size and age and have a variety of different constructions and heating systems. Table 1 summarises the key details of each of the cottages reviewed by this study.

Building Ref	Building Type	Heating	Size (sqft)	Wall type	Roof type	Floor type
14	Detached	LPG	1225	Render on timber frame	Tile	Timber/ Solid
15	End Terrace	LPG + Rayburn	1045	Render on timber frame	Tile	Timber/ Solid
19	Semi Detached	LPG + Rayburn	1560	Cavity	Tile	Solid
20	Semi Detached	LPG	1247	Cavity	Tile	Solid
21	End Terrace	LPG	1514	Cavity	Tile	Solid
119	Semi Detached	Electric Night Storage + Rayburn	2508	Solid Wall	Tile	Timber/ Solid
123	Semi Detached	Rayburn	1320	Solid Wall	Tile	Solid
131	Semi Detached	LPG + Rayburn	1388	Solid Wall	Tile	Timber/ Solid
132	Semi Detached	LPG	1208	Solid Wall	Tile	Timber/ Solid
144	End Terrace	Electric Night Storage	1622	Solid Wall	Tile	Solid
164	Semi Detached	Solid Fuel	2621	Solid Wall	Tile	Timber/ Solid
165	Semi Detached	Solid Fuel	2019	Solid Wall	Tile	Timber/ Solid
166	Semi Detached	LPG + Rayburn	1798	Solid Wall	Tile	Timber/ Solid
167	Semi Detached	LPG + Rayburn	1444	Solid Wall	Tile	Timber/ Solid
168	Mid-Terrace	Rayburn	1286	Solid Wall	Tile	Solid
169	Semi Detached	Electric	998	Solid Wall	Tile	Solid
170	Semi Detached	LPG	2019	Solid Wall	Tile	Timber/ Solid
204 (The Bothy)	Detached	LPG	2048	Solid Wall	Tile	Timber/ Solid
220 (Forester's Cottage)	Detached	LPG	2494	Solid Wall	Tile	Timber/ Solid
234 (The Lodge)	Detached	LPG	3052	Solid Wall	Thatch	Timber/ Solid

Table 1: Construction types and fuels associated with each of the cottages

As a result of the limited insulation within the fabric of these dwellings and the relatively high carbon intensity associated with the heating systems and fuels that are currently being used (see table 4), the CO_2 emissions associated with the energy use of the cottages is significant. West Dean College has recognised this and are currently investigating ways in which they could reduce the energy consumption and CO_2 emissions from these properties.

Aim of this study

This study reviews the options for reducing the energy demands and CO_2 emissions from the cottages on the West Dean College site using two alternative strategies:

1. Extension of the existing heating network to provide a low carbon source of heat to the cottages; and
2. Whole-house energy efficient refurbishment of the dwellings' fabric and services to reduce the energy demands and meet these demands in a way that results in lower carbon emissions.

In theory these are not mutually exclusive options and could be undertaken together (with the possible exception of the use of certain individual heating systems). However, for the purposes of the study we have assumed that the cost implications are such that only one of the approaches can be delivered.

Existing Buildings

As shown in Table 1, the cottages have a range of different construction types, ages and sizes and hence the energy demands are likely to vary considerably between properties. To estimate their energy use we drew from a range of studies of similar buildings and from industry benchmarks. As such, for space heating and hot water we assumed average energy use of 300 kWh/m^2/year. For electricity, regulated electricity use (for fixed lighting, pumps and fans) have been estimated based on studies of similar buildings and unregulated electricity use (for appliances) were based on the BRE calculation methodology. These estimates are summarised in Table 2.

Building Ref	Size (sqft)	Estimated Heating Demand (kWh/year)	Estimated Electricity Demand (kWh/year)	Estimated CO_2 emissions ($kgCO_2$ /year)
14	1225	34,142	3,019	9,926
15	1045	29,125	2,885	8,627
19	1560	43,479	3,187	12,300
20	1247	34,755	3,032	10,083
21	1514	42,197	3,168	11,976
119	2508	69,900	3,460	18,914
123	1320	36,790	3,074	10,603
131	1388	38,685	3,109	11,085
132	1208	33,668	3,008	9,804
144	1622	45,207	3,212	12,736
164	2621	73,050	3,480	19,696
165	2019	56,271	3,345	15,516
166	1798	50,112	3,277	13,971
167	1444	40,246	3,136	11,482
168	1286	35,842	3,055	10,361
169	998	27,815	2,840	8,283

170	2019	56,271	3,345	15,516
204	2048	57,080	3,353	15,718
220	2494	69,510	3,457	18,817
234	3052	85,062	3,541	22,671
Total		959,205	63,985	268,086

Table 2: Estimated energy demands and CO_2 emissions for the cottages.

Note that these are broad estimates to allow comparison of the two options in terms of CO_2 savings. For a more detailed understanding of the energy demands from different properties, the metered energy consumption should be used (if this data is available and reliable).

Potential for district heating

Proposed network route

The following maps of the site (Figure 2 and Figure 3), show the existing heat network route and the proposed network route if the cottages were to be connected to the system.

Main image Google Maps: Imagery©2013 Digital Globe, GeoEye, Getmapping plc, Infoterra Ltd & Bluesky, Map data©2013 Google
Inset image Google Maps: Map data©2013 Google

Figure 2: Route of the existing heat network

Main image Google Maps: Imagery©2013 Digital Globe, GeoEye, Getmapping plc, Infoterra Ltd & Bluesky, Map data©2013 Google
Inset image Google Maps: Map data©2013 Google

Figure 3: Route of the potential heat networks

As the figures show, the primary new elements of the 'proposed heat network' are the pipe runs that connect to the cottages. In addition to these, the proposed network also includes the possible relocation of the boiler house to a site to the north of the A286. The new boiler house location would make one of the existing pipe runs redundant and require a new main pipe run to connect to the boiler house. In addition this alteration would require careful consideration of the pipe sizing of the new elements to ensure correct operation of the system on the existing network.

Capital Costs

The additional length of heat network in the proposed layout is likely to be in the order of 700m. Pipework for heat networks can cost between £200 and £1,500 per metre, depending on the civil engineering costs associated with digging the trenches and laying the pipe, and also on the type and diameter of the pipe. The system for this site is likely to be at the lower end of this scale and, as the costs cited above represent quotes from larger suppliers, local or smaller contractors may be able to quote lower costs, particularly for the civil works. Based on previous quotes, the College estimates pipework costs to be in the order of £180 – 200 per meter.

Each property would require a Heat Interface Unit (HIU) and, if billing is to be based on metered energy use, a heat meter. Again costs for these components can vary but are likely to be around £1,500 per dwelling.

Environmental benefits

Estimated carbon savings for this option are shown in Table 3.

Existing CO_2 emissions from the 14 cottages (kgCO_2 /year)	268,086
CO_2 emissions from the 14 cottages following connection (kgCO_2 /year)	40,716
Potential CO_2 savings (kgCO_2 /year)	227,369

Percentage reduction in CO_2 savings	85%

Table 3: Estimated scale of CO_2 savings that could be achieved through the connection of the cottages to the heat network.

The carbon savings are due to the change in the fuel used to provide heat to the homes. Biomass has a much lower carbon intensity than the existing fuels being used in the dwellings (predominantly lpg or electricity), as shown by the emissions factors, taken from Building Regulations Part L 2010, in Table 4.

Fuel	Biomass (communal systems)	LPG	Electricity
Carbon emissions factor ($kgCO_2/kWh$)	0.013	0.245	0.517

Table 4: Carbon emissions factors for different fuels

Operational cost impacts

Connection to the heat network is likely to provide significant fuel bill savings to residents of the cottages for a number of reasons:

- Lower price of fuel;
- More efficient systems, as the heat interface units are likely to be significantly more efficient that the heating systems they replace
- No servicing costs (unless a 'standing charge' for connection to the heat network is applied to cover this)

The exact savings will depend on the exact energy consumption, the cost of the current fuels, the cost of existing servicing and the cost of heat obtained from the heat network.

The addition of more heat demands and the potential relocation of the boiler house provides an opportunity to upgrade the older of the two existing boilers. Although this would add capital costs to the project, a new boiler is likely to be more efficient and would potentially qualify under the Renewable Heat Incentive to receive payments per unit of heat generated, which should normally provide a return on the investment.

Other implications and considerations

For the residents of the properties the connection to a heat network is likely to provide a number of practical benefits. For those currently using LPG, the complications associated with the ordering, delivery and storage of fuel to each of the properties would be removed.

Heat networks and the plant operating on them tend to work better with greater load and diversity (as long as the system has been sized correctly) and the economic viability is often improved. As such it is possible that the addition of the cottages on the network will have a beneficial impact upon the heat network as a whole.

For most of the properties, this solution would potentially require little intervention. The existing boiler would be removed and replaced with the HIU, which should be compatible with the existing internal heating system, although this is something that would need to be assessed for each property.

An additional benefit associated with the creation of a new boiler house would be the potential to increase the flue capacity. Currently the two boilers within the existing boiler house cannot be run together because of the limitations of the current flue; a new boiler house would allow this issue to be resolved.

Risks and other considerations

The installation of a heat network pipe across the A286 is likely to require discussion with the local authority and/or highways agency, for which adequate time would need to be allowed in the project programme.

Sufficient biomass fuel would need to be sourced to meet the additional heat demand on the network, although it is presumed that this will be available from the existing sources on the estate.

Potential for energy efficiency and fabric improvements

2.6.1 *Proposed measures*

Table 5 sets out the options for energy efficiency measures that could be applied to the cottages. The cottages are all different, in size, layout and age, as well as in their construction and existing heating systems, so it is likely that the package of measures chosen would vary between dwellings.

Building Ref	Assumed existing measures	Primary Measure	Alternative Measure(s)	Indicative Cost
Walls	Solid and Cavity Walls (U-value around 0.75- 2.0 $W/m^2.k$)	Internal Solid Wall Insulation or Cavity Wall Insulation (as appropriate) (U-value around 0.2-0.3 $W/m^2.k$)	External Solid Wall Insulation (U-value around 0.2-0.3 $W/m^2.k$)	£5,000 – £15,000
Floor	Solid floor (U-value around 0.5 to 2.0 $W/m^2.k$)	Insulated floor (U-value around 0.2-0.4 $W/m^2.k$)		£300 – £500
Roof	No or little loft ins (U-value around 0.5 to 2.0 $W/m^2.k$)	Fully insulated roof (U-value around 0.2 $W/m^2.k$)		£500 – £1,000
Windows	Single Glazing (U-value around 3.0-5.0 $W/m^2.k$)	Low-e, argon filled, double glazed (U-value 1.2-1.4 $W/m^2.k$)	Triple glazed (U-value 0.7-1.0 $W/m^2.k$)	£4,000 – £6,000
Ventilation	Natural	Mechanical Ventilation with Heat Recovery (MVHR)	Natural	£1,000 – £3,000
Doors	Solid uninsulated (U-value around 3.0$W/m^2.k$)	Solid Insulated Door (U-value 1.0-1.4 $W/m^2.k$)		£1,000 – £2,000
Heating system	Mixture of LPG boiler, Rayburn and Electric Night Storage	Biomass back boiler	Ground Source Heat Pump, Air Source Heat Pump, or high efficiency LPG boiler	£3,000 – £8,000
Draught proofing		Draught proofing		£200 – £400
Other		Possible addition of Solar Water Heating and/or Photovoltaic		£3,000 – £5,000

Table 5: List of potential energy efficiency measures that could be applied to the dwellings

The costs and savings discussed below assume that a basket of measures – comprising one of the improvement measures for each of the building elements listed above – is applied to each of the cottages. Based on our understanding of similar packages of measures applied to similar properties[53] (as reported by various organisations) it is assumed that 'whole-house' energy efficient refurbishments will achieve CO_2 savings averaging around 70%.

Capital costs

Based on the measures set out above and an understanding of similar scale refurbishment schemes that have been delivered, the capital cost is likely to be in the range of £20,000 to 50,000 per home. Assuming a middle range value of £30,000 to £35,000 the cost for delivering a whole-house retrofit solution to the 20 dwellings is likely to be in the order of £600,000 to £700,000.

This is an indicative figure and a specific cost estimate would need to be based on a detailed assessment of each individual property and the list of appropriate measures identified. This could be undertaken by requesting a Green Deal assessment, which, as well as identifying improvements and estimating the related annual carbon savings and implementation costs, would also establish the subset of works that could be eligible for Green Deal finance. Some works that are not 'green dealable' may be eligible for support under the Energy Company Obligation (ECO), and the Green Deal assessment could be used as a basis to seek ECO subsidy.

Environmental benefits

From similar whole-house retrofit projects studied, the range of CO_2 savings achieved varies between 60-80% so for the purposes of this study we have assumed that an average reduction of 70% could potentially be achieved. Carbon savings for this option are shown in Table 6.

Existing CO_2 emissions from the 14 cottages (kgCO_2 /year)	268,086
CO_2 emissions from the 14 cottages following connection (kgCO_2 /year)	80,426
Potential CO_2 savings (kgCO_2 /year)	187,660
Percentage reduction in CO_2 savings	70%

Table 6: Estimated scale of CO_2 savings that could be achieved through energy efficiency refurbishment of the cottages

Running costs

Based on similar examples of whole-house retrofits applied to similar properties, a basket of improvements set out above could be expected to deliver reductions in the energy bills for the properties in the order of 50-70%.

Other implications and considerations

Depending on the eventual heating system installed, the move from an existing lpg boiler or solid fuel heating system is likely to provide the same practical benefits for the residents as those described in the case of connection to the heat network.

This option is likely to cause significant disruption to the residents of the dwellings since many of the measures are likely to be very intrusive. The implication of this is that residents may need to clear the houses and potentially move out for a period of time to allow the work to be completed, or at least put up with the disruption.

[53] Sources include: EST, Building a Greener Britain (FMB, 2008), Greenspec, Retrofit and replicate (Hyde Housing, 2009), St Vincent's Housing, Whole House Retrofit Assessment Methodology (Urbed & Carbon Coop, 2012), Castle Rock Endivar Housing Association.

Care would need to be taken in selecting the refurbishment measures to apply to each of the properties to ensure that the improvements do not adversely impact on the aesthetic qualities of the buildings. Measures such as external solid wall insulation, some glazing products and use of solar thermal or photovoltaic panels could potentially have a negative impact upon the appearance of the property. This can either be addressed by choosing alternative measures, selecting appropriate products and/or by following guidance that has been produced by bodies such as English Heritage.

Conclusions

This basic analysis indicates that in terms of both the relative carbon savings and the relative capital costs, the two strategies are likely to be fairly comparable. As such, the choice of which strategy to pursue is more likely to be influenced by the practical implications for the College and the residents of the dwellings and potentially the longer term financial implications.

Error! Reference source not found. 7 summarises the main differences between the two options and the relative advantages and disadvantages of each.

	Heat Network Connection	Fabric and Energy Efficiency Improvements
Indicative CO_2 savings	Based on the assumption in our indicative calculations 230 tonnesCO_2 per year	Based on the assumption in our indicative calculations 190 tonnesCO_2 per year (although could be larger or smaller based on the extent of the improvements)
Indicative capital costs	The total capital cost could be in the order of £300,000 to 400,000 (assuming around 700m of pipework at £250/meter, installations of HIU's and heat meters to each property and an assumption of £100–200k for additional plant). However, the proposed upgrade of the existing system, which would involve the development of a new energy centre and potential improvements and upgrades to the existing plant and infrastructure, would add additional costs.	The total capital cost could be in the order of £600,000 to 700,000 (assuming an average cost of £30-35k per property for the basket of measures suggested). This option would allow some flexibility in that the capital costs could be higher or lower depending on the extent of the improvements made.
Operational costs	Should deliver a significant reduction in energy bills for residents (depending on the price charged for the heat) May deliver a return on the initial investment if the Renewable Heat Incentive can be obtained	Likely to deliver in the order of 50-70% reduction in energy bills for residents
Practical Implications	Potentially less direct implications for the residents in carrying out the works Would require additional biomass fuel to be obtained	Potentially extensive disruption to residents during the works
Other benefits	Could have a benefit for the operation of the heat network as a whole May enable the move to a new boiler house and upgrades to the flue and boilers	Should improve the value of the properties Could use Green Deal financing and may also be eligible for money from the Energy Company Obligations
Risks and constraints	Installing a heat main across the A286 could be difficult and would certainly be more expensive than the relatively easy network sections over soft ground. It would also require the approval and co-operation of the local authority and/or highways agency.	Would need to consider the implication on the appearance of the properties, particularly with regard to the use of external wall insulation and new windows

Table 7: Summary of the comparative advantages and disadvantages of the two options