Adur District Council Energy Study

FINAL REPORT

for

Adur District Council, SEEDA
Brighton & Hove CC,
West Sussex CC,
Shoreham Port Authority
& the HCA

26/05/09

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Table of Contents

Table of Figures

Abbreviations

ACS	Adur Core Strategy
AD	Anaerobic digestion
ASHP	Air source heat pump
ATT	Advanced thermal treatment
BCO	Building Control Officer
CHP	Combined heat and power
C&I	Commercial & Industrial waste
CSH	Code for Sustainable Homes
DH	District heating
DNO	Distribution network operator
DUoS	Distribution Use of System
ESCO	Energy Services Company
EU ETS	European Union Emissions Trading Scheme
GHG	Greenhouse Gases
GIS	Geographical Information System
GSHP	Ground source heat pump
HOB	Heat-only boiler
IRR	Internal rate of return
JAAP	Joint Area Action Plan
LEC	Climate Change Levy Exemption certificate
LES	Local electricity supply company
LZCT	Low or zero carbon technology
MSW	Municipal Solid Waste
NPV	Net Present Value
PV	Photovoltaics or Present Value
PW	Private wire
RDA	Regional Development Agency
RES	Renewable energy system
RO	Renewables Obligation
ROC	Renewables Obligation certificates
RUE	Rational Use of Energy
SHW	Solar hot water system
SRC	Short Rotation Coppice

Organisations

ADC	Adur District Council
BHCC	Brighton and Hove County Council
BERR	Department of Business Enterprise and Regulatory Reform
DEFRA	Department Environment, Farming and Rural Affairs
HCA	Homes and Community Agency
EC	European Commission
EST	Energy Savings Trust
SEEDA	South East England Development Agency
WSCC	West Sussex County Council

1 EXECUTIVE SUMMARY

1. Adur District will be home to significant new residential and commercial development over the coming decades. Foremost among this development is the regeneration of Shoreham Harbour, a nationally significant initiative that will deliver 8,000 new dwellings, 104,000 m^2 of office space and further 60,000 m^2 of retail, leisure and commercial space. Shoreham Harbour has achieved New Growth Point Status. On a smaller scale, but still significant to the regeneration of the area, are a number of other strategic housing and employment sites planned throughout the wider Adur District.

2. The redevelopment of Shoreham Harbour and developments around Adur District will span a period of rapid change in the legislation concerning the standards to which new buildings are constructed. The UK government is committed to challenging targets for CO_2 reduction and integration of renewable forms of energy generation into the national energy mix, such as the 2020 requirement under the EU Directive to ensure that 15% of national energy use is renewably sourced. In response to these targets the government is determined to ensure that additional energy demand and CO_2 emissions arising from new build housing and non-domestic buildings are minimized, while balancing this objective with the need to provide the supply of housing and employment space to meet the needs of a growing population.

3. The government has announced a range of policy initiatives that, through a mixture of regulation and incentivisation, will ensure that the energy demand and CO_2 impact of new buildings will be progressively reduced. The eventual goal is to ensure that all new housing built after 2016 will be zero carbon and that all new non-domestic buildings built after 2019 will contribute nothing to national net CO_2 emissions. The key instrument to achieving this will be tightening of the Building Regulations, which set the standard of CO_2 emissions performance required by new buildings. The trajectory of tightening of the Building Regulations towards the zero carbon standards is set-out in the government policy statement '*Building a greener Future*'[1]. To complement the proposed changes to the Building Regulations, the government has also introduced the *Code for Sustainable Homes*, a national standard to guide the house building industry toward increasing the sustainability of construction of new homes, in terms of energy and CO_2 emissions, but also in terms of a range of other key sustainability issues, such as efficiency of water use, waste management and sustainable sourcing of materials, among others.

4. In addition to these national policy initiatives, there is a duty on local government to assure that new developments in their regions maximise the opportunities for CO_2 reduction and renewable energy generation. Planning Policy Statements PPS1 on delivering sustainable development and PPS22 on renewable energy, require local authorities to devise Local Development Frameworks (LDF) that will ensure that the national objectives are effectively translated into the local development context.

5. Adur District Council has commissioned this study, along with Brighton Hove City Council, West Sussex City Council and SEEDA to inform local policy-making with respect to the energy and CO_2 performance of new developments in the Adur District and the Shoreham Harbour regeneration area, to ensure that commitments under PPS1 and 22 are met and that all opportunities for creating low carbon developments are maximised.

[1] Note that Building a Greener Future is concerned with domestic building. The ambition to achieve zero carbon in non-domestic buildings from 2019 was set out in the Budget 2008. The definition of the zero carbon standard in both domestic and non-domestic buildings has since evolved through a number of consultation documents (http://www.communities.gov.uk/publications/planningandbuilding/zerocarbondefinition).

6. In recognition of the regional significance of the Shoreham Harbour Regeneration and its importance to local sustainability targets, a detailed assessment is made of energy strategies that have potential to deliver a very low carbon development. It is acknowledged that planning for other development in the region is at an earlier stage, however by considering a range of generic development types that reflect the likely nature of these developments, it has been possible to produce some broadly applicable policy recommendations for inclusion in the Adur Core Strategy and site development documents.

7. The results of the study inform the Shoreham Harbour Joint Area Action Plan (JAAP), a key document in both the Adur and Brighton & Hove Local Development Frameworks, and the Adur Core Strategy. The main findings are summarized below:

Shoreham Harbour Joint Area Action Plan

8. Adur District Council (ADC), Brighton and Hove City Council and West Sussex County Council, Shoreham Port Authority, the Homes and Communities Agency (HCA) and SEEDA have identified the harbour area as a potential flagship zero carbon development opportunity, which could highlight the district as a national leader in the conception and development of sustainable zero carbon developments.

The local challenge

9. The plot below highlights the scale of the challenge to achieve a zero carbon development at Shoreham Harbour by demonstrating the level of CO_2 emissions that would result from building the developments to current standards.

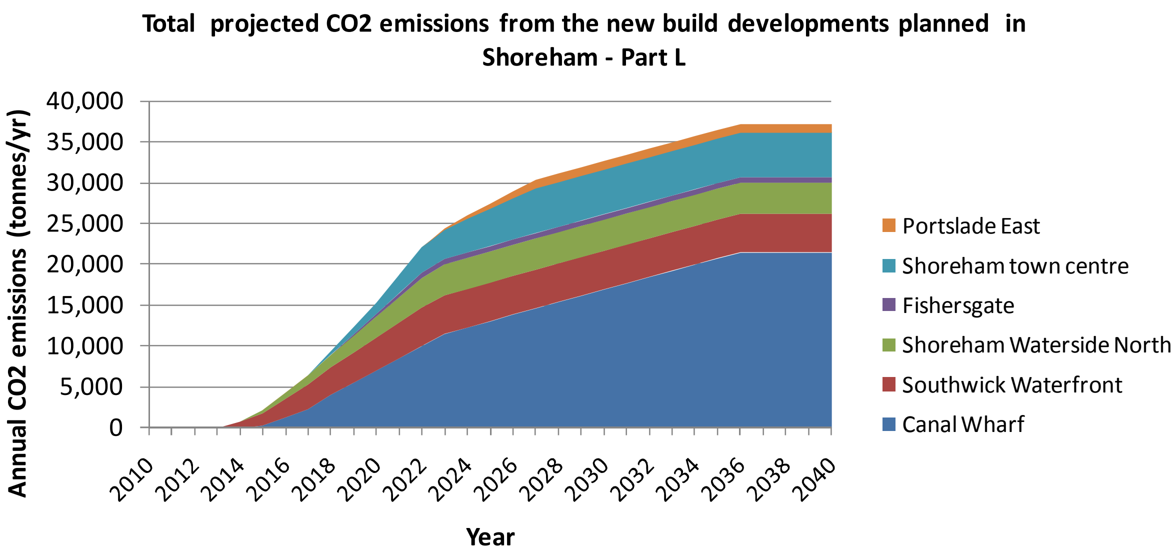


Figure 1 - annual CO_2 emissions which will result from the Shoreham Harbour new build developments if all buildings continue to be built to part L 2006 (domestic) or best practice benchmarks (non-domestic).

10. Annual CO_2 emissions by 2040 would exceed 35,000 tonnes/yr if developments were built at current standards. Legislation will drive substantial CO_2 reduction. Meeting mandatory central government CO_2 reduction targets at Shoreham Harbour will require these baseline emissions to be reduced by a minimum of 80%:

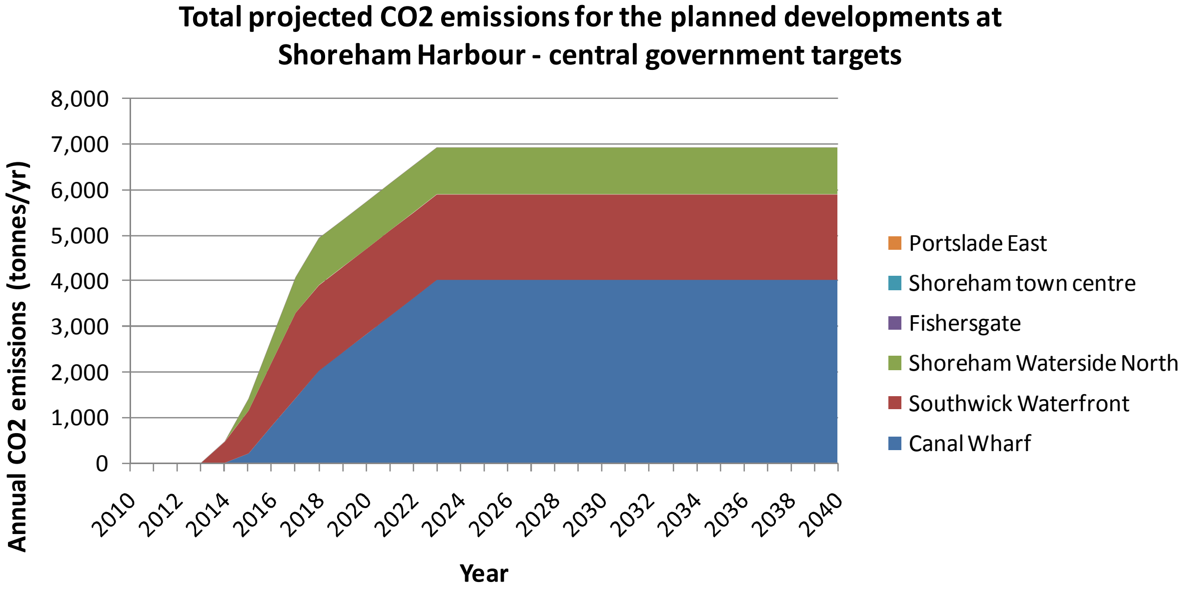


Figure 2 - annual CO2 emissions which will result from the Shoreham Harbour new build developments if all buildings are built to the building regulations standard in force at the time of build.

11. Attainment of these CO_2 reduction standards will be onerous and require significant capital investment.

Low carbon strategies at Shoreham Harbour

Site-wide combined heat and power systems

12. Initial projections indicate that the nature of developments at Shoreham Harbour, incorporating a large fraction of flats and built at high density, will be well-suited to site-wide energy infrastructure, such as district heating (DH) systems. When supplied by a low carbon source of heat, such as from a biomass fuelled combined heat and power (CHP) system, these site-wide infrastructures can provide large CO_2 savings relatively cost-effectively in high density sites with large absolute and highly concentrated heat demands.

13. The technical and economic viability of two potential district network configurations at Shoreham Harbour have been studied – an East of Harbour network and a Whole Harbour network which comprise the East of Harbour network and a west harbour extension. A range of CHP systems have also been assessed, including gas and biomass fuelled technologies.

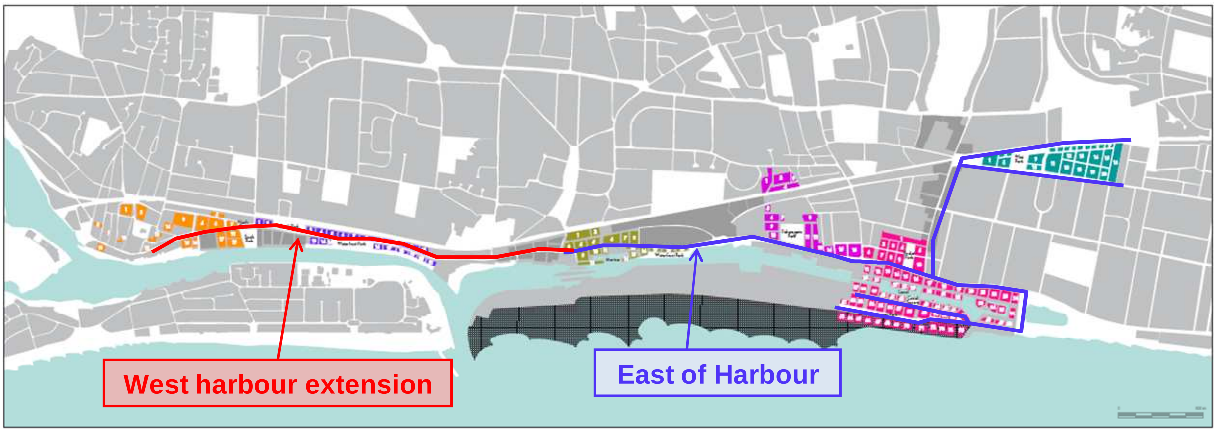


Figure 3 – Potential district heating network configurations studied at Shoreham Harbour

14. For each CHP and district heating system option, the capital costs of installation of the system have been estimated and cashflow analyses have been performed. These cashflow analyses have shown that generally the economic proposition improves as the scale of the system is increased, but that in all cases the net present value (NPV) (assessed at 10% discount rate over 25 years) is negative.

15. The whole harbour DH system (i.e. extending the whole length of the harbour and connecting each of the major development sites) has been shown to provide the best economic performance when combined with a biomass-fuelled CHP system (assuming a 3.5 MWe capacity CHP system, based on well-proven steam-cycle technology). The cashflow analysis for this system is summarised in the table below:

Capital cost of system		**Steam biomass (3.5 Mwe)**
CHP energy centre	£	7,500,000
CHP replacement cost	£	897,720
District heating system (including HIUs)	£	10,538,945
Total capital costs	*£*	*18,936,665*
Avoided costs (developer contribution)		
Domestic boilers and gas connections	£	7,903,561
Comercial boilers	£	678,815
Total avoided costs	*£*	*8,582,375*
Present value of operating costs		
O&M	£	742,467
CHP fuel	£	5,842,749
boiler fuel	*£*	*1,344,174*
Present value of revenues		
Domestic heat sales	£	5,051,586
Comercial heat sales	£	4,067,031
Electricity export	£	1,998,950
ROC revenue	£	4,569,029
Total present value of operating costs & revenues	*£*	*7,757,207*
Net present value	**-£**	**2,597,082**

Figure 4 – Summary of cashflow analysis for a whole harbour district heating network served by a biomass-fuelled, steam cycle CHP system

16. The economics of the CHP and district heating systems will not be attractive to private sector Energy Service Company (ESCO) partners without a significant level of additional capital funding (or low cost of capital finance). The NPV shown in the table above is calculated over a 25 year life, however the upfront capital contribution that an ESCO is willing to make is likely to be calculated over a shorter time horizon (typically they might assess an investment opportunity over 10 years). Based on this level of capital contribution the upfront funding gap for the steam-cycle biomass fuelled system has been estimated at over £7 million.

17. Shoreham Harbour power station may provide a convenient source of low carbon heat to the district heating system over the period to 2025, when the power station is due to be decommissioned. Over this period the district heating system would be built up and a large number of heat customers connected. This would provide a very good business case for investment in a new energy centre, potentially comprising biomass CHP, to replace the power station. However, there are a number of issues concerning extraction of waste heat from the power station and connecting between the power station and the district heating network (which may require submersion of heat pipes) that would require a detailed technical feasibility and cost assessment.

18. This biomass-fuelled CHP and district heating system delivers an 80% reduction on regulated CO_2 emissions, compared to a Part L 2006 baseline. This is sufficient to meet the CO_2 reduction requirements of Code level 4 of the Code for Sustainable Homes. The system also delivers around a 60% reduction in the total non-domestic emissions of the developments.

19. To facilitate attainment of the zero carbon standard, additional low carbon energy generation will also be required in addition to any site-wide CHP system. This could be provided by building integrated renewable energy generation technologies e.g. photovoltaics (PV), or developers could be allowed to access a range of more cost-effective offsite "allowable low carbon solutions" e.g. MW-scale wind offsetting or making capital contributions to a low carbon buy-out fund.

20. The capital costs of attaining zero carbon status at Shoreham Harbour via deployment of site-wide CHP systems and either recourse to onsite renewable energy generation technologies or offsite MW scale wind carbon offsetting are presented in the graph below. Cost estimates are shown for a systems based on natural gas and biomass-fuelled CHP systems:

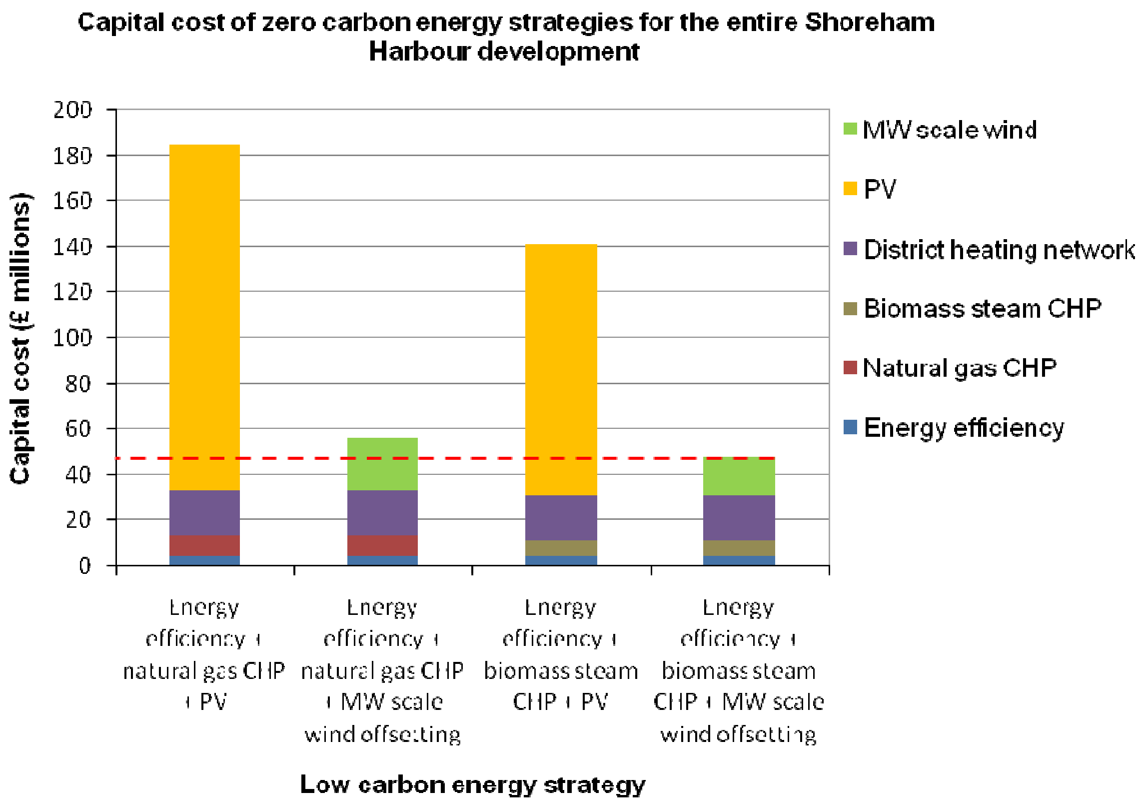


Figure 5 – Capital cost of achieving zero carbon status at Shoreham Harbour for a range of low carbon energy strategies

21. Zero carbon energy strategies which incorporate building integrated low carbon technologies e.g. roof mounted solar PV are significantly more expensive than strategies which allow developers access to

(at least in part) offsite low carbon "allowable" solutions e.g. the installation of MW scale wind turbines in locations remote from a site.

22. The least capital cost energy strategy to achieve zero carbon across the Shoreham Harbour development has an estimated total capital cost of £ 45 million. The breakdown of this capital investment between the major components is tabulated below:

Component of energy system	Capital cost (undiscounted)
Energy efficiency measures (extra-over cost compared to meeting Part L 2006)	£ 4.5 million
Biomass CHP energy centre (3.5 MWe)	£ 7.2 million
District heating network (Whole Harbour)	£ 19.7 million
MW-scale wind turbines	£ 16.9 million

Figure 6, Breakdown of the total capital cost of the lowest capital cost approach to achieving zero carbon developments across Shoreham Harbour

23. The capital investment shown in the table above does not make any allowance for the savings made in the costs of avoided plant, such as the individual boiler plant and gas connections that are replaced by the district heating system.

24. The timescales of Shoreham Harbour developments are such that a significant proportion of the additional costs shown above would be incurred just to meet the requirements of the Building Regulations[2], i.e. are not specifically related to the zero carbon aspirations of Shoreham Harbour.

The Adur Core Strategy

25. In addition to the Shoreham harbor development, there are a number of potential strategic housing and employment sites that are being investigated through the Adur District Council's Core Strategy. These developments are significantly smaller in scale – residential developments are typically hundreds of dwellings and employment sites of 15,000 to 30,000 m^2 (Shoreham airport is an exception and is likely to be significantly larger). Much of this development is proposed for greenfield sites and is expected to be built out at lower density than the high density, large-scale flatted developments of Shoreham Harbour.

26. An analysis of a range of energy system configurations for these development types has been conducted in order to identify the most cost-effective approaches to meeting the energy and CO_2

[2] Building Regulations are expected to change in 2010 and 2013 to require respective 25% and 44% reductions of CO_2 emissions from a Part L 2006 baseline. Zero carbon standards are expected to be in force from 2016 for domestic properties and from 2019 for non-domestic buildings.

emissions standards that are expected to be introduced through Building Regulations over the coming years.

27. Without the scale or density to justify site-wide energy systems, energy solutions developed at an individual building level become more relevant. In all cases a good level of energy efficiency should be achieved in the building construction, this conserves energy and reduces energy bills for tenants and is also the most cost-effective way of reaching CO_2 reductions of 15 to 20%.

28. To reach the 25% level of CO_2 reduction, which will be introduced through Part L in 2010 (and which is required by level 3 of the Code for Sustainable Homes), it may be more cost-effective to integrate some form of low carbon energy generation, such as a PV system or heat pump, rather than to improve the energy efficiency of the fabric further. This level of CO_2 reduction can typically be achieved at an additional cost of £2 - £ 5k per dwelling, depending on the dwelling and development type.

29. To achieve the higher level of CO_2 reduction required by level 4 of the Code for sustainable homes (which will become building regulations in 2013) is more onerous. It generally requires a renewable form of heating, such as biomass boiler or heat pump, with additional requirement for renewable electricity generation in some dwelling types. The capital costs associated with these strategies range between £5k to £10k per dwelling. To achieve higher levels of CO_2 reduction through individual building scale measures becomes highly capital intensive. To achieve the CO_2 reductions required by levels 5 and 6 of the Code can incur additional capital costs of more than £ 20k. At these levels of CO_2 reduction, communal energy systems tend to become more cost-effective, even on sites where the heat density is not ideal.

Adur District Council sustainability preferred approach policy statements

30. Analysis of the most technically viable and cost-effective low carbon energy strategies for the various forms of developments likely to be constructed in the Adur District has allowed a number of sustainability policy statements to be developed that are appropriate to the Adur Core Strategy. These statements are summarized below.

Policy Recommendation 1: Energy Efficiency targets

Developers will be encouraged to minimise the energy consumption and CO_2 emissions of development. In all developments, consideration should be given to how energy consumption can be reduced through appropriate building layout and orientation, building form and design, use of natural ventilation and accounting for the micro-climate.

Developers of domestic properties should achieve a reduction of at least 15% of Part L2006 regulated emissions, i.e. of the Target Emissions Rate (TER), through application of energy efficiency measures. Developers of larger family houses (e.g. 3 or more bedrooms), should seek to exceed this minimum. The minimum reduction of CO_2 emissions through energy efficiency measures may be updated from time-to-time in response to changes to Part L of the Building Regulations.

It is recommended that developers of non-domestic buildings should adopt energy efficiency standards capable of delivering at least a 10% reduction of CO_2 emissions from a Part L 2006 baseline and make an assessment of the optimal level of CO_2 reduction through energy efficiency on a case-by-case basis.

Policy Recommendation 2 – Supporting combined heat and power systems and heating networks

A strategic policy is recommended that:

Ensures that local, existing heating and cooling networks are identified and safeguarded.

Maximizes the opportunities for providing new networks that are supplied by decentralized energy (including renewable generation).

Ensures that developers evaluate the technical and economic viability of combined cooling, heat, and power (CCHP) and combined heat and power (CHP) systems on all new developments, and where a new CCHP/CHP system is installed as part of a new development, examine opportunities to extend the scheme beyond the site boundary to adjacent areas.

Ensures that developers study the technical and economic viability of the following heat and cooling network strategies before submitting a planning application:

- connection to existing CCHP/CHP distribution networks
- site-wide CCHP/CHP powered by renewable energy
- communal heating and cooling fuelled by renewable sources of energy
- natural gas-fired CCHP/CHP

Ensures that it is feasible for new developments to connect to existing heating and cooling networks.

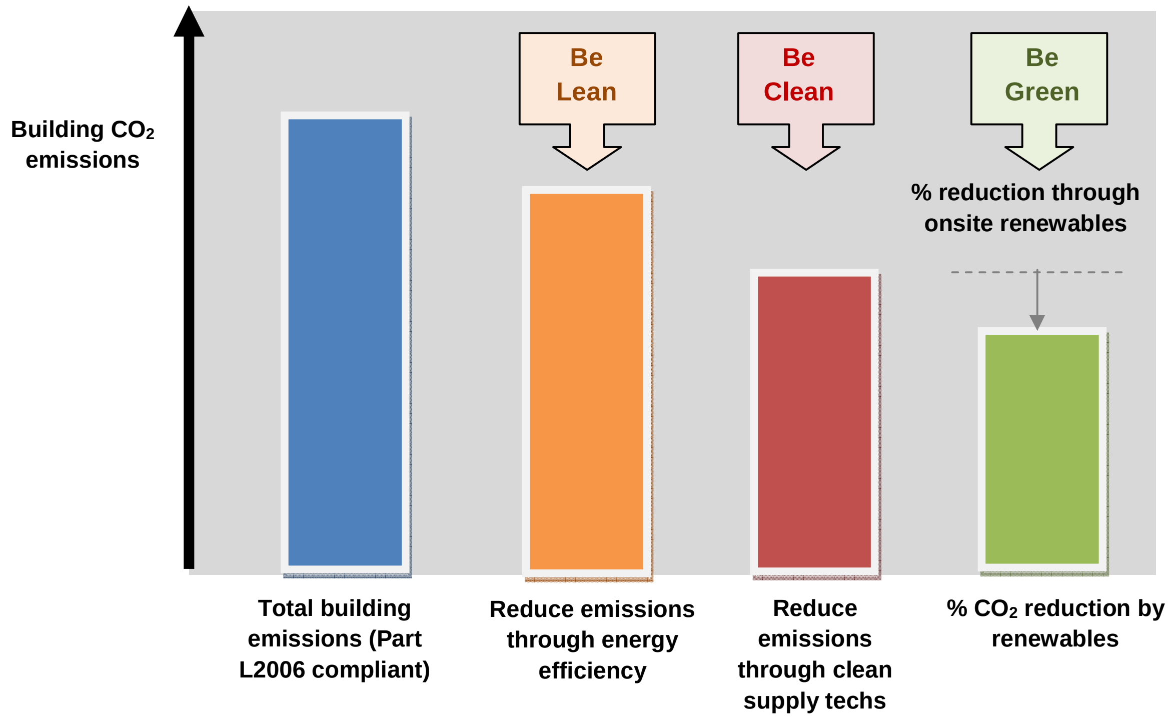
Developers of the Mash Barn (New Monk's Farm) site should assess the opportunity for a district heating system. The developers of this site should be required to provide an assessment of district heating fed by gas CHP or biomass heat-only boilers as a means of meeting or exceeding minimum CO_2 emissions reductions required by the Building Regulations. The developers should also be required to assess the potential for extension of a district heating network to the adjacent airport and Old Salt's Farm developments.

Developers at EWAR and Sompting Fringe should also be required to assess the potential for heat networks, including potential extensions to existing commercial districts, such as Lancing Business Park.

Policy Recommendation 3 – Onsite renewable energy supply

A policy is recommended that requires developers of all major developments[3] to provide a percentage reduction of CO_2 emissions through supply of renewable energy. The percentage reduction shall be based on a calculation of the residual emissions, where the residual emissions are those remaining following application of policies 1 and 2 and include calculation of both regulated and unregulated CO_2 emissions. The sequential reduction of building CO_2 emissions by application of policies 1 to 3 is illustrated schematically in the figure below.

[3] A major development is more than 10 dwellings or 1000 m^2 GFA for non-residential development



The percentage reduction of residual CO_2 emissions to be delivered through supply of onsite renewable energy shall depend on the date of submission of a detailed planning application, as follows:

1. Prior to 2013, at least a 10% reduction of residual CO_2 emissions shall be delivered by onsite supply of renewable energy.
2. Post 2013, at least a 20% reduction of residual CO_2 emissions shall be delivered by onsite supply of renewable energy.

If a good quality[4] community gas CHP system has been installed on the site, this should count as equivalent to a 10% CO_2 reduction through onsite renewable energy generation.

Policy Recommendation 4 – Code for Sustainable Homes and BREEAM

Requiring developers to achieve Code for Sustainable Homes and BREEAM standards will ensure that broad principles of sustainable construction are adopted in domestic developments within the region.

The CO_2 emissions standards of increasing Code Levels will become mandatory through revisions of the Building Regulations, however, the Code will remain voluntary unless required as a planning condition.

BREEAM only sets mandatory CO_2 emissions requirements at the highest levels, however a BREEAM requirement will encourage developers to reduce CO_2 to achieve credits toward the required rating.

Adur District Council should require developers of new build domestic developments to achieve the following standards of the Code for Sustainable Homes, unless developers can demonstrate that to do so would adversely affect the viability of a particular site.

- Post 2010 – CSH level 3

[4] The CHP system has been certified as good quality under the CHPQA accreditation scheme.

- Post 2013 – CSH level 4

Developers of non-domestic buildings should be required to achieve a minimum BREEAM 'Very Good' standard.

Policy Recommendation 5 – Development of low carbon allowable solutions

Incorporate a strategic policy which supports:

1. Standalone renewable energy schemes

Proposals for renewable energy developments, including any ancillary infrastructure or building will be favourably considered if:

1) Their scale, form, design, materials and cumulative impacts can be satisfactorily assimilated into the landscape or built environment and would not harm the appearance of these areas; and

2) They would not impact adversely on the local community, economy, biodiversity or historical interests.

2. A local Adur low carbon buy-out fund

Adur District Council will explore the option of a local Adur-wide low CO_2 buy-out fund.

The buy-out fund will provide a potential route for developers to direct investment in 'Allowable Solutions', in line with the government's proposed definition of zero carbon homes and buildings.

Access to the buyout option will only be granted for those sites where it has been demonstrated that the required level of onsite CO_2 mitigation (i.e. the 'Carbon Compliance' level – expected to be 70% of regulated emissions) has been achieved.

The tariff level of any CO_2 buy-out will be determined following further evidence base work, but will be set at a level which encourages developers to explore all relevant onsite clean/renewable energy generation technologies in the first instance. The level of the buy-out tariff will be informed by government policy on zero carbon homes, specifically the capped level for investment in Allowable Solutions.

Capital contributions to the CO_2 buy-out fund will be used to fund major low carbon projects in the Adur District. These projects may include (but are not limited to):

1. Installation of stand-alone renewable schemes in suitable locations
2. Energy efficiency retrofitting in the existing build stock
3. Development of district heating schemes and potential expansion of district heating network to serve the existing build stock

These policy statements are supported by a robust evidence base developed in this study and summarized in Section 7. The application of these policies to specific developments sites is summarized in the following section.

Site specific policy recommendations

Residential sites

In all the residential developments identified below, a reduction of Part L 2006 regulated emissions (i.e. the Part L 2006 Target Emissions Rate) of at least 15% shall be achieved through application of energy efficiency measures (see Policy Recommendation 1).

The recommended energy strategies and policies to be applied to the currently identified residential sites are summarized in the table below:

Site	Scale	Density (dph)	Programme	Anticipated Regulation	Recommended Energy Strategy	Policy
Mash Barn	450-550	40	2013-2018	Mix of Part L2013 and ZCH	Potential for district heating with biomass HOB (unlikely to be sufficient demand for biomass CHP, unless smaller technology develops). Photovoltaics or site wind[5] required to meet ZCH standard in later stages.	1. Investigate feasibility of a district heating system served by a biomass-fuelled heating technology. 2. Provide a 20% reduction of total residual residential CO_2 emissions through supply of renewable energy
Old Salt's Farm	25-525	40	Post-2018	ZCH	Potential for connection to Mash Barn DH system. PV or site wind potentially required to reach ZCH standard. Alternative strategy individual biomass boilers or ASHPs and PV / site wind.	1. Investigate the feasibility of connection to local DH schemes. 2. Provide a 20% reduction of total residual residential CO_2 emissions through supply of renewable energy

[5] Site wind refers to medium to large-scale wind turbines installed within the site. It does not refer to building integrated wind turbines.

Sompting Fringe	30-335	40	post-2018	ZCH	Individual biomass boilers or ASHPs and PV or site wind	1. Investigate the feasibility of connection to local DH schemes. 2. Provide a 20% reduction of total residual residential CO_2 emissions through supply of renewable energy
Shoreham Town Centre	320	40	2013-2018	Mix of Part L2013 and ZCH	Potential for connection into Shoreham Harbour district heating system. Alternative strategy individual biomass boilers or ASHPs and PV/site wind.	1. Investigate the feasibility of connection to local DH schemes. 2. Provide a 20% reduction of total residual residential CO_2 emissions through supply of renewable energy
Sites in existing settlements	870	> 40	2008 - 2016	Part L2010 and Part L2013, depending on time of construction	Variable depending on timing.	1. Investigate the feasibility of connection to local DH schemes. 2. (i) For major developments developed prior to 2013, provide a reduction of total residual CO_2 emissions of 10% through supply of renewable energy. (ii) For major developments developed post-2013, provide a reduction of total residual CO_2 emissions of 20% through supply of renewable energy. 3. For smaller developments where targets for CO_2 reduction through onsite renewables are not achieved, an equivalent contribution to the Low Carbon Buy-Out fund will be required.

Non-residential sites

In all development below, achieve a minimum 10% reduction of CO_2 emissions from Part L 2006 regulated emissions through use of energy efficiency measures.

Site specific policy recommendations are given below:

Site	Use	Scale	Programme	Anticipated Regulation	Energy Strategy	Policy
Shoreham Airport	Aviation/ office	37,550 - 49,650 sqm	2013-2016	Part L 2013	Consider the feasibility of a common district heating system with the Mash Barn mixed-use site. Consider a CHP system with site-wide district heating.	1. Investigate feasibility of a district heating system served by a biomass-fuelled heating technology. 2. Provide a 20% reduction of total residual CO_2 emissions through supply of renewable energy
Shoreham cement works	Leisure / office	45,000 sqm	post 2016	Part L 2013 / zero carbon buildings	Consider the feasibility of a site-wide district heating system with CHP or boilers fuelled by renewables. Site wind or photovoltaics may be required to meet the Building Regulations.	1. Investigate the feasibility of site wide district heating and renewable-fuelled CHP or boilers. 2. Provide a 20% reduction of total residual CO_2 emissions through supply of renewable energy
Eastbrook allotments	Office	15,000 sqm	2013-2016	Part L 2013	Renewable fuelled boiler plant or air source heat pumps.	1. Provide a 20% reduction of total residual CO_2 emissions through supply of renewable energy

EWAR	Office	30,000 sqm	post 2016	Part L 2013 / zero carbon buildings	Consider potential for district heating systems extending to Sompting Fringe or neighbouring commercial / Industrial uses. Consider renewable fuelled boilers or CHP to feed heat network. Potential requirement for photovoltaics or site wind to meet zero carbon buildings policy.	1. Investigate feasibility of a district heating system served by a biomass-fuelled heating technology. 2. Provide a 20% reduction of total residual CO_2 emissions through supply of renewable energy
Mash Barn	Retail, office & commu nity use	23,875 - 39,175 sqm	2013 – 2018	Part L2013/2016	Consider potential for district heating, potentially linked to Old Salt's Farm and/or Shoreham Airport. Consider renewable fuelled boilers or CHP to serve the heat network	1. Investigate feasibility of a district heating system served by a biomass-fuelled heating technology. 2. Provide a 20% reduction of total residual CO_2 emissions through supply of renewable energy.

Local renewable resources - GIS resource mapping

31. The ability for developers to invest in offsite measures to mitigate CO_2 emissions from their developments could result in more cost-effective CO_2 saving. Large-scale wind is one technology that delivers relatively cost-effective CO_2 savings that could be explored. The regional potential for onshore wind has been assessed.

32. The Adur District has a significant land based wind resource and large areas of open green space. However, GIS resource mapping indicates that the number of suitable MW scale wind sites in the district is severely restricted by local geography, including:

- The site of the South Downs National Park
- Wind turbine restriction zones surrounding Shoreham Airport
- The presence of an active Gatwick flight corridor over the region
- Benchmarks governing the suitable separation distance of wind turbines from existing buildings

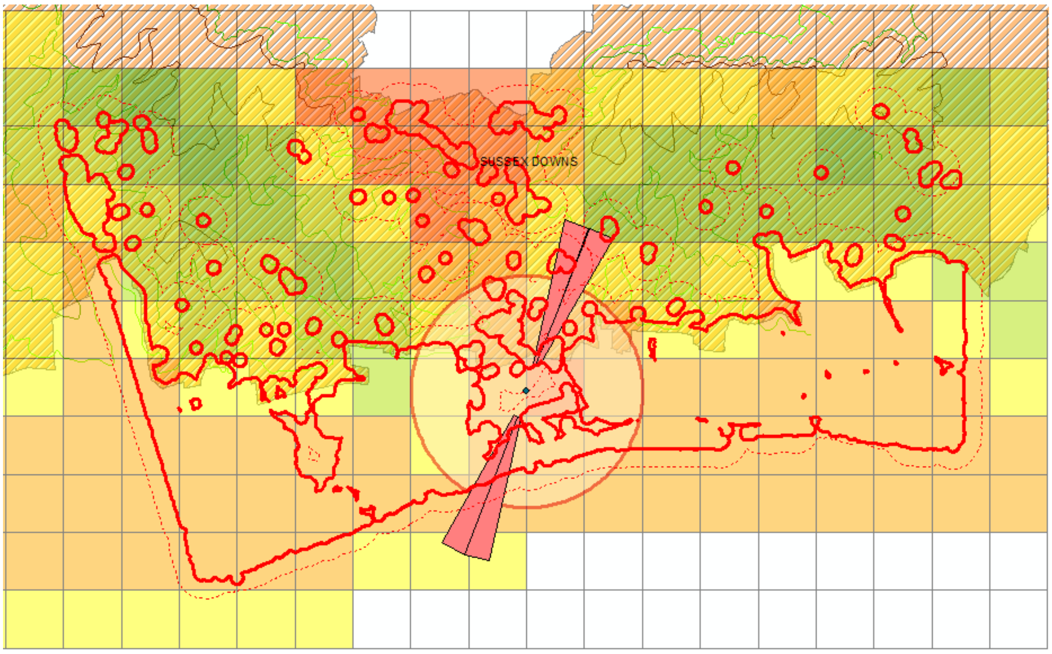


Figure 7 - Map of wind speed variation and wind turbine restriction zones across the Adur District. Solid red lines indicate 100m exclusion zones around buildings (dotted red lines indicate 400m exclusion zone). Red shaded blocks are exclusion zones due to Shoreham Airport flight paths. Note that the majority of high wind speed areas (green shaded) are located within the Sussex Downs AONB, where planning restrictions will apply.

33. The abundant wind resource in the English Channel has led the Crown Estate to earmark an area just off the coast near Brighton in their round 3 offshore wind programme. Plans for development of an offshore wind farm at the site are currently at an early stage and it is not clear what interest in such a development local stakeholders in the Adur District might play. It is feasible that a mechanism could be established such that developers could invest in the offshore wind array as part of an 'allowable solution' to mitigate the CO_2 emissions of developments in the Adur District.

Biomass Resource availability

34. The most cost-effective means of creating a very low carbon development at Shoreham Harbour is likely to be based around a biomass-fuelled CHP system and district heating network. The availability of local resource to supply this system has been assessed.

35. The Adur District is not itself home to a large quantity of woodland. However, the South East is England's most wooded region with more than 270,000 ha of existing woodland. The catchment area of the Shoreham system could extend a radii of 50 miles, without increasing the CO_2 content of the fuel to unacceptable levels. This encompasses much of the counties of East and West Sussex.

36. An estimate of the annual yield of woodfuel from woodland in East and West Sussex has been made, The annual resource is expected to be sufficient to provide woodfuel for approximately 16 MWe of biomass CHP capacity.

37. The system at Shoreham Harbour would be a significant draw on the local woodfuel resource. However, the opportunities and benefits of a growing wood fuel market have been recognized by the Forestry Commission, which is actively involved in supporting wood fuel projects in the South East region and facilitating development of a sustainable wood fuel supply chain. As part of this, the Forestry Commission is developing a South East Wood Fuel Implementation Plan in the South East region. The establishment of a substantial wood fuel demand in the Adur district is well-aligned with these regional objectives.

2 INTRODUCTION

2.1 Climate change and the need for national environmental policy

An overwhelming body of scientific evidence indicates that the Earth's climate is changing rapidly, and to a large extent as a result of increases in greenhouse gas emissions produced by human activities.

It therefore falls upon national governments to implement policy to achieve a reduction in greenhouse gas emissions (especially carbon dioxide). The lack of sound commercial models for CO_2 reduction means that policy is the key driver in mitigating climate change. The Kyoto Treaty, operating at the international scale, has spearheaded a set of frameworks in which trading blocs (such as the EU) and national governments have begun to act.

The UK has committed to a 60% reduction in CO_2 emissions by 2050 (from 1990 levels), with real progress by 2010 and 2020. The government's emissions reduction goals for 2020 and 2050 will become statutory through the Climate Change Bill, with the introduction of five-year 'carbon budgets' (total emissions limits). Integral to achieving these goals are the government's targets to produce 10% of UK electricity from renewables by 2010 and 20% by 2020 and the UK's commitment under the EU Renewable Energy Directive to produce 15% of all UK energy from renewables by 2020.

It is in the wider context of international obligations that Government - and ultimately UK Local Authorities - must frame their low carbon energy policies.

2.2 Implications of national planning guidance and building regulations at the local level

2.2.1 Planning policy

In order to facilitate the attainment of the international low carbon obligations outlined above, the UK government has produced documents which guide the formulation of local policy documents relating to renewable/clean energy production and the mitigation of global climate change.

PPS1: *Delivering Sustainable Development* and **PPS22: *Renewable Energy*** set out a clear and challenging role for regional and local spatial strategies. They are expected, through the Local Development Documents (LDDs) and development plan documents (DPDs) to set policies on provision of energy from low carbon and renewable sources. These policies should be designed to exploit the full potential of local opportunities, while ensuring the targets set are not unrealistic and do not undermine the new development required to meet the needs of the community.

All local policies should be informed by and complement the increasingly stringent regulations on development CO_2 emissions to be introduced through the Building Regulations. However, Local Planning Authorities (LPAs) are also expected to identify where local circumstances justify higher standards for particular developments. In these instances, the requirement for higher levels of performance should be set out in advance in a DPD.

In assessing the potential opportunity for accommodating renewables and low carbon technologies in new developments, LPAs are encouraged to:

- pay particular attention to opportunities for utilizing and expanding existing decentralised energy supply systems, and fostering the development of new opportunities for decentralized energy from renewable and low-carbon energy sources to supply proposed and existing development;
- consider allocating sites for renewable and low-carbon energy sources, and supporting infrastructure, taking care to avoid stifling innovation;

- look favourably on proposals for renewable energy, including on sites not identified in development plan documents;
- not require applicants to demonstrate either the overall need for renewable energy and distribution or for a particular proposal for renewable energy to be sited in a particular location;
- avoid policies that set stringent requirements for minimising impact on landscape and townscape if these effectively preclude the supply of certain types of renewable energy, and therefore other than in the most exceptional circumstances such as within nationally recognised designations, avoid such restrictive policies;
- ensure that a significant proportion of the energy supply of substantial new development is gained on-site and renewably and/or from a decentralised, renewable or low-carbon, energy supply.

In all cases LPAs should ensure that policies are technically feasible, do not jeopardise the development needs of the community by undermining the viability of sites, consider the potential that offsite supply of low carbon energy may be more cost-effective and set clear timetables for introduction of policies to provide certainty to the developer community.

The high-level objectives of these planning policies are translated to the local level through the policies set out in the South-East Plan, which in turn provides the policy background on which all local development frameworks in the South East are based. The policies within the South East Plan of particular relevance to this energy strategy are as follows:

Cross-cutting policy CC4: Sustainable Construction – This policy seeks to ensure that the environmental impacts associated with new buildings are minimized both during their construction and throughout their subsequent occupied lifetime. With respect to energy, the policy refers to the need to design to facilitate provision of a proportion of a development's energy supply from renewable, low carbon or decentralized sources. The policy acknowledges the government's commitment to improve CO_2 emissions standards through the Building Regulations, but encourages LPAs to set higher standards in DPDs (particularly with respect to energy and energy efficiency) where the particular local circumstances justify a higher target. The policy statement and supporting text also refers to the need for reduction and increased recycling of construction wastes, sourcing of low environmental construction materials and the need to encourage adoption of best practice standards such as the Code for Sustainable Homes.

NRM11: Development Design for Energy Efficiency and Renewable Energy – This policy states that developers should submit an assessment of a development's energy demand and, for housing schemes of over 10 houses and commercial schemes of over 1,000 m^2, provide 'at least' 10% of the energy demand from renewable sources.

NRM12: Combined Heat and Power – This policy states that Local Development Documents should encourage the incorporation of CHP of appropriate scales in all developments and, in large mixed-use developments, should also encourage incorporation of district heating systems. The policy also supports the use of biomass fuel, where there is an appropriate opportunity.

NRM13 – 15: Regional and sub-regional renewable energy targets and locations for their development – These policies set the regional and sub-regional targets for renewable energy generation, informed by the UK government's overall commitments under, for example, the EU Directive on renewable energy supply (15% of the UK's energy supply should be from renewable sources by 2020). Policy NRM15 then deals with where this renewable energy generation should be located and states that local development frameworks should support such projects in order to achieve the regional target. The locations should be selected to minimize adverse impacts on landscape, wildlife and amenity and, outside urban areas, should give priority to developments in less sensitive parts of the countryside, including prior developed land and in major transport areas.

This study provides the evidence base required to guide and support local low carbon energy policy over the critical period to 2020 and beyond. The policy recommendations derived from the following analysis will assist Adur District Council (ADC), Brighton and Hove County Council (BHCC), West Sussex County Council (WSCC) and SEEDA to ensure that maximum advantage is taken of opportunities to reduce carbon emissions from developments in Adur District and in Shoreham Harbour.

2.2.2 Planned changes to the Building Regulations

The government has announced as policy objectives that all new domestic properties built post-2016 should be zero carbon and that all new non-domestic properties should be zero carbon post 2019[6]. These standards will be brought into effect through tightening of the Building Regulations, specifically through changes to Part L ('Conservation of Fuel and Power'), which deals with energy and CO_2 emissions standards of new buildings.

The trajectory of Building Regulations toward the zero carbon standard for domestic properties is likely to be via two interim steps in 2010 and 2013, before the introduction of the zero carbon standard in 2016. At these interim steps, changes will be made to Part L to reduce the permissible CO_2 emissions from new dwellings compared to the emissions from a current Building Regulation (Part L 2006) compliant dwelling. The percentage reductions in emissions expected to be enforced at each step are tabulated below:

Year	% CO_2 emissions improvement on Part L 2006	Notes
2010	25%	These percentage improvements relate to reduction of the emissions from fuel and electricity use in heating, ventilation and fixed lighting – these are known as regulated emissions. Emissions relating to cooking and appliance use are excluded.
2013	44%	
2016	Zero carbon homes standard introduced	To achieve zero carbon status will require all emissions, including those related to appliances, to be mitigated in some manner. Further discussion of the zero carbon standard is given in section 2.2.2.1.

Figure 8, Proposed amendments to the CO_2 emissions standards in forthcoming revisions of the Building Regulations (expressed as percentage reductions from current Part L)

The steps toward the zero carbon standard for non-domestic buildings is currently less clear. It is likely that improvements of the emissions standard of non-domestic buildings will be enforced through changes to Part L in 2010 and 2013, with the possibility of further interim steps between 2013 and the introduction of the zero carbon standard in 2019. The change to Part L in 2010 is likely to enforce a 25% reduction in emissions from the current standard, in line with improvement required in domestic buildings. The change in 2013 may also follow the changes planned for domestic buildings, i.e. a 44% reduction from current standards, although it is recognized that the technical challenges in delivering large emissions reductions in non-domestic buildings is quite different to that in the domestic sector and so an alternative trajectory may be deemed to be more appropriate.

[6] Building a Greener Future: Policy Statement, Communities and Local Government, http://www.communities.gov.uk/documents/planningandbuilding/pdf/building-greener.pdf

KEY CONCLUSIONS

- Tightening of building regulations over the coming decade will enforce mandatory CO_2 reduction standards on new build homes and non-domestic buildings

- The CO_2 reductions required of new build dwellings will follow the trajectory below:
  - 2010 - 25% reduction in baseline regulated emissions
  - 2013 – 44% reduction in baseline regulated emissions
  - 2016 – Zero carbon

- The CO_2 reduction standards that will be required of new build non-domestic buildings are less clear. In this report we will assume the following trajectory:
  - 2010 – 25% reduction in baseline emissions
  - 2013 – 44% reduction in baseline emissions
  - 2019 – Zero carbon

The definition of what constitutes a zero carbon building is currently the subject of a government consultation, both for domestic and non-domestic buildings. The proposed definition is discussed briefly below.

2.2.2.1 UK government definition of zero carbon

In 2009, the government consulted on the definition of zero carbon homes and non-domestic buildings that will be adopted in 2016 for homes and 2019 for non-domestic buildings[7]. The proposal identified a hierarchical approach to reducing CO_2 emissions, with certain minimum amounts of CO_2 reduction to be achieved through energy efficiency (demand reduction) and onsite energy generation and directly connected renewable heat. The consultation invited views on the appropriate levels of reduction to be achieved through these means. It is not proposed that all emissions (i.e. regulated emissions and those related to appliances and cooking) should be reduced by these onsite measures. Instead, the zero carbon definition introduces the concept of ‘allowable solutions’ to deal with the final tranche of a site’s emissions. These allowable solutions could be onsite measures, but may also include a variety of offsite measures.

[7] Definition of zero carbon homes and non-domestic buildings consultation http://www.communities.gov.uk/publications/planningandbuilding/zerocarbondefinition

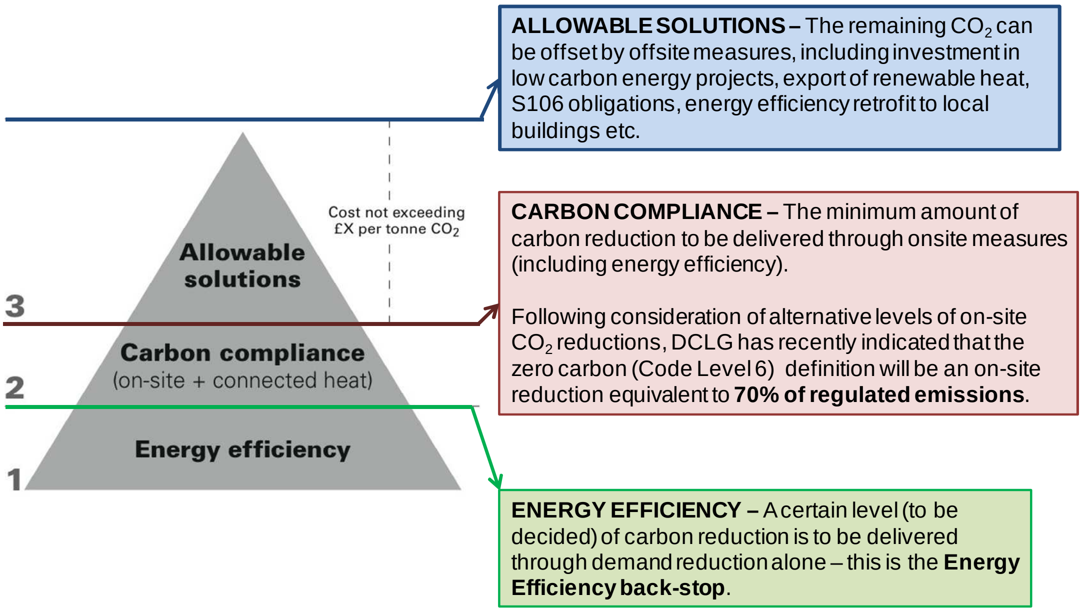


Figure 9, hierarchical approach to CO_2 savings favoured by UK government

The three levels of the zero carbon hierarchy are described below:

1. Energy efficiency

An energy efficiency backstop level is likely to be enforced that will ensure buildings are built to a good standard of fabric performance and that overall energy demand will be reduced. Energy efficiency measures can be a cost-effective way to deliver CO_2 emissions reductions and provide 'locked-in' benefits to the home-owner. To reach very high levels of energy efficiency can be highly costly.

2. Carbon compliance

The carbon compliance level is the level of CO_2 emissions reduction to be delivered through the combination of energy efficiency and onsite renewable or low carbon generation measures (including connected renewable heat). Following the consultation on the definition of zero carbon homes and buildings it was announced that the carbon compliance level would be 70% of Part L 2006 regulated emissions[8].

3. Allowable solutions

The remainder of the site's CO_2, including CO_2 associated with cooking and use of appliances, will be dealt with via allowable solutions. The measures that will constitute allowable solutions are subject to ongoing work by the government. Following the zero carbon homes and buildings consultation, which sought views on a range of possible allowable solutions, the following measures were identified as having received 'broad support':

- *Further carbon reductions on site beyond the regulatory standard*
- *Energy efficient appliances meeting a high standard which are installed as fittings within the home*

[8] Speech by the Minister of Housing and Planning, July 2009, http://www.communities.gov.uk/statements/corporate/ecozerohomes

- *Advanced forms of building control system which reduce the level of energy use in the home*
- *Exports of low carbon or renewable heat from the development to other developments*
- *Investments in low and zero carbon community heat infrastructure*
- *Other allowable solutions remain under consideration*

The cost that a developer is expected to pay to mitigate the remaining carbon emissions through allowable solutions will be capped.

The government low carbon hierarchy should therefore promote the most cost effective low carbon energy strategies at all stages (basic fabric efficiency measures, cost-effective onsite measures, offsite measures in optimal locations).

The planned trajectory of Building Regulations toward the zero carbon standard and the likely definition of the zero carbon standard itself must inform the development of carbon emissions and renewable energy targets in the Adur District Council Local Development Framework (LDF). The proposed definition of zero carbon should also inform the development of low carbon strategies for the Shoreham Harbour developments.

2.2.3 The Code for Sustainable Homes

The Code for Sustainable Homes (CSH) has been introduced as a national standard to guide the house building industry towards greater sustainability. The Code encompasses the whole range of sustainability issues, including energy and CO_2, but also considering water consumption, waste management, sourcing of materials and site ecology, among other sustainability issues. There are 9 categories defined in the Code, each dealing with a different aspect of sustainable construction.

The Code rates the sustainability of new homes from Level1 to 6 based on performance in each of these categories. Credits are awarded on the basis of performance of the home in each category, with an increasing number of credits available for meeting increasingly stringent standards within the categories. The Code defines a minimum 'score' that must be achieved overall for the property to achieve each Code rating. Code Level 1 represents a modest improvement over current Building Regulation standards, whereas achieving Code Level 6 is extremely challenging, not least in the energy category where net zero carbon standard must be reached.

The Code for Sustainable Homes is a voluntary standard, so unless the local planning authority requires that a certain Code Level be achieved, private house builders are not required to build to any particular Code Level. Most publicly funded housing, i.e. social housing, is now being built to Code Level 3 and from 2011 onwards all publicly funded housing will be required to meet Code Level 4.

The intention of the Code is that it signals the direction of change that Building Regulations are likely to follow. For example in the Energy Category of the Code, the CO2 improvements required to achieve Code Levels 3 and 4 are equivalent to the improvements that will be enforced through the changes to Part L in 2010 and 2013 respectively. By 2016, the Building Regulations will require that all new build homes are net zero carbon (as defined by the hierarchical approach discussed in Section 2.2.2.1), whereas the Code for Sustainable Homes requires zero carbon standard to be achieved at Code Level 6, the most challenging of the levels (albeit that the definition of zero carbon in the Code is currently different to that proposed in the zero carbon homes consultation). The CO2 emissions standards for each of the Code Levels are shown in the table below:

Code Level	% reduction Part L 2006 regulated CO_2 emissions
1	10%
2	18%
3	25%
4	44%
5	100%
6	Zero carbon[1]

[1] The definition of zero carbon in the Code for Sustainable Homes is currently different from the zero carbon definition that government is currently consulting on for adoption in the Building Regulations. To achieve Code Level 6, only onsite renewable energy generation or renewable electricity that is supplied to the dwellings by a direct physical connection can be included in the calculation of carbon emissions. This definition may be brought into line with the proposed Building Regulations.

Figure 10, Minimum CO_2 emissions reduction standards (reduction on current Part L2006 regulated emissions) defined at each level of the Code for Sustainable Homes

The uptake of the Code for Sustainable Homes among private house builders is relatively low at the current time, as meeting the Code standard increases the build cost (this increase is considerable at high Code Levels). However, a large proportion of the cost of achieving Code ratings is associated with the measures that must be taken to meet the CO_2 emissions standards. As Building Regulations are tightened and these emissions standards become the minimum permitted by regulations, then the uptake of the Code is expected to increase.

There is currently no equivalent Code for Sustainable Non-Domestic Buildings, however it is expected that such a standard will soon be introduced in order to provide a route map for the construction industry towards the 2019 zero carbon standard. In the meantime, local authorities are using planning policy to drive greater sustainability in non-domestic buildings, often requiring that new premises meet a certain overall CO2 reduction target compared to current Part L and that a certain percentage of the building's energy demands are met from renewable sources (e.g. the Merton Rule).

The tightening of the Building Regulations described above provide a base case for the energy standards that must be met at developments in Adur District. In the following, the potential to exceed these standards, for example through achieving certain Code for Sustainable Homes Levels, is explored, based on an understanding of the nature of planned developments and an assessment of local resources.

CODE FOR SUSTAINABLE HOMES SUMMARY

- The Code for Sustainable Homes (CSH) has been introduced as a national standard to guide the house building industry towards greater sustainability

- Attainment of CSH levels requires developers to reduce baseline energy use and CO_2 emissions, but also requires a range of other sustainability issues to be assessed e.g.
    - Efficient use of water
    - Efficient waste management and provision of recycling facilities
    - Site ecology
    - Sustainable sourcing of construction materials

- Although the Code is voluntary, the CO_2 reduction standards it sets out point to the direction of change of Part L of the Building Regulations over the coming decade:
    - Code Level 3 – 25% reduction on Part L 2006 regulated emissions (expected to be adopted as Part L 2010)
    - Code Level 4 – 44% reduction on Part L 2006 regulated emissions (expected to be adopted as Part L 2013)
    - Code Level 6 – Zero carbon –including all emissions associated with appliances and cooking (the zero carbon homes standard is expected to become mandatory from 2016)

- There is currently no equivalent Code for Sustainable Non-Domestic Buildings, however it is expected that such a standard will soon be introduced in order to provide a route map for the construction industry towards the 2019 zero carbon non-domestic building standard

3 STRATEGIES FOR ACHIEVING LOW CARBON TARGETS

To build very low carbon developments, in line with the CO_2 emissions reduction standards of high levels of the Code for Sustainable Homes (e.g. levels 5 & 6) and the likely similar standards of the Code for Sustainable Buildings, is very onerous and requires substantial capital investment in energy demand reduction and low carbon generation measures. The following sections will explore the low carbon strategies and technologies which will allow the new build developments in the Adur District to attain the required national and local low carbon targets in the most appropriate and logical manner.

There are many technological strategies which can be deployed to reduce the carbon emissions emitted by both new and existing developments. These strategies employ mixtures of the following low carbon measures:

1. **Thermal performance/fabric improvement measures:**
   Examples include: reducing heat loss from buildings through improving the insulation in the fabric and reducing the air permeability of the building, improving the efficiency of the heating system (boiler efficiency, improved heating controls etc.). These measures reduce the heating and hence fuel demands of buildings.

2. **Clean energy generation technologies:**
   These technologies generate heat, electricity or a combination of the two from non-renewable resources (e.g. natural gas-fired CHP). The overall system efficiency of clean energy systems is higher than those of conventional heating and electrical systems, allowing significant CO_2 savings to be realized.

3. **Renewable energy generation technologies:**
   These technologies directly generate heat (e.g. solar water heating), electricity (e.g. solar photovoltaics) or a combination of the two (e.g. biomass-fired combined heat and power systems) from renewable sources.

3.1 Onsite and offsite low carbon systems

Onsite low carbon technologies include building fabric improvement measures, micro-generation technologies integrated into buildings e.g. roof-mounted PV, CHP engines and site-wide DH networks, and any other technology sited on (or in the immediate vicinity of) a new development. These technologies provide heat and / or electricity to the buildings directly, by generating heat or electricity within the building or by providing heat over a district heating system.

Under the proposed definition of zero carbon buildings set out in the recent government consultation document, offsite low carbon technologies such as mega-watt scale wind turbines operating in locations remote from a new development could be counted towards mitigating a site's CO_2 emissions, so long as it can be shown that sufficient investment in new CO_2 reduction capacity has been made (they are potential 'Allowable Solutions').

The use of offsite systems e.g. MW scale wind turbines can be relatively commercially attractive. Turbines can be sited in optimal offsite locations with high wind speeds, instead of being sited in potentially less suitable locations adjacent to new developments. MW scale turbines in very windy locations may represent a commercially viable low carbon energy generation opportunity.

It should be noted that the zero carbon standard defined as the minimum requirement to achieve level 6 of the Code for Sustainable Homes differs from the definition proposed for Building Regulations. Currently, offsite solutions are not eligible to contribute to CO_2 reduction targets under the Code. This may change in future, to bring the Code into line with the Building Regulations.

3.2 Low carbon technology cost effectiveness

Despite the fact that there is a broad range of low carbon technologies available to building developers, previous extensive studies[9] and past experience indicate that developers will very likely deploy low carbon strategies based on assessments of:

1. **Technical feasibility:**
   A low carbon strategy must be appropriate for deployment on a given site, and allow attainment of the required carbon reduction target.
2. **Capital expenditure**
   Developers strongly favour the feasible low carbon strategy which represents the lowest capital expenditure.

Technologies which save a fixed quantity of carbon at the lowest capital cost are said to have a *high CO_2 capital cost effectiveness* (measured in capital £ per kg of CO_2 saved) – these technologies will be strongly favoured by developers.

The graphs presented below display the capital cost effectiveness of a comprehensive list of low carbon technologies (including thermal/fabric improvements and active generation technologies) in both the domestic and non-domestic sectors. Results are displayed for a typical semi-detached house (although variations with house size are negligible) in an urban setting (~50 dwellings per hectare) and a typical non-domestic property:

[9] The growth potential for microgeneration in England, Wales and Scotland – Element Energy http://www.berr.gov.uk/whatwedo/energy/sources/sustainable/microgeneration/research/page38208.html

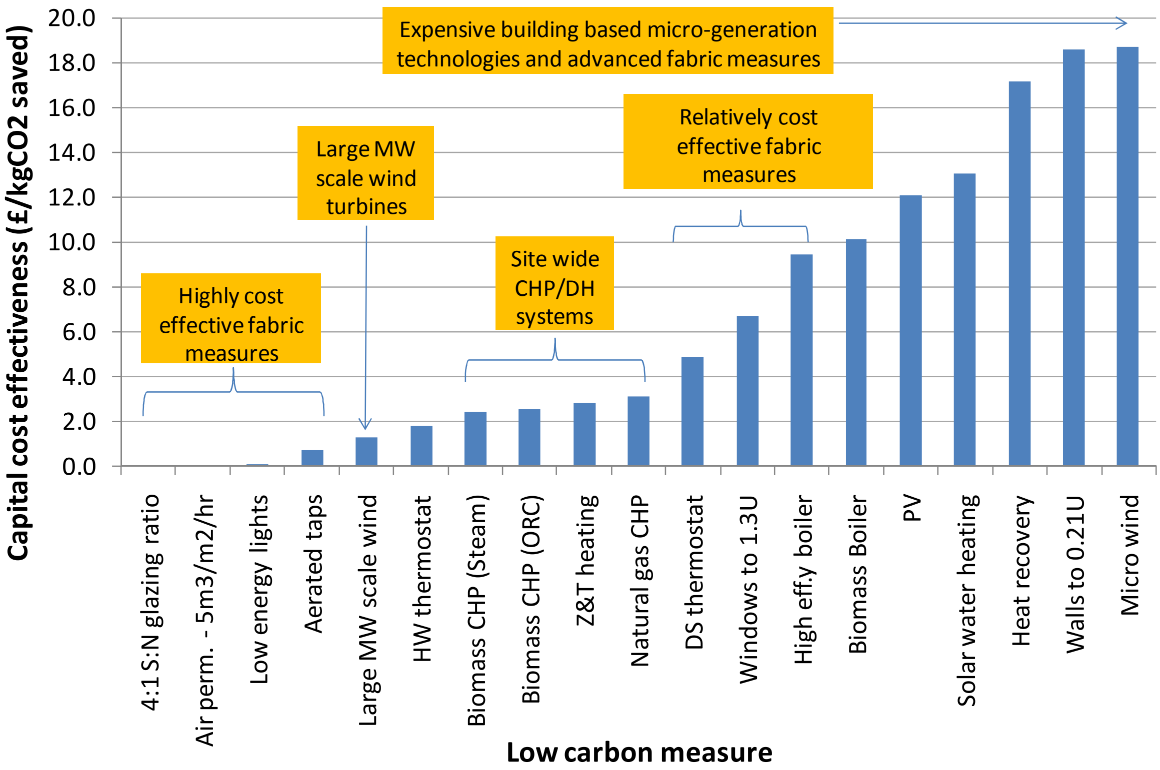


Figure 11, Capital cost effectiveness of a comprehensive range of low carbon technologies for a typical domestic property

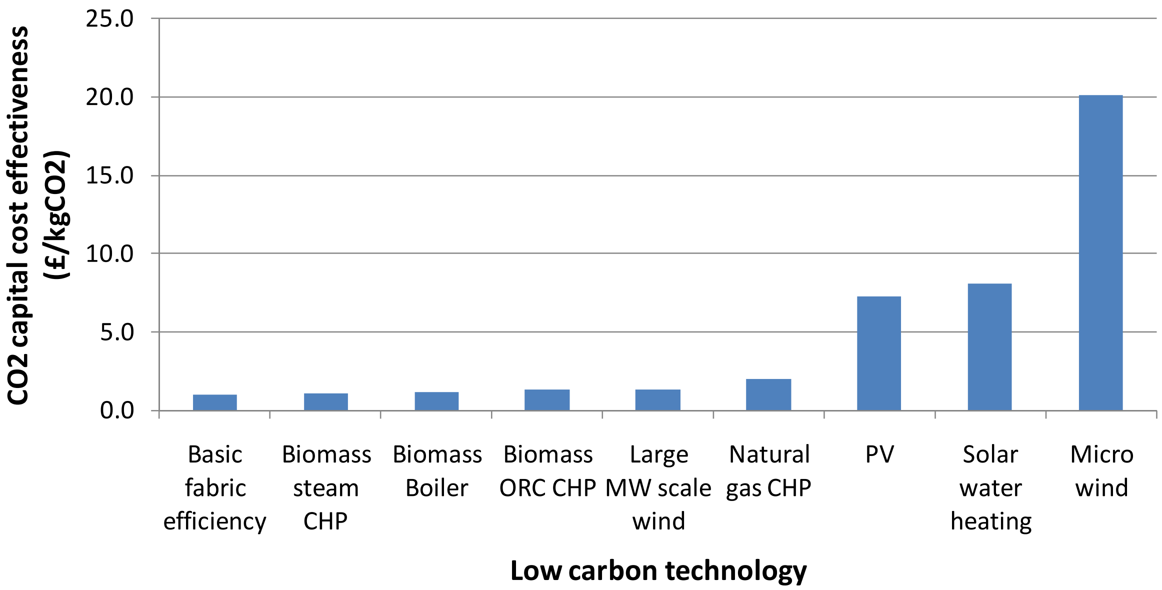


Figure 12, CO_2 capital cost effectiveness of low carbon technologies for a typical non-domestic property

The graphs illustrate several key points:

1. Basic building design and performance improvements e.g. solar orientation (4:1 ratio of S:N glazing) and reduced air permeability provide the most cost effective CO_2 savings in both domestic and non-domestic properties. Advanced fabric measures e.g. reducing the U-values of walls and windows to very low levels, are not cost effective (they are costly to achieve and deliver diminishing returns).

2. Large MW-scale wind turbines and site-wide CHP systems with district heating networks (biomass or gas-fired) are the most capital cost effective energy generation technologies (biomass boilers are competitive in the non-domestic sector only). CHP/DH systems are likely to be even more cost effective at Shoreham Harbour due to the high density of the planned developments.

3. Building mounted renewable energy generation technologies are extremely expensive and are not economically favourable relative to MW scale wind and CHP/DH based low carbon systems for achieving high carbon emissions reductions.

The graphs above and preliminary cost analysis therefore indicate that the most cost effective new build low carbon energy strategies in the Adur District are likely to incorporate:

1. A basic level of building thermal/fabric performance improvement from baseline – the exact fabric standards appropriate will be discussed in Section 3.3.

2. Deployment of MW scale wind turbines and/or CHP/DH systems (or biomass boilers in non-domestic properties) – subject to technical feasibility.

Note that this outline strategy is relatively robust and the similar solutions apply even if:

1. Developers favour low ongoing technology running costs over low upfront capital costs

2. Technology capital costs vary markedly over the time frame of this study (present – ~2035). Variation in cost over the time period has been included in this assessment.

The logic described above, which is supported by the proposed government approach to reaching the zero carbon standard in homes and non-domestic buildings, will be applied in the following analyses of suitable energy strategies for Shoreham Harbour and the wider Adur District. In the following section the energy strategy for Shoreham Harbour regeneration is considered in detail.

KEY CONCLUSIONS

- CO_2 reductions can be derived from:
    - Increased building fabric performance – "be lean"
    - Clean energy production and delivery e.g. natural gas-fired CHP – "be clean"
    - Deploying renewable energy generation technologies – "be green"
- Developers tend to strongly favor the technically feasible low carbon strategy which represents the lowest capital cost.
- Analysis of generic development types indicates that the most capital cost effective low carbon energy strategies will likely incorporate:
    - Highly cost effective building thermal/fabric performance improvements
    - MW scale wind turbines or site-wide CHP/DH systems fuelled by biomass or natural gas (and biomass boilers in non-domestic properties)
- Building integrated renewable micro-generation technologies and advanced fabric measures e.g. heat recovery, incur comparatively higher capital costs.
- Variations in capital costs with time and consideration of whole life costs are not likely to significantly affect the relative cost effectiveness of low carbon energy technologies between now and 2026.

3.3 Energy efficiency/ fabric performance improvement standards

The energy requirements and CO_2 emissions of a development can be greatly reduced by designing the development layout and buildings for maximum energy efficiency.

Heating demand can be reduced by incorporating passive solar gain through orientation and glazing, and heat loss minimised by highly insulated buildings. Cooling demand in summer can be mitigated or eliminated by designing for efficient natural ventilation through site layout and window design, and through the incorporation of shading and thermal mass. Consideration of daylight access reduces lighting requirements, which should be supplied through energy efficient light fittings.

Occupant knowledge and behaviour can also affect energy efficiency and demand. However, quantitative assessment of energy consumer behaviour is beyond the scope of this report.

The consideration of appropriate energy efficiency standards requires a different approach for residential buildings and for commercial and public buildings. In residential buildings space heating and hot water represent the highest energy demand, making building insulation and air tightness key to minimising energy demand. However in an office, for example, electricity demand is typically dominant therefore the efficient control of electrical lighting and appliances can be expected to have a significant impact on energy demand. Appropriate system zoning to allow user control of their local heating, cooling and lighting demands, as well as automatic control such as dimming of lights when there is sufficient daylight, are key.

The commitment of Adur District Council to regeneration and expansion in the domestic and commercial sectors demands that appropriate and cost effective energy efficiency/fabric performance improvement strategies be considered for a representative range of residential and non-domestic properties. The representative properties studied were as follows:

1. Domestic properties

    a. Two bedroom flat
    b. Three bedroom flat
    c. Semi detached three bedroom house
    d. Detached three bedroom house

2. Non-domestic properties

    a. Mechanically ventilated office

    A three storey office of approximately 850 m^2 per floor was modelled. Glazing was considered to constitute 50% of the external walls in all the areas except the server room. The office includes two large open plan areas, a meeting room, a common room, a north facing server room, a central circulation area and toilets. The occupied areas have been assumed to be mechanically ventilated, with natural ventilation in the circulation area, Extraction fans were incorporated in the toilets and cooling was incorporated in the server room only.

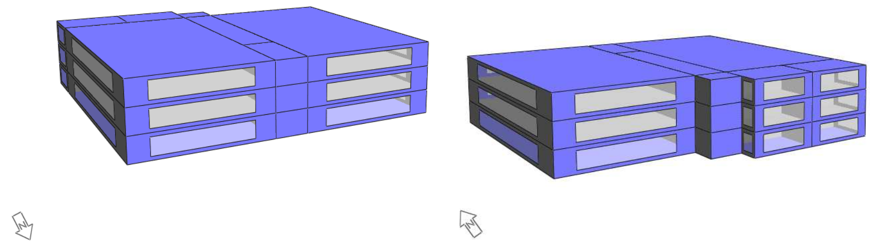


Figure 13 - Mechanically ventilated office used for modelling

b. Large retail building

A 1350 m^2 supermarket was modelled. The building comprises of a large display area, two storage areas: one for frozen/cold products and another for general storage, an office, a changing area and toilets. The display area and the storage for cold/frozen products has been assumed to be air conditioned. The changing area and the conventional storage area were assumed to be mechanically ventilated. The office was modelled to be naturally ventilated and the toilets modelled to utilize an extraction system.

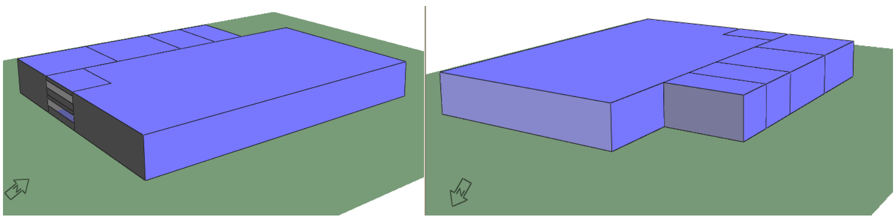


Figure 14 - Large retail building simulated

Energy simulations were carried out for the representative residential building types using government approved NHER (National Home Energy Rating) software to carry out Standard Assessment Procedure calculations and NHER energy calculations. The Standard Assessment Procedure (SAP 2005) forms the basis for demonstrating dwelling compliance with Part L1 of the Building Regulations 2006.

Detailed thermal dynamic simulations of the representative non-domestic properties were carried out using IES Environmental 5.9 - one of the most complex Part L compliant software simulation programmes. IES allows the simulation of real conditions in a building to accurately calculate the building gains and losses and therefore determine the building energy loads and CO_2 emissions. The models were run on an hourly basis assuming a period of one year and assuming profiles of use as established by the National Calculation Method required to comply with Part L.

The results of these energy simulations were used to assess the level of CO_2 savings that could be achieved in the residential sector at Shoreham Harbour through the application of energy efficiency measures in isolation.

KEY CONCLUSIONS

- Significant reductions in baseline CO_2 emissions can be achieved on new build development sites by:
  - Carefully designing site layout and orientation e.g. to maximize solar heat gains in winter
  - Improving the thermal performance and air tightness of buildings to prevent heat loss
  - Installing energy efficient fittings e.g. low flow taps or fittings for energy efficient light bulbs
- Energy efficiency strategies for domestic and non-domestic properties differ markedly:
  - In homes heating demands are high and energy efficiency strategies should be focused on increasing building thermal performance and air tightness
  - In non-domestic buildings (e.g. an office) electrical demands tend to dominate and energy efficiency strategies should concentrate on light dimming and zoned lighting controls etc

- Given the Adur projected new build form, a number of representative domestic and non-residential building types were simulated - using energy modeling software – to determine the CO_2 and energy reduction standards achievable through packages of energy efficiency measures.

3.3.1 Energy efficiency in domestic properties

Several energy efficiency scenarios have been developed and used to assess the CO_2 reduction improvements (over Part L 2006) that could be achieved through the improvement of energy efficiency features alone (i.e. prior to consideration of renewable and low carbon energy systems). The energy efficiency packages are applied to four typical dwelling types – a flat and terrace, semi and detached houses – selected to be broadly representative of the type of dwellings that will be constructed in Adur and Shoreham Harbour.

Six energy efficiency scenarios were simulated. Energy efficiency standards (including improvements in building fabric, air tightness, thermal bridging, heating system efficiency and controls, water system insulation, and lighting fittings efficiency) were progressively improved to illustrate the process by which dwellings will adapt from standard practice to exemplary energy efficiency. This progressive approach helps to demonstrate the sequential implementation of energy efficiency features which will be required to allow residential properties in Adur to achieve very high levels of CO_2 reduction with respect to Part L 2006 emissions standards and the low heat loss parameters aspired to in the Code for Sustainable Homes.

The six energy efficiency scenarios that were modeled are outlined below:

- **Part L Compliant Case:** The minimum level of energy efficiency features required to achieve compliance with current Part L Building Regulations.

- **Medium Case:** Application of very simplistic energy efficiency features. These improvements are highly cost effective and easily achievable with the current standard of fabrication

- **Good Case:** Application of a highly cost effective level of fabric efficiency.

- **Very Good Case:** Very good energy efficiency features which presently represent going beyond the norm.

- **Excellent Case:** Excellent energy efficiency features requiring a challenging fabrication standard - but which has been previously achieved in the UK

- **Exemplary Case:** Exemplary energy efficiency features leading to the achievement of a heat loss parameter of less than 0.8 W/m^2/K - required by the Code for Sustainable Homes level 6

The costs associated with the energy efficiency packages increase incrementally from the Part L compliant case to the Exemplary Case. Further discussion of these costs is given later in this Section.

For dwellings, the core energy efficiency improvements required for the above energy efficiency scenarios are summarised in the following table:

Energy Efficiency Scenarios	Part L	Medium	Good	Very Good	Excellent	Exemplary
U-value - walls (W/m2K)	0.3-0.33	0.29	0.26	0.22	0.15	0.15
U-value - windows (W/m2K)	2 door 2.55	1.8 door 2.55	1.6 door 2	1.4 door 2	0.8 door 1.3	0.8 door 1.3
U-value ground floor (W/m2K)	0.22	0.22	0.22	0.2	0.11	0.11
U-value roof (W/m2K)	0.2	0.2	0.15	0.12	0.11	0.11
Air tightness (m3/hm2 @ 50Pa)	9-10	8	7	4	3	1
Thermal bridging - Y value W/m2K	0.08	0.08	0.08	0.08	0.04	0.04
Lighting	75% efficient lighting fittings	75% efficient lighting fittings	75% efficient lighting fittings	75% efficient lighting fittings	100% efficient lighting fittings	100% efficient lighting fittings
Water tank insulation	75 mm insulation	75 mm insulation	75 mm insulation	75 mm insulation	110 mm insulation	110 mm insulation
Ventilation	Naturally ventilated	Naturally ventilated	Naturally ventilated	Naturally ventilated	Naturally ventilated	Mechanically ventilated with heat recovery

Heating Efficiency	90% condensing	90% condensing	91.3% condensing	91.3% condensing	91.3% condensing	91.3% condensing

Figure 15 – Energy efficiency improvements required under progressively rigorous improvement scenarios

The corresponding heat loss parameter (and improvement over Part L) achieved for the different dwellings simulated for the studied energy efficiency scenarios are presented in the table below:

Energy Efficiency Scenarios	Part L	Medium	Good	Very Good	Excellent	Exemplary
Heat Loss Parameter achieved	1.16-1.64	1.16-1.58	1.08-1.47	0.98-1.32	0.77-0.98	0.56-0.79
Improvement over Part L 2006 CO_2 emissions (%)	0%	3% - 7%	10%-11%	15%-18%	25% - 32%	1%-15%

Note that the specifications in the exemplary case are designed to achieve a very low heat loss parameter. This requires air permeability of the dwelling to be reduced to a very low level, necessitating the use of a mechanical ventilation system. As a result of the additional electricity consumption of this system, the CO_2 reduction compared to current Part L is lower in the Exemplary case compared to Excellent or Very Good.

Figure 16- Improvements in heat loss parameters for progressively rigorous energy efficiency scenarios

Estimations of the additional costs associated with achieving the improved building fabric specifications described in Figure 15 are tabulated below for a variety of dwelling types. Note that these are the costs of improving the U-values of the building elements and improving air tightness, the costs of heating plant and lighting are not included. There is a large increase in cost associated with the improvement from an ‘Excellent' to ‘Exemplary' fabric package. This is due to the requirement for a mechanical ventilation system in the Exemplary case.

Dwelling	Medium	Good	V. Good	Excellent	Exemplary
Flat	£250	£320	£450	£860	£3,100
Terrace	£100	£140	£660	£2,015	£4,500
Semi	£200	£310	£1,030	£2,830	£5,580
Detached	£350	£620	£1,600	£4,000	£7,000

Figure 17, Estimated additional capital cost implications of each of the domestic energy efficiency packages (costs are given per dwelling).

The cost of fabric improvement packages are plotted against the CO_2 emissions improvement (relative to Part L 2006 standard) shown in Figure 16. The dotted vertical lines on the plot indicate the levels of CO_2 emissions reductions required to comply with the requirements of various levels of the Code for Sustainable Homes (also marked are the CO_2 reduction levels that are expected to be required by the 2010 and 2013 tightening of the Building Regulations).

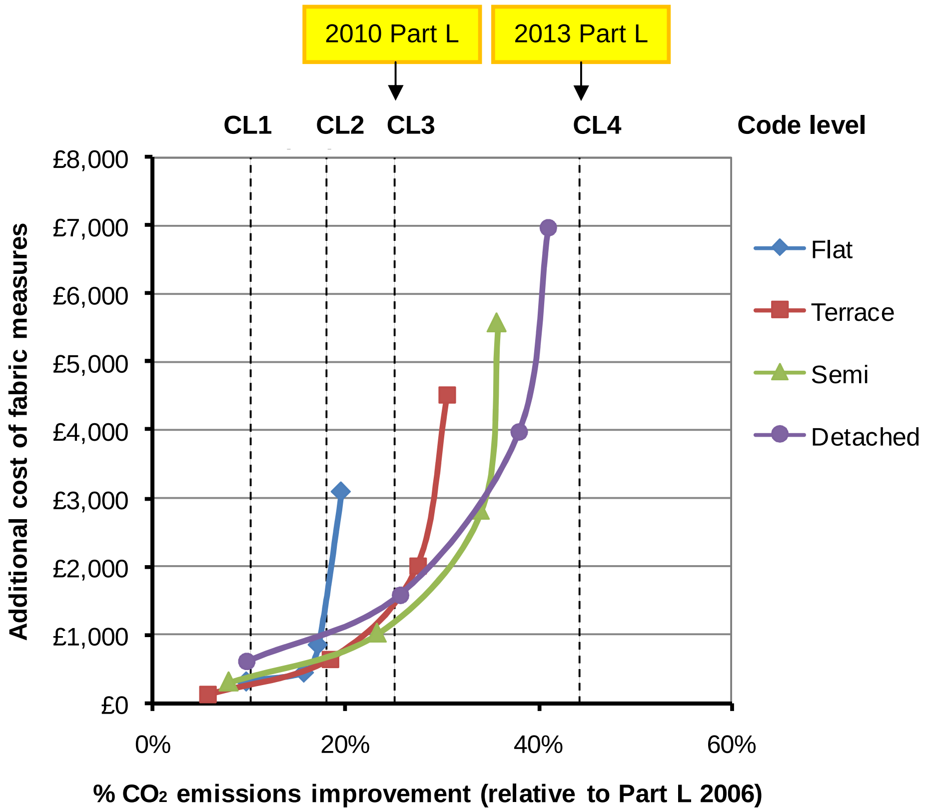
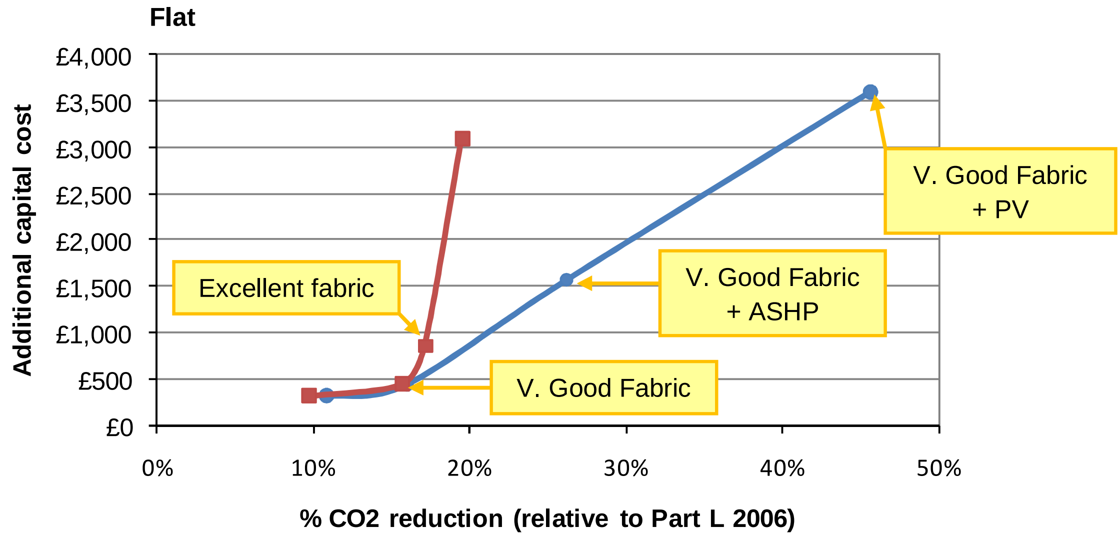


Figure 18, Additional capital cost of delivering CO_2 emissions reductions by improvements in the building fabric alone.

The additional costs of improving the fabric efficiency to deliver a 20 – 25% improvement on Part L is relatively limited at around £1,000 per dwelling (except in the case flats, where an improvement beyond 20% is more difficult to achieve). The costs of delivering improvements beyond the 25% level increase rapidly in all house types (and at lower levels of improvement in the flats).

It is more cost-effective to achieve higher levels of CO_2 reduction through combination of energy efficiency measures with low carbon energy generation technologies than through fabric improvements alone. This is highlighted in the plots shown in Figure 19, which compare the cost of reducing CO_2 emissions through fabric efficiency alone with the cost of achieving CO_2 reductions via a combination of fabric measures and low and zero carbon technologies (LZCT), for the flat and detached house. It is clear that higher levels of CO_2 reduction can be achieved more cost-effectively by combining the 'Very Good' level of fabric improvements (as specified in Figure 15) with low carbon generation technologies rather than increasing the level of fabric improvement further to the 'Excellent' specification.

Cost of achieving CO_2 emissions reductions via fabric improvement alone compared with the lowest cost approach to reducing emissions through combination of energy efficiency low or zero carbon technologies



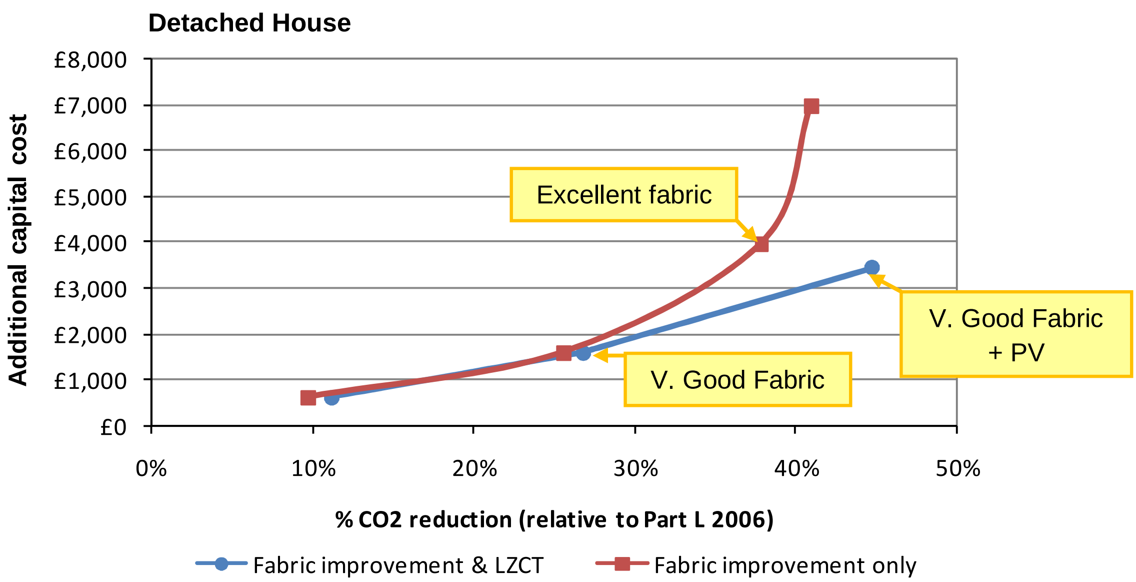


Figure 19, Comparison of cost of achieving increasing levels of CO_2 reduction through improvements to the dwelling fabric (i.e. U-values, air permeability etc.) alone with cost of achieving similar levels of reduction through combination of fabric improvement and low carbon technologies.

3.3.1.1 Recommended level of residential energy efficiency improvements

The recent UK government consultation on the nature of zero carbon homes and non-domestic buildings suggested that all buildings will be required to improve their standards of energy efficiency with respect to current baseline Part L standards (see section 2.2.2.1). The level of improvement delivered by fabric efficiency in new homes has been the subject of a further study by the Zero Carbon Hub[10]. This study recommended minimum levels for the improvement to be achieved through fabric efficiency, expressed in terms of maximum permissible energy consumption per m^2 ($kWh/m^2/yr$), covering space heating and space cooling (assuming a notional dwelling). The levels fabric efficiency proposed for the zero carbon homes definition will be enforced from 2016. An interim improvement level may be included as part of the change to Part L of the Building Regulations expected in 2013.

Based on the analysis presented in the preceding section of the relationship between the level of CO_2 reduction achieved through improving the dwelling's fabric performance and the additional costs incurred, the Very Good level of fabric improvement is recommended for developments in the Adur district (see Figure 20 for the Very Good specification). This level of fabric improvement will form part of the most cost-effective strategies for meeting the CO_2 reduction levels required by the tightening of Building Regulations. Where higher levels of CO_2 reduction than those delivered by this fabric package are sought, it will be more cost-effective to deliver the additional improvement through provision of low carbon generation solutions.

The Very Good fabric standard will be also be assumed to be the minimum standard of energy efficiency required in the Shoreham Harbour development.

The improvements that must be made to the building fabric of dwellings to achieve this standard are outlined in the table below:

Building element	Assumed specification for domestic properties
U-value - walls (W/m2K)	0.22
U-value - windows (W/m2K)	1.4 door 2
U-value ground floor (W/m2K)	0.2
U-value roof (W/m2K)	0.12
Air tightness (m3/hm2 @ 50Pa)	4
Thermal bridging - Y value W/m2K	0.08
Lighting	75% efficient lighting fittings
Water tank insulation	75 mm insulation
Ventilation	Naturally ventilated
Heating Efficiency	91.3% condensing

[10] Defining a fabric energy efficiency standard for zero carbon homes, Zero Carbon Hub, November 2009

Heat Loss Parameter achieved	0.98-1.32
Improvement over Part L (%)	15%-18%

Figure 20 - Specification of energy efficiency measures to give a cost-effective CO2 emissions reduction of 15 to 20 % compared to Part L 2006.

KEY CONCLUSIONS

- CO_2 savings in excess of 30% (with respect to baseline regulated emissions) can be achieved through application of intensive fabric efficiency improvement packages.
- A high standard of fabric efficiency improvements can facilitate savings of ~20% in new build residential properties and are relatively cost effective (~£1,000 - £1,600 per dwelling depending on type)
- Attaining higher CO_2 savings using fabric performance measures results in a rapid increase in capital cost and a rapid decline in CO_2 saving cost effectiveness.
- The capital costs of attaining higher CO_2 reduction standards can be reduced by using the basic levels of fabric performance improvements and active low carbon energy generation technologies.
- The recent government consultation on the definition of zero carbon homes suggests that new build developments will be required to demonstrate a cost effective and technically viable improvement in baseline energy efficiency. The 'Very Good' fabric package (see Figure 20) has been shown to provide a CO_2 reduction of 15 to 20% compared to Part L 2006 in a cost-effective manner. A minimum 20% reduction of regulated emissions through energy efficiency is recommended for domestic developments within Adur District.
- Further work has been done by the Zero Carbon Hub to define the minimum fabric efficiency standard that should be set as the first level of the zero carbon hierarchy. The minimum fabric efficiency standard proposed would produce around a 25 to 30% reduction of Part L 2006 regulated emissions. The fabric efficiency standards proposed for the zero carbon definition should be achieved in the Shoreham Harbour development.

o A 20% reduction of Part L2006 regulated emissions through improved fabric efficiency will be assumed in the analysis which follows.

3.3.1.2 Energy efficiency in non-domestic properties

Three different energy efficiency scenarios have been selected to illustrate how the energy efficiency of non-residential buildings can be improved from standards compliant with Part L 2006 of the Building Regulations to an excellent level of energy/fabric efficiency corresponding to the highest standards currently achievable:

- Base Case; building meets the minimum energy efficiency requirements of Part L 2006 of the Building Regulations.
- Very Good; cost effective and feasible improvement s with respect to the Part L 2006 minimum requirements.
- Excellent; exemplary energy efficiency scenario – illustrates a challenging but technically feasible standard of energy efficiency improvement.

The energy efficiency improvements required (under the 3 scenarios outlined above) are detailed in the tables below for the office and retail buildings modeled:

Energy Efficiency Scenarios- Office building	Base Case	Very Good	Excellent
% of glazing	50% for open plan office and meeting/common rooms, 0% for other areas	50% for open plan office and meeting/common rooms, 0% for other areas	50% for open plan office and meeting/common rooms, 0% for other areas
U-values - walls (W/m^2K)	0.29	0.22	0.15
U-values - windows (W/m^2K)	1.8	1.4	0.8
U-values - roof (W/m^2K)	0.19	0.12	0.11
U-values - groundfloor (W/m^2K)	0.22	0.2	0.18
Air tightness (m^3/hm^2 (@50Pa))	10	5	3
Heating	Central heating using water radiators	Central heating using water radiators	Central heating using water radiators
Heating generator seasonal efficiency	0.9	0.93	0.96
Delivery Efficiency	0.91	0.91	0.91
System seasonal efficiency	0.819	0.846	0.874
Domestic Hot Water System	Same generator than Space heating	Same generator than for space heating	Same generator than for space heating
Delivery efficiency	0.6	0.65	0.7
Cooling	Fan coils only for cooling IT rooms	Fan coils only for cooling IT rooms	Fan coils only for cooling IT rooms
Ventilation	Mechanical ventilation in the occupied areas with natural ventilation in the circulation area, extraction fans in the toilets and air conditioning in the server room only.		

Heat recovery efficiency	65%	70%	7%
Lighting efficacy	3.75-12 W/m2 depending on the space	3.5-10 W/m2 depending on the space	4.5-9 W/m2 depending on the space
Dimming for lighting	Yes	Yes	Yes

Figure 21 – Energy efficiency improvements required under progressively stringent energy efficiency scenarios – office building

Energy Efficiency Scenarios – Retail building	Base case	Very Good	Excellent
Percentage of glazing	100% of the front entrance only of the display area and 40% of external area of the offices, 0% elsewhere		
U-values - walls (W/m^2K)	0.29	0.22	0.8
U-values - windows (W/m^2K)	1.8	1.4	0.15
U-values - roof (W/m^2K)	0.2 (for the current configuration 0.192 is the maximum)	0.12	0.11
U-values - groundfloor (W/m^2K)	0.22	0.2	0.18
Air tightness (m^3/hm^2 (@50Pa))	7 (assumption = 0.175ach)	5 (assumed as 0.125)	3 (Assumed as 0.075ach)
Heating	Electric heating system. Central plant	Electric heating system. Central plant	Electric heating system. Central plant
Heating generator seasonal efficiency	2	2.2	2.5
Delivery Efficiency	0.91	0.91	0.91
Seasonal Coefficient of Performance	1.82	2.002	2.275
Domestic Hot Water System	Gas boilers	Gas boilers	Gas boilers
Seasonal Coefficient of Performance	0.6	0.75	0.85
Delivery Efficiency	0.6	0.7	0.75
Cooling	Fan coil units	Fan coil units	Fan coil units
Generator nominal Energy Efficiency Ratio (EER)	3.125	3.125	3.125
Generator Seasonal EER	2.6	2.8	3
Cooling delivery efficiency	0.91	0.91	0.91

SEER (Seasonal Energy Efficiency Ratio)	2.005	2.141	2.275
Ventilation	Mechanical ventilation for all areas except offices assumed as naturally ventilated from fresh air supply from large spaces		
Heat recovery efficiency	0.5	0.6	0.7
General lighting power density (W/m2)	1.88-10	1.5-10	1.3-8
Display lighting power density (W/m2)	20	18	16
Dimming for lighting	No	Yes for office lighting	Yes for office lighting

Figure 22 – Energy efficiency improvements required under progressively stringent energy efficiency scenarios – retail building

The energy demands of the modeled office and retail buildings can be broken down into gas and electricity usage. The reductions in the energy demand of the modeled buildings with increasing levels of energy efficiency are displayed in the tables below:

Office building	Base Case	Very Good	Excellent
Gas Use (kWh/m2/year)	19.8	12.4	8.3
Electricity Use (kWh/m2/year)	77.8	72.6	68.9

Figure 23 – Estimated energy demands of the modelled office building for the different energy efficiency scenarios simulated

Retail building	Base case	Very Good	Excellent
Gas Use(kWh/m2/year)	21.3	18.3	17.0
Electricity Use (kWh/m2/year)	136.5	117.8	100.4

Figure 24- Estimated energy demands of the modeled retail building for the different energy efficiency scenarios simulated

The estimated carbon emission reductions (with respect to baseline regulated emissions) associated with these energy demand values are detailed in the tables below:

Energy Efficiency Scenarios – Office building	Base case	Very Good	Excellent
Carbon emission reduction over 'Base	0.0%	9.9%	16.3%

Case'			

Figure 25 – Estimated carbon emission reductions for the different energy efficiency scenarios simulated – Office building

Energy Efficiency Scenarios – Retail building	Base case	Very Good	Excellent
Carbon emission reduction over 'Base Case'	0%	13.7%	26.1%

Figure 26 – Estimated carbon emission reductions for the different energy efficiency scenarios simulated – Retail building

3.3.1.3 Recommended level of non-domestic energy efficiency improvements

As was the case for residential properties, the recent UK government consultation on the nature of zero carbon homes and non-domestic buildings suggests that all new build non-domestic buildings will be required to improve their standards of energy efficiency with respect to current baseline Part L standards.

The exact level of energy efficiency improvements which will be mandatory is not defined at present, but it is likely that a cost effective level of energy efficiency improvements will be required. This approach ensures that attainment of the required standard will not severely impact upon the economic viability of new build developments.

The fabric/energy efficiency standard recommended for non-domestic developments within Adur and Shoreham Harbour corresponds to the "Very Good" scenario outlined in the section above. This standard could facilitate a CO_2 reduction of ~10% in the baseline regulated emissions of office developments and a ~14% reduction in the planned retail developments.

This reduction standard will be assumed in the analysis undertaken throughout this report.

KEY CONCLUSIONS

- The recent government consultation on the definition of zero carbon homes and non-domestic buildings suggests that new build developments will be required to demonstrate a cost effective and technically viable improvement in baseline energy efficiency. A 10% minimum reduction in baseline regulated CO_2 emissions standards should be recommended for all new build non-domestic properties in the Adur District (including Shoreham Harbour).

- A 10% reduction in regulated emissions is assumed in the following analysis.

3.3.2 Summary – Recommended energy efficiency standards

The energy efficiency standards assumed in this report for the new build developments in Adur and Shoreham Harbour are summarised in the following table:

New build development type	Cost effective CO_2 reduction standard (% of baseline regulated emissions)
Residential properties	15 – 20%
Office	9.9%
Retail	13.7%

Figure 27 – Cost effective CO_2 reductions achievable through basic energy efficiency

As mentioned in the analysis outlined in this section, the energy efficiency improvement standards outlined in the table above are highly feasible technically and highly cost effective.

There are several advantages of applying a basic and cost effective level of energy efficiency/fabric performance improvements to new build developments:

1. **Cost effectiveness**
   Application of basic fabric performance improvements represents the most cost effective method of reducing carbon emissions in both residential and non-domestic properties – see Figure 11 and Figure 12.

2. **Future-proofing of domestic building designs**
   Incorporating basic thermal/fabric improvement measures at this early stage future proofs building designs for higher CO_2 reduction standards, which will require mandatory improvements in building thermal performance.

   By changing building designs now, developers can avoid constantly updating designs as low carbon legislation becomes increasingly more stringent. This can save developers money in the long term.

3. **Decreased consumption of natural resources**
   Improved building thermal performance decreases the consumption of natural resources and reduces fuel bills for occupants.

It is recommended that a 'Very Good' level of cost-effective energy-efficiency measures are implemented in the new build domestic and non-domestic buildings in Adur. The minimum level of energy efficiency improvement stipulated under the zero carbon definition, i.e. the energy efficiency back-stop level, should be applied at Shoreham Harbour. The recent work by the Zero Carbon Hub on 'Defining a fabric energy efficiency standard for zero carbon homes' (November 2009) has proposed back-stop levels for the domestic sector, although energy efficiency backstops for non-domestic buildings have not yet been determined.

In order to reduce the CO_2 impact of the Shoreham Harbour developments and other developments around Adur to a very low level, low carbon energy generation measures will also be required. The options for providing renewable and low carbon energy to the developments are considered in the following sections.

4 SHOREHAM HARBOUR – LOW CARBON ENERGY STRATEGY

In order to fall in line with the preferred government low carbon approach - and facilitate the study of low carbon energy strategies which deliver cost effective CO_2 savings - the low carbon energy strategies studied for Shoreham Harbour in the following section will investigate and incorporate:

1. A cost effective level of building thermal/fabric performance improvements.
2. Implementation of natural gas and biomass fuelled combined heat and power (CHP) systems connected to district heating (DH) networks (where appropriate).

   A comprehensive range of appropriate system configurations will be explored in section 4.2.1.
3. Offsetting/mitigation of any remaining CO_2 emissions using quantifiable allowable solutions:
   a. Offsite MW scale wind carbon offsetting
   b. Microgeneration e.g. roof mounted photovoltaics – although such strategies are expected to be expensive.

A comprehensive range of alternative low carbon energy strategies will also be considered. Preliminary planning data[11] indicates that major domestic development planned for Shoreham Harbour is likely to be concentrated into modern blocks of flats. Therefore “block by block” low carbon energy startegies should be devised which address this specific build nature.

These strategies will consider the carbon reduction potential and economics of:

1. Block biomass heating – using a centralised biomass boiler and district heating network

   This technology is well grounded and well understood. Large scale biomass boilers (as opposed to domestic units) can provide relatively cost effective CO_2 savings.

2. Air source and ground source heat pumps

   Ground and air source heat pumps are emerging heating technologies. These technologies extract heat from the ground or air respectively using an electrically powered pump. A refrigerant cycle converts the low grade heat extracted from ground or air into higher temperature heat for supply to the building’s heating system. By extracting heat from the surroundings, the heat pump supplies more heat energy to the building than electrical energy required to power the pump (the Coefficient of performance (COP) is the ratio of heat energy supplied to electrical energy consumed and can be as high as 3.5 to 4 for a high efficiency heat pump).

   These technologies may become even more attractive if the national grid electricity CO_2 intensity decreases in the coming decades. If the grid decarbonises significantly, ground source and air source heat pumps could provide very low carbon space and water heating.

[11] Martin Howard – BBP Regeneration

4.1 Energy load growth

Significant domestic and non-domestic new build development is planned at Shoreham Harbour.

The Shoreham Harbour Regeneration Partners have identified the Shoreham Harbour development as a potential sustainability exemplar and flagship low/zero carbon development opportunity. The development recently achieved Growth Point Status and associated central government funding to pursue significant carbon reduction with respect to baseline emissions projections.

Deployment of a well grounded and optimal low carbon technology strategy at Shoreham Harbour will place the region at the forefront of national efforts toward delivery of cost effective and viable low/zero carbon developments.

The harbour region encompasses the development areas of:

- Canal Wharf
- Boundary Road / Fishersgate
- Portslade East
- Southwick Waterfront
- Shoreham Waterside North
- Shoreham town centre

Figure 28, New build developments planned at Shoreham Harbour

The developments in the Shoreham Harbour Action Plan Area will result in significant growth in energy demand. In the plots below, the growth in demand for heat and electricity are shown assuming that the developments are built to current standards, i.e. to Part L 2006.

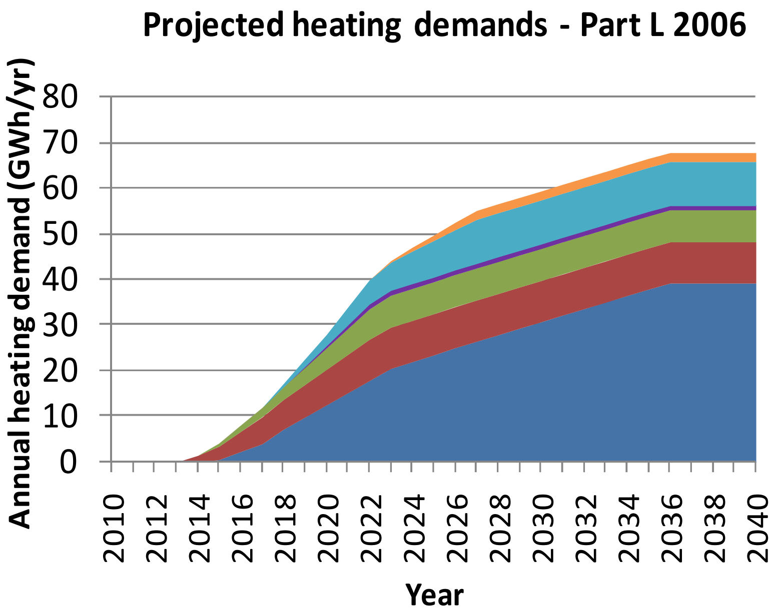


Figure 29, Projected annual heating demands at Shoreham Harbour (current build standards)

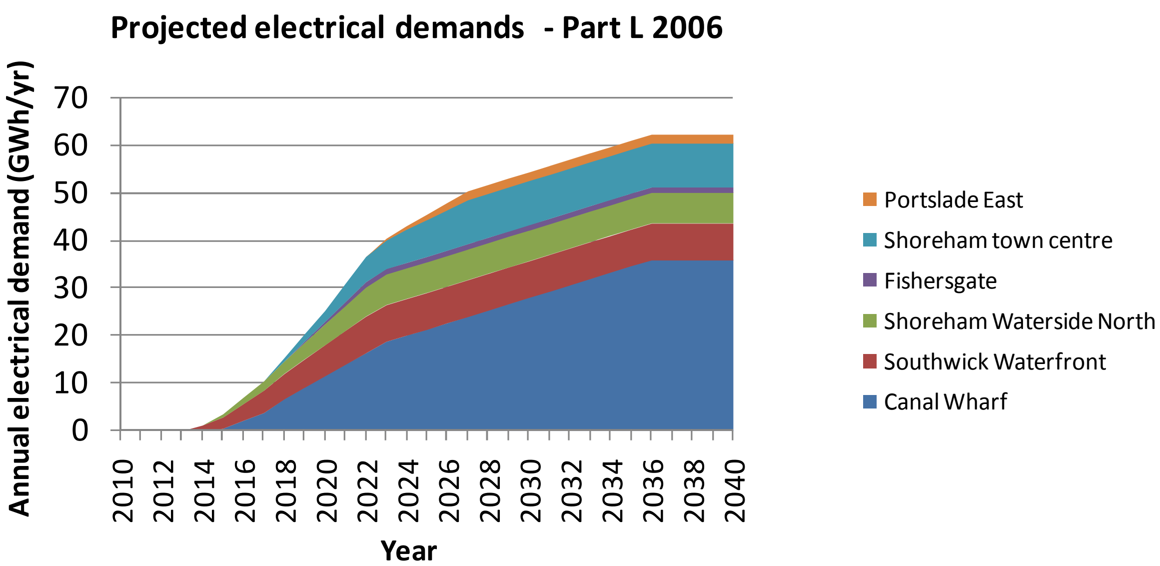


Figure 30, Projected annual electrical demands at Shoreham Harbour (current build standards)

The CO_2 emissions associated with these energy loads would be very significant, as shown in the plot below. These projections put into context the scale of the effort that is required in order to develop a very low or zero carbon development at Shoreham Harbour.

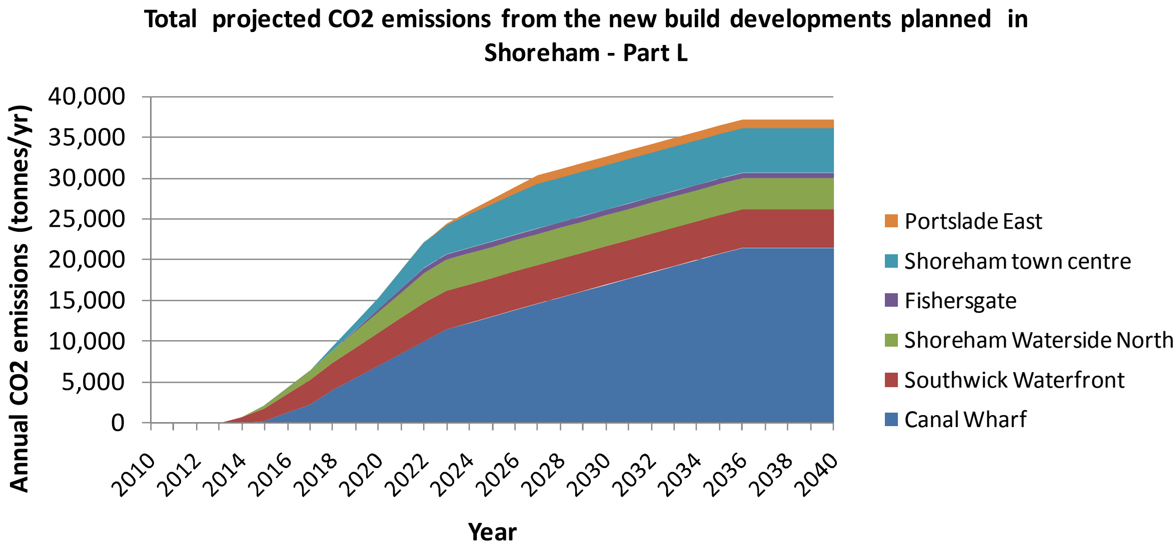


Figure 31, Projected annual CO_2 emissions at Shoreham Harbour (current build standards)

As shown in the plot above, the development timescales are such that the vast majority of energy load growth occurs after the key date of 2016 for zero carbon homes and substantially after 2019, when non-domestic buildings should also be built to a zero carbon standard. Therefore, if these developments are built to be in line with the Building Regulations that are in force at the time the buildings are constructed, a substantial reduction in emissions compared to current Part L standards will be required. This is shown in the plot below (in reality developers would have a period of 1-year after achieving building approval in which they could build to the standard in force when approval was granted, so, for example, non-zero carbon homes could still be built up to 2017).

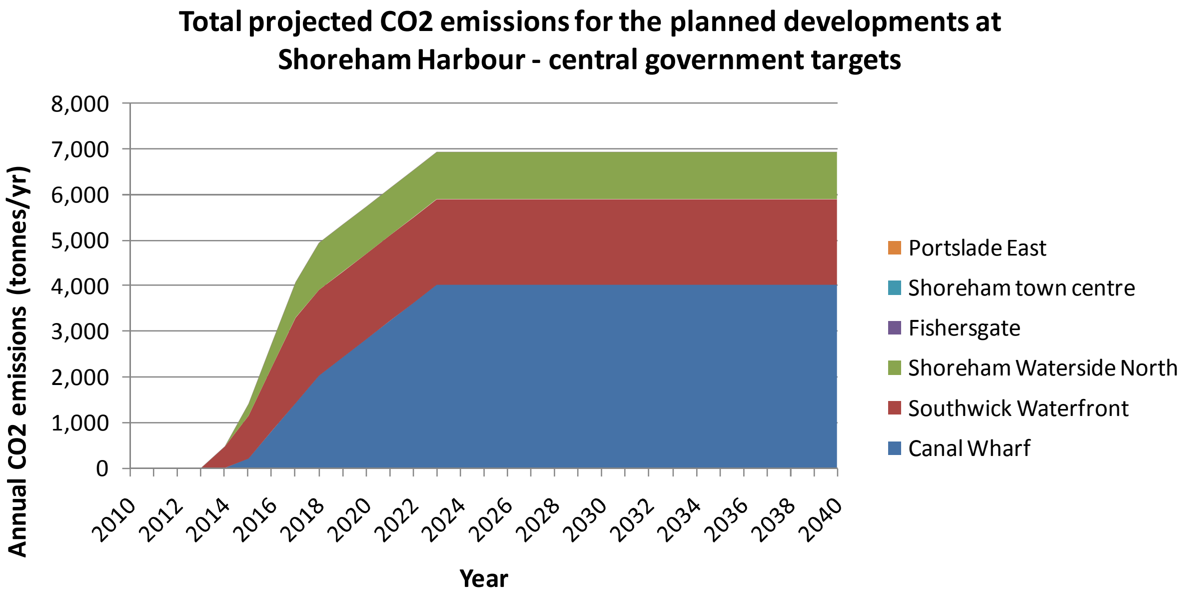


Figure 32, Projected annual CO_2 emissions at Shoreham Harbour if government CO_2 reduction targets can be achieved. N.B almost all emissions occur after the domestic and non-domestic zero carbon standards are introduced (2016 and 2019 respectively)

An approximate 80% reduction in annual CO_2 emissions by 2040 would be delivered if buildings are built to adhere to the Regulations at the time of construction.

KEY CONCLUSIONS

- Shoreham Harbour Regeneration Partners have identified the Shoreham Harbour development as a potential sustainability exemplar and flagship low/zero carbon development opportunity
- If new build properties at Shoreham are built to current building regulations (Part L 2006), annual CO_2 emissions from the site are expected to exceed 35,000 tonnes post 2040.
- The phasing of development at Shoreham Harbour is such that most new build takes place after 2019. After this date, all new build developments (in both the domestic and non-domestic sectors) will be required to demonstrate zero carbon status.
- Attainment of even mandatory central government CO_2 reduction targets requires an 80% reduction in the baseline projected annual CO_2 emissions of Shoreham Harbour – the development will need to be extremely low carbon
- An opportunity exists to go further and achieve zero carbon status at Shoreham Harbour..

4.2 Energy strategy analysis

4.2.1 CHP & District heating

A district heating system consists of centralised energy plant, which could be boilers or a combined heat and power (CHP) plant, and a distribution system to convey the heat and/or power across the site to the end-users.

Heat is distributed around the site via a network of pipes, usually in the form of hot-water (sometimes steam is used as the heat transfer medium). Each building served by the network has a connection to the network's flow and return pipes. Heat is transferred to the building's internal heating system by way of a heat exchanger, called a heat interface unit (HIU). The HIU will incorporate a heat meter so that the amount of heat supplied to the property can be recorded. From the perspective of the building occupant, the level of control over the heating system should be identical to that enjoyed by a building served by an individual boiler.

Properties connected to the district heating network do not require a boiler or connection to the natural gas infrastructure. Depending on the design of the system, hot-water storage tanks may or may not be required in the buildings. Installation of hot-water storage in the buildings takes up space, but can reduce the peak heat loads that have to be met by the district heating system, which in turn can reduce the size of the pipes required in the network and overall network cost.

A district heating network requires a significant capital investment. The cost of the system is primarily dictated by the peak heat demand, the length of the network and the number of individual connections.

The ground conditions will also heavily influence the installation costs, a large part of which is the cost of digging trenches.

The capital cost of the district heating system is recouped through sale of heat to the end-users (and sale of electricity if the system is served by a CHP plant). The economics of district heating systems improve with increasing heat density of the development, as this corresponds to increasing revenue opportunity (sale of heat) relative to capital investment (amount of pipe). The presence of buildings with large individual heat loads will also help the economics, as this provides high revenue potential through a single connection.

The Shoreham Harbour developments are potentially attractive for district heating systems in this respect, as the density of the residential developments (dwellings per hectare) is high, with much of the housing units likely to be provided in blocks of flats. There is also significant commercial and mixed-use development, which will increase the overall heat loads.

4.2.1.1 District heating system configurations

The phasing of developments is particularly important for consideration of site-wide infrastructure, especially where the infrastructure links between developments. The phasing of the individual developments in the Shoreham Harbour area, in terms of build of residential units and commercial, leisure and community space is shown Figure 34. Based on this phasing information, Southwick Waterfront and Shoreham Waterside North are the earliest development opportunities and so could be 'nucleating' points for district heating systems.

An extension of a district heating system from Southwick Waterfront to Canal Wharf is likely to be beneficial given the overlap in the programmes of the two developments and the substantial commercial space that is being developed at Canal Wharf. Any extended district heating system between these two developments would also facilitate connection of the Boundary Road development.

Connection of a district heating system from Southwick Waterfront to Shoreham Waterside North is less clearly advantageous, as the developments at the western end of the harbour (i.e. Shoreham Waterside North and Shoreham Town Centre) will not create the same scale of heat load.

In light of these considerations, two potential scenarios for district heating systems have been assessed for the Shoreham Harbour Regeneration, varying in the extent of the heat network.

1. **East of Harbour system** – A system nucleating at the early development of Southwick Waterfront and extending East to connect the Boundary Rd, Fishersgate and Canal Wharf developments. It is also assumed that the network is extended to connect Portslade East, when this is developed later in the overall programme.
2. **Whole harbour system** – The harbour extends to the west to connect to Shoreham Waterside North and Shoreham Town Centre (shown on the map in Figure 33 as the West Harbour Extension.

These proposed system options are shown on the map below:

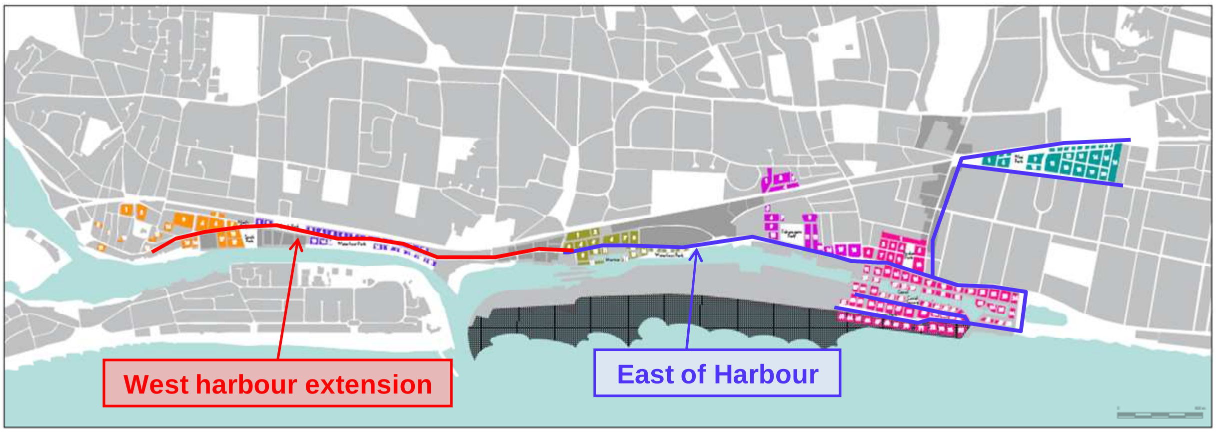


Figure 33, Map of Shoreham Harbour developments highlighting 3 potential DH networks

Phasing of developments in Shoreham Harbour Area Action Plan

Development	Use		2009 - 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Southwick Waterfront	resi	dwellings		104	104	104	104	120	120	120	120	120								
	office	m^2		1,726	1,726	1,726	1,726	102	102	102	102	102								
	retail/leisure/comm	m^2		1,669	1,669	1,669	1,669													
ShorehamTown Centre	resi	dwellings						106	106	106	106	106	106	106	106	106	106			
	office	m^2						679	679	679	679	679	679	2,632	679	679	679			
	retail/leisure/comm	m^2						870	870	870	5,873	5,874	870	870	870	870	870			
Shoreham Waterside	resi	dwellings			96	96	96	96	117	117	117	117	73							
	office	m^2			492	492	492	492	278	279	279	279								
	retail/leisure/comm	m^2			549	549	549	549	1,286	1,287	1,287	1,287								
Boundary Rd	resi	dwellings			104	104	104	104	60	60	60	59								
	office	m^2																		
	retail/leisure/comm	m^2			285	285	285	285												
Canal Wharf	resi	dwellings						146	146	146	146	146	146	146	146	146	213	213	213	213
	office	m^2				8,437	8,437	10,340	10,340	10,340	10,340	10,340	10,340	1,903	1,903	1,903				
	retail/leisure/comm	m^2				612	612	2,206	2,206	2,206	2,206	2,206	2,206	1,594	1,594	2,004	410	410	410	410
Portslade East	resi	dwellings											78	78	78	78	78			
	office	m^2																		
	retail/leisure/comm	m^2																		
TOTAL	resi	dwellings		104	305	305	305	573	550	550	550	549	404	330	330	330	397	213	213	213
	office	m^2		1,726	2,217	10,654	10,654	11,612	11,398	11,399	11,399	11,399	11,019	4,535	2,582	2,582	679			
	retail/leisure/comm	m^2		1,669	2,503	3,115	3,115	3,911	4,363	4,364	9,367	9,368	3,077	2,464	2,464	2,874	1,280	410	410	410

Figure 34, Phasing of build of residential units and commercial and community space in the Shoreham Harbour developments

4.2.1.2 District heating system costs

District heating network cost estimates have been made for each of the systems described above. Given the very early masterplan stage of the developments within the Shoreham Harbour area, these costs can only be considered to be outline indications. More detailed cost estimates can be made once the layouts of the developments are better defined.

For the purpose of this outline costing exercise, the district heating system has been assumed to comprise of two levels – a main distribution level, which transports heat around and in between sites, and a branch level, which connects the individual buildings. The network cost is therefore primarily composed of:

- Distribution network
- Branch pipes
- Heat exchanger units

The capital investment estimates for each of the systems are shown in the table below together with the main assumptions regarding the network configurations:

DH systems	East of Harbour	Whole harbour
Length of main pipe (m)	9,525	12,475
Number of blocks	99	129
Length of distribution pipe (m)	1,980	2,580
Number of domestic HIUs	5,934	7,920
No of block HIUs	44	71
Costs (£)		
Mains pipe	4,770,917	6,239,917
distribution pipe	594,000	774,000
Domestic HIU	5,934,000	7,920,000
Block HIU	440,000	710,000
Cost of internal risers	252,900	319,500
Contingencies (prelims, design, management)	2,857,329	3,756,479
TOTAL COST (£)	**14,286,646**	**19,717,500**

Figure 35, Budget capital cost estimates for the 2 district heating network scenarios

4.2.1.3 The CHP system

There are a variety of types of CHP system that could be used to serve the Shoreham Harbour district heating systems, including gas-fired systems and systems fuelled with biomass. The characteristics of these different types of system differ substantially, with implications for their applicability within the proposed district heating system. A summary of the key characteristics of a number of potential types of CHP technology are given below:

Technology	Fuel	Electrical capacity range	Electrical efficiency	Heat:Power ratio	Comment
Reciprocating engine	Gas	5 kW to MWs	30 – 40%	1.5:1	Very well known
Hot air turbine	biomass	100 – 200 kW	20%	2:1	Potential small-scale biomass technology, but at very early stage of development.
Steam turbine	Flexible (inc. biomass)	> 3.5 MW	20 – 25%	3:1	Most proven biomass technology, but only at large-scale[1]
Organic Rankine cycle	Flexible (inc. biomass)	0.5 to 1.5 MWe	15%	4.33:1	Early commercial biomass technology. Not yet used in the UK.

[1] UK-based biomass system supplier Talbotts have developed a 2.5 MWe steam turbine based system, which is being trialled. However, other large-scale biomass plant suppliers no longer offer systems below 3.5 MWe as the plant economics were not found to be viable at smaller scales.

Figure 36, Summary of the key features of potential CHP engine technologies

For the most efficient operation, the CHP system should operate to follow the heat-load, such that all heat produced is useful heat (i.e. heat is only produced when there is a simultaneous demand or the heat can be stored). It is not cost-effective to size the CHP system to meet the peak heat-load, as this will lead to a costly and under-utilised plant. The plant's economics are dependent on it accumulating a high number of annual run hours. As a general rule-of-thumb, the CHP plant should be sized such that it operates for the equivalent of at least 5,000 hours at full load.

The appropriate CHP capacities for each of the proposed district heating system options have been assessed, based on a heat-load following operation and accumulation of 5,000 full load run hours per year. In the first instance, these sizing estimations are based on the final heat load developed on each of the systems (assuming that buildings are constructed to with the 'Very Good' fabric package, as discussed in Section 3.3), although it is recognized that these heat loads will develop over a period of time. The CHP capacities are shown in the table below:

CHP system electrical capacity	East of Harbour system	Whole Harbour system
Gas engine	4.5 MWe	6 MWe
Biomass steam	2.2 MWe	3 MWe
Biomass ORC	1.5 MWe	2 MWe

Figure 37, Outline sizing of CHP engine options for the district heating system scenarios. Sizing is based on the heat load, assuming that fabric efficiency improvements in line with the 'Very Good' fabric package, as discussed in Section 3.3, is applied (domestic and non-domestic buildings).

Even in the case of the most extensive district heating system, the heat load is somewhat low for a biomass steam-based CHP system (based on the heat loads expected following application of energy efficiency measures). The smallest commercial plant at around 3.5 MWe will be under-utilised in this system, which will make economic viability more challenging. Biomass fuelled Organic Rankine Cycle (ORC) technology is available in a suitable size range, although the commercial maturity is not as well-advanced as for steam biomass systems.

4.2.1.4 DH system economics

iscounted cashflow analyses have been performed for each of the potential district heating system configurations. In the case of the East of Harbour system, gas engine and biomass ORC CHP technologies have been assessed. In the case of the 'Whole Harbour' system, a steam-based biomass system is also assessed.

The cashflows include all capital costs, ongoing costs and revenues associated with each of the projects. The key cost and revenue parameters are summarized below:

Costs

- Capital investment in equipment and installation of the energy centre (including CHP engine, back-up boiler capacity, building and civils, grid-connection costs)
- Capital investment in the installation of the district heating network and heat-interface units.
- Fuel costs (biomass and natural gas)
- O & M costs

Long term revenue

- Sale of heat, power and possibly cooling to site occupants
- Sale of 'guarantees' of energy supply (maintenance) to site occupants
- Sale of excess electricity to the grid
- Trading of Renewable Obligation Certificates (ROCs)

Up-front revenue

- Avoided costs from the developer for conventional heating plant and utility infrastructure

A number of key assumptions have been made in calculating these cost and revenue terms, which are tabulated below:

Parameter	Assumption
CHP heat sale price	Indexed to BERR's domestic gas price projections[1]
CHP electricity export price	3 p/kWh
Gas price	BERR's gas price projections
Woodchip price	£ 50/tonne (50% wet woodchip)
ROC price	£ 40 /MWh
ROC banding for biomass CHP	2 ROCs/MWh
Period of assessment	25 years
Discount rate	10%

1 The price heat is sold at is indexed to the price of heat delivered by a conventional gas-fired boiler (gas at domestic or consumer prices as appropriate). An additional margin is added to cover district heating system maintenance, billing etc.

Figure 38, Key assumptions in the economic analysis of CHP/DH options

The cashflow analysis accounts for the phased growth of heat demand over the 25 year lifetime of the assessment. It is assumed that the CHP plant and the bulk of the district heating network are invested in at the outset of the project. Costs for HIUs and branch network costs are incurred as the buildings are developed and connected.

The results of the cashflow analyses are shown in the tables below.

4.2.1.4.1 East of Harbour system

Capital cost of system	**Gas engine (4.5 MWe)**		**Biomass ORC (1.5 MWe)**	
CHP energy centre	£	4,950,000	£	6,250,000
CHP replacement cost	£	592,495	£	748,100
District heating system (including HIUs)	£	7,658,066	£	7,658,066
Total capital costs	*£*	*13,200,562*	*£*	*14,656,166*
Avoided costs (developer contribution)				
Domestic boilers and gas connections	£	4,231,419	£	4,231,419
Comercial boilers	£	423,318	£	423,318
Total avoided costs	*£*	*4,654,738*	*£*	*4,654,738*
Present value of operating costs				
O&M	£	155,287	£	279,538
CHP fuel	£	5,159,874	£	2,932,870
boiler fuel	£	730,982	£	730,982
Present value of revenues				
Domestic heat sales	£	2,384,532	£	2,384,532
Comercial heat sales	£	2,541,129	£	2,541,129
Electricity export	£	2,174,019	£	752,603
ROC revenue	£	-	£	1,720,236
Total present value of operating costs & revenues	*£*	*1,053,537*	*£*	*3,455,109*
Net present value	-£	7,492,287	-£	6,546,319

Figure 39, Summary of the economic appraisal of the 'East of Harbour' district heating system option, based on two potential CHP engine technologies

4.2.1.4.2 Whole Harbour system

Capital cost of system	**Gas engine (6 Mwe)**	**Biomass ORC (2 Mwe)**	**Steam biomass (3.5 Mwe)**
CHP energy centre	£ 6,000,000	£ 8,150,000	£ 7,500,000
CHP replacement cost	£ 718,176	£ 975,523	£ 897,720
District heating system (including HIUs)	£ 10,538,945	£ 10,538,945	£ 10,538,945
Total capital costs	*£ 17,257,121*	*£ 19,664,467*	*£ 18,936,665*
Avoided costs (developer contribution)			
Domestic boilers and gas connections	£ 7,903,561	£ 7,903,561	£ 7,903,561
Comercial boilers	£ 678,815	£ 678,815	£ 678,815
Total avoided costs	*£ 8,582,375*	*£ 8,582,375*	*£ 8,582,375*
Present value of operating costs			
O&M	£ 285,564	£ 514,412	£ 742,467
CHP fuel	£ 9,488,285	£ 5,394,085	£ 5,842,749
boiler fuel	£ 1,344,174	£ 1,344,174	*£ 1,344,174*
Present value of revenues			
Domestic heat sales	£ 5,051,586	£ 5,051,586	£ 5,051,586
Comercial heat sales	£ 4,067,031	£ 4,067,031	£ 4,067,031
Electricity export	£ 3,997,901	£ 1,384,954	£ 1,998,950
ROC revenue	£ -	£ 3,165,609	£ 4,569,029
Total present value of operating costs & revenues	*£ 1,998,495*	*£ 6,416,511*	*£ 7,757,207*
Net present value	**-£ 6,676,251**	**-£ 4,665,582**	**-£ 2,597,082**

Figure 40, Summary of the economic appraisal of the 'Whole Harbour' district heating system option, based on appropriate gas- and biomass-fuelled engine technologies.

In each case the economics of the proposed DH systems are NPV negative over a 25-year period (at 10% discount rate). Generally the economics improve with increasing scale of the DH system.

The negative Net Present Values resulting from the simple economic analysis presented above highlight the significant financial barriers to the implementation of site wide energy systems. The revenues generated by sale of heat and electricity (assumed in the analyses above to be exported to the grid) are insufficient to pay off the large capital investment in the energy centre and the district heating network. Of the two system scenarios assessed, the full site-wide network (i.e. Whole Harbour system) offers the more economical opportunity. In the following section, potential implementation strategies for this Whole Harbour network are assessed.

4.2.1.4.3 Impact of windfall sites

The economic analyses have been based on the most recent projections for supply of housing, commercial and community space in the key development areas. Based on these projections, a total of approx 8,000 houses and 160,000 m^2 of commercial space will be provided in the harbour developments once fully built out. All of these properties are assumed to be connected to the district heating system in the Whole Harbour network scenario.

Additional development in the harbour area may be brought forward by the market and these 'Windfall' sites may also connect to the district heating system. As discussed in 4.2.1.3, well-proven biomass CHP systems are not commercially available at less than 3.5 MWe capacity. A system of this size would have some spare capacity to accommodate additional loads on the district heating system (Whole Harbour system), without requirement for scaling up. Clearly the connection of additional loads would result in increased costs for the district heating system, mainly in increased distribution level pipework and heat exchangers. If the intention were to have the capacity to connect windfall sites, initial investment in a larger capacity heat mains pipe from the outset may also be wise.

In the table below the economics of the Whole Harbour system are shown under the assumption that the market brings forward a 20% increase in housing supply (the commercial and community development is assumed to be unchanged).

Capital cost of system	**3.5 Mwe biomass CHP**
Biomass CHP energy centre	£ 7,500,000
CHP replacement costs	£ 897,720
District heating system (including HIUs)	£ 11,561,023
Total capital costs	*£ 19,958,743*
Avoided costs (developer contribution)	
Domestic boilers and gas connections	£ 9,414,608
Comercial boilers	£ 678,815
Total avoided costs	*£ 10,093,423*
Present value of operating costs	
O&M	£ 809,256
CHP fuel	£ 6,368,334
boiler fuel	£ 1,465,554
Present value of revenues	
Domestic heat sales	£ 6,005,800
Comercial heat sales	£ 4,067,031
Electricity export	£ 2,178,766
ROC revenue	£ 4,980,037
Total present value of operating costs & revenues	*£ 8,588,491*
Net present value	-£ 1,276,830

Figure 41, Discounted cashflow analysis of the Whole Harbour system assuming that windfall sites bring forward a 20% increase in the number of domestic units.

The impact of Windfall sites connecting to the district heating system is significant, reducing the negative NPV (at 10% over 25 years) to approximately £1.3 million. This is based on the assumption that the windfall sites will be brought forward along the length of the heating main already assumed in the Whole Harbour system, without requiring significant additional mains pipework (e.g. additional connections between Southwick and boundary Rd, Southwick and Shoreham Waterside or Boundary Road and Portslade East).

4.2.1.4.4 Licence exempt electricity supply

The economic analysis of the Whole Harbour system shown in Section 4.2.1 assumes that electricity generated from the CHP system is exported to the grid and hence a relatively low value is assigned to it. A higher value may be derived from this electricity if the company managing the CHP system (e.g. the operational ESCO) were to sell electricity directly to retail customers in addition to supplying them with heat over the district heating system.

In order to supply electricity to consumers, the ESCO or management company would become a license exempt electricity supply company – this is a class of electricity supplier that, because it supplies only small amounts of electricity, is eligible to be exempt from the licensing regime that regulates the large electricity supply companies.

If the ESCO were to become a license exempt supply company it would be able to sell electricity to consumers at the appropriate retail electricity prices (differing for domestic and commercial consumers). The ESCO would incur a number of charges to supply electricity, such as a payment to the operator of the electricity distribution system used to transport the power and costs related to billing of consumers, however, the profit on electricity supplied to consumers in this way will be significantly higher than when exported to the grid.

4.2.1.4.5 Additional subsidies for renewable generation

To-date, the uptake of renewables of the scale of interest for Shoreham Harbour has primarily been supported through the Renewables Obligation (RO). Under the RO, generators of renewable electricity are awarded certificates for every MWh of renewable electricity they produce. These certificates can be traded with electricity supply companies, on whom there is an obligation to acquire enough certificates each year to prove that a certain percentage of the electricity they have supplied has been generated from renewable sources (the percentage increases each year towards the target of 10% in 2010 and likely target of 20% in 2020). The value of Renewable Obligation Certificates (ROCs) varies with supply of renewable energy relative to the target, but has typically varied around £40 to 45/MWh.

In 2008, the government announced a change to the RO such that the level of support it offered would be differentiated between technologies. Relatively mature electricity generating technologies such as large scale wind turbines will continue to receive 1 ROC for every MWh of electricity generated, however, technologies that are considered to be further from commercial maturity will receive either 1.5 or 2 ROCs per MWh. Good quality biomass fuelled CHP, of the type assessed here for Shoreham Harbour, will fall into the 2 ROCs/MWh band.

There has been no analogous subsidy mechanism to support the uptake of renewable heat technologies. Renewable heat technologies, such as biomass boilers, have been supported through a number of capital grant programmes (of fairly limited scale) and support has been offered to potential growers of energy crops in an attempt to establish a biomass supply chain. However, it has been recognized by government that renewable heat could make a large contribution toward meeting its CO_2 reduction and renewable energy generation objectives, and so direct support for renewable heat is now on the agenda.

Toward the end of 2008, the government announced two new policy initiatives to support the uptake of renewable generation – a renewable feed-in tariff (FIT) for electricity and a renewable heat incentive (RHI) to support increased generation of renewable heat. Both the FIT and the RHI will take the form of a premium tariff paid for each MWh of renewable electricity or heat. The details of these two policies are still under consideration by government, both in terms of how the subsidy will operate (i.e. who will administer the scheme, how will renewable heat production (in particular) be measured, who will pay the tariff etc.) and what the levels of tariff will be. In both the case of the FIT and the RHI it is likely that the level of support offered will vary between different types of technology and different technology scales.

These two subsidies will have an impact on the viability of biomass CHP and district heating schemes at Shoreham Harbour. However, with such scarce detail on either policy at the current time, it is difficult to make definitive statements on how significant the impacts will be. In recognition of this uncertainty, the economic proposition has been assessed over a range of potential FIT and RHI values. The results of this analysis are shown as a map of negative (unattractive) and positive (attractive) NPV in the figure below. Note that it has been assumed that the FIT will replace the value that would have been achieved by selling electricity to the grid, but that the RHI is assumed to be additional to the revenue gained from sale of heat to consumers over the district heating system. It is also assumed that technologies that are eligible to receive a FIT are no longer supported by the RO (this will most likely be achieved by constraining the FIT to technologies of less than 5 MW electrical capacity and the RO to technologies of size above this threshold). Note that developer investment in the district heating system at the level of value of avoided boiler and gas connections are included in this assessment of project economics.

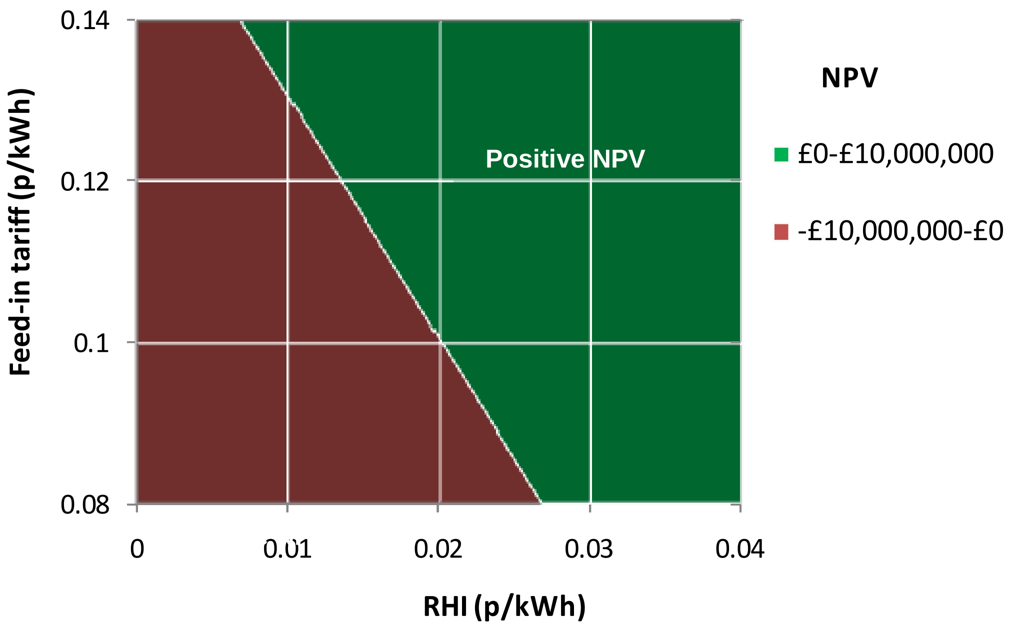


Figure 42, Plot of the ranges of level of renewable feed-in-tariff (FIT – subsidy for renewable electricity) and renewable heat incentive (RHI – subsidy for renewable heat) at which the Whole Harbour district heating system is expected to provide a positive return on investment.

A FIT of greater than £0.08/kWh is probably likely, given that the existing support through the RO for good quality biomass CHP is approximately at this level (depending on fluctuations in the ROC value). The plot suggests that at this lower bound assumption for the level of FIT, the project would reach break-even (assuming a discount rate of 10%) at a RHI of around £ 0.025/kWh. If the FIT were to be substantially higher, say £0.12/kWh, then the project would reach viability at an RHI of less than £0.015/kWh. Although it is not possible to predict the levels at which these tariffs will eventually be set, the range of tariff discussed above and shown in Figure 42 are not unrealistic.

Adur District Council, SEEDA and other potential stakeholders in energy initiatives in Adur should maintain a watching brief on announcements on the levels at which the RHI and FIT are to be set for technologies of a type and scale relevant to Shoreham Harbour.

4.2.1.5 Carbon savings - combined heat and power engines and district heating

Deployment of centralized CHP engines and district heating networks could facilitate significant CO_2 savings in both the domestic and non-domestic sectors at Shoreham Harbour. The reduction in emissions delivered by a gas CHP system and a biomass steam cycle system are shown in the plots below for the domestic and non-domestic sector.

Note that these charts show the percentage reduction of emissions compared to the baseline scenario, which is current Part L. In the domestic sector, the total CO_2 emissions are shown as being composed of regulated emissions (those relating to heating, ventilation and lighting) – these are the only emissions covered by the current Part L – and unregulated emissions, relating to appliances and cooking. This distinction is useful for discussion of how the systems perform against the standards of the Code for Sustainable Homes and the proposed zero carbon homes definition. For example, Code Level 4 and 5 stipulate 44% and 100% reductions of regulated emissions respectively. Code Level 6 requires net zero carbon standard to be achieved, which also includes the unregulated emissions. In 2010 and 2013 the building regulations will be amended to require 25% and 44% reductions of regulated emissions from current Part L. The proposed zero carbon definition for Building Regulations (discussed in Section 2.2.2), introduces the concept of a carbon compliance level, which is the level of carbon reduction to be delivered through onsite measures and will be set at 44%, 70% or 100% of regulated emissions. The remaining emissions (including the unregulated emissions) will be dealt with through the 'allowable solutions', which include a range of offsite measures.

Domestic properties:

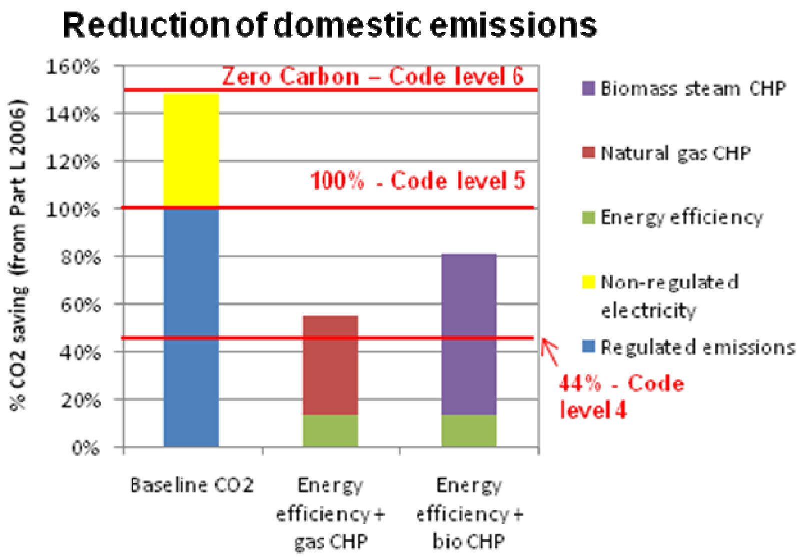


Figure 43 – CO_2 reductions achievable in the domestic sector through deployment of biomass and natural gas fired CHP engines and district heating systems at Shoreham Harbour

Both natural gas and biomass fuelled systems promote CO_2 reductions which exceed CSH level 4 emissions standards in the domestic sector. The biomass steam cycle system delivers around an 80% reduction of regulated emissions.

In the case of the non-domestic sector emissions have not been split into regulated and unregulated, i.e. 100% of the baseline emissions in this case covers all of the building emissions, including appliances, small power etc. For the Shoreham Harbour developments, the gas and biomass steam CHP systems deliver CO_2 emissions reductions of 40% and 55% respectively (of the total emissions).

Non-domestic properties:

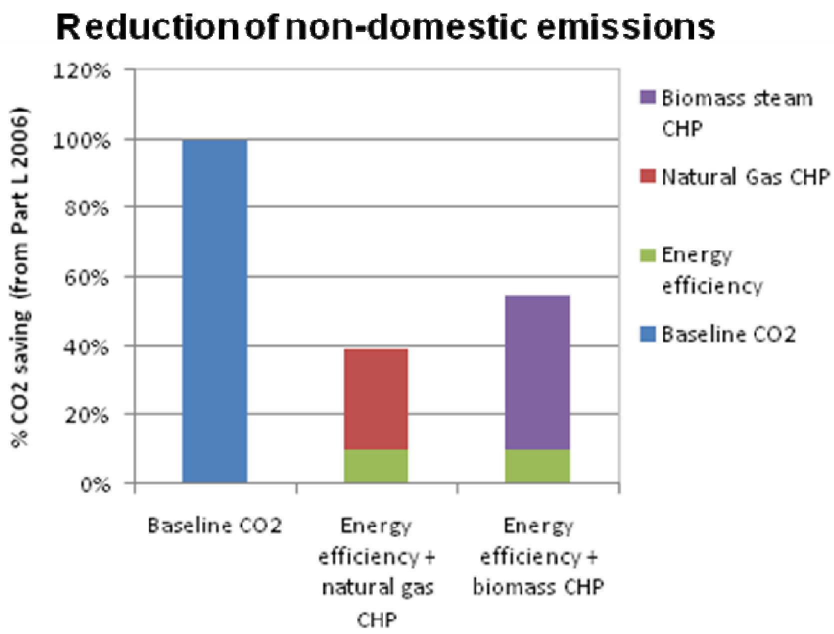


Figure 44 – CO_2 reductions achievable in the non-domestic sector through deployment of biomass and natural gas fired CHP engines and district heating systems at Shoreham Harbour

KEY CONCLUSIONS

- Site-wide CHP systems can facilitate compliance with CSH level 4 in residential developments at Shoreham Harbour and a minimum saving of ~40% in the non-domestic sector.
- Biomass steam CHP systems can facilitate large CO_2 savings in both the residential (80% with respect to baseline regulated emissions) and non-domestic sectors (55% with respect to baseline emissions).
- The 80% level of CO_2 emissions in the domestic sector delivered by the biomass CHP system may exceed the level of emissions reduction required by onsite means under the zero carbon homes definition (levels of 44%, 70% and 100% are under consultation).
- The remaining CO_2 emissions attributable to the development could be met by investment in ‘Allowable Solutions’, including a range of offsite measures.
- In order to comply with Level 6 of the Code for Sustainable Homes, further investment in onsite measures would be required, such as PV capacity.

4.2.2 Block by block low carbon energy strategies

It has been shown that significant carbon savings could be delivered by CHP and district heating systems serving the Shoreham Harbour developments. The economic appraisal of a number of CHP/DH options has shown that the systems are unlikely to represent attractive investment opportunities, unless there is an element of public funding. In addition to the financial risks, there are a number of other barriers to successful implementation of these systems, for example the level of coordination needed between the developers of the various sites (although the JAAP should provide a means of facilitating this kind of cooperation between developers).

An alternative to site-wide energy systems is to address the carbon emissions of dwellings and commercial buildings at the individual building level. The early masterplan information received on the Shoreham Harbour developments suggests that the built form will largely comprise flatted blocks, achieving a high dwelling density. In the following the approach to achieving large reductions in the carbon emissions standards of these blocks is considered. The block energy strategies will comprise:

1. A basic and cost effective level of energy efficiency/fabric performance improvements

   A basic level of fabric improvement has been shown to be cost effective means of reducing carbon emissions and falls in line with the recent UK government consultation on the definition of zero carbon.

   Plus either,

2. Biomass block heating

   Or

3. Ground or air source heat pumps

It is assumed that residential development at Shoreham Harbour will be built to a high density and concentrated into modern blocks of mostly 2-3 bedroom apartments. In this analysis, we will assume a representative "block" structure of 150 dwellings, built to a density of ~250 habitable rooms per hectare (derived from initial planning visions)[12] .

4.2.2.1 Block biomass heating

Large scale biomass boilers can provide cost effective CO_2 savings when used to provide communal heating (via a block based heating network) to a large number of domestic properties.

Figure 45 – communal biomass boiler

The technology is mature and reliable and can modulate down to low heat outputs. Biomass boiler systems are typically sized to meet the entire heating demands (both space heating and hot water) of the development to which they are connected.

Heat demand and profile analysis indicates that a typical Shoreham block would require a communal biomass boiler with a capacity of 600kW of thermal output. Such a system is likely to incur a capital cost of ~£200,000. The technology is reasonably mature, and little cost reduction is envisaged.

Application of basic fabric efficiency measures and a communal biomass heating system could reduce block CO_2 emissions by more than 55% with respect to baseline regulated emissions. This level of carbon reduction would be consistent with Code for Sustainable Homes level 4.

4.2.2.2 Air source heat pumps

Air source heat pumps (ASHPs) are an emerging electrically powered heating technology. Electrical pumps and a refrigerant cycle are used to extract latent heat from the outside air to heat internal domestic space and provide domestic hot water. The heating energy provided by the heat pump exceeds the electrical consumption of the pump by a multiple known as the coefficient of performance. If the average

[12] Data received from Martin Howard – BBP Regeneration

operational coefficient of performance of the heat pump is large enough, electrically powered heat pumps can reduce heating derived CO_2 emissions relative to incumbent gas boiler heating solutions.

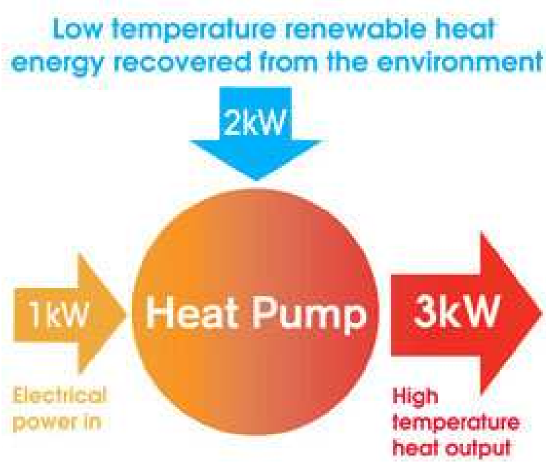


Figure 46 – heat pumps provide more heating energy than they consume in electrical energy. The ratio between heat energy out and electrical consumption is known as the coefficient of performance (COP). The heat pump illustrated above has a COP of 3

Air Source heat pumps are at a relatively early stage of commercialization, however the core technology is well-known (similar to conventional air-conditioning equipment). Several leading air conditioning manufacturers including Daikin and Mitusubishi now manufacture and install reliable air source heat pump systems (Altherma[13] and Ecodan[14] respectively).

Individual apartments in a block would require an individual air source heat pump unit. This configuration avoids potential problems with respect to the metering of individual apartment heating use. The units are typically relatively compact~1m x 1m x 30cm and would need to be installed on balconies or facades to allow the unit access to the external air. Heat load analysis and extensive contact with the heat pump industry indicate that a 5kWe heat pump would be suitable for a typical 2-3 bed flat.

[13] Daikin Altherma heat pump – http://www.daikin.co.uk/news/items/altherma.jsp
[14] Mitsubishi Ecodan heat pump - http://www.mitsubishi-aircon.co.uk/default.asp?url=http%3A//www.mitsubishi-aircon.co.uk/mitsubishi_electric.asp%3Fid%3D168227

Figure 47 – A 5kWe rated Mitsubishi Ecodan air source heat pump

Based on a conservative average seasonal coefficient of performance of 3 (Mitsubishi have field test results which indicate that higher COPs are attainable), air source heat pumps – in conjunction with basic fabric improvement measures - could reduce baseline block CO_2 emissions by more than 32%. This level of CO_2 reduction would be consistent with CSH level 3.

A 5kWe Ecodan ASHP currently has an installed capital cost of ~£3,700 per apartment (including the unit, cylinder and installation). This would result in a capital on-cost for the block of more than £550,000 (although some economies of scale may reduce this capital cost).

4.2.2.3 Ground source heat pumps

Ground source heat pumps operate in an identical manner to ASHPs, but extract latent heat from the ground instead of the air. Since the ground temperature is more constant and does not reduce dramatically in winter (as ambient air temperature does), the COPs of GSHPs are typically greater than those of ASHPs. A typical average seasonal COP of ~3.5 will be assumed in this report.

Several different GSHP system configurations are possible. Refridgerant fluid can be sent through long horizontal ground loops to extract heat from the ground (the long loops maximize heat transfer from the ground). This configuration is preferable where large quantities of open or greenfield space are accessible to a new build sites, and trenches can be easily dug for the placing of coils/loops.

However, on a dense development site such as that at Shoreham Harbour, vertically aligned closed loop boreholes must be used. Boreholes are dug deep into the ground and long loops are aligned vertically to conserve surface space.

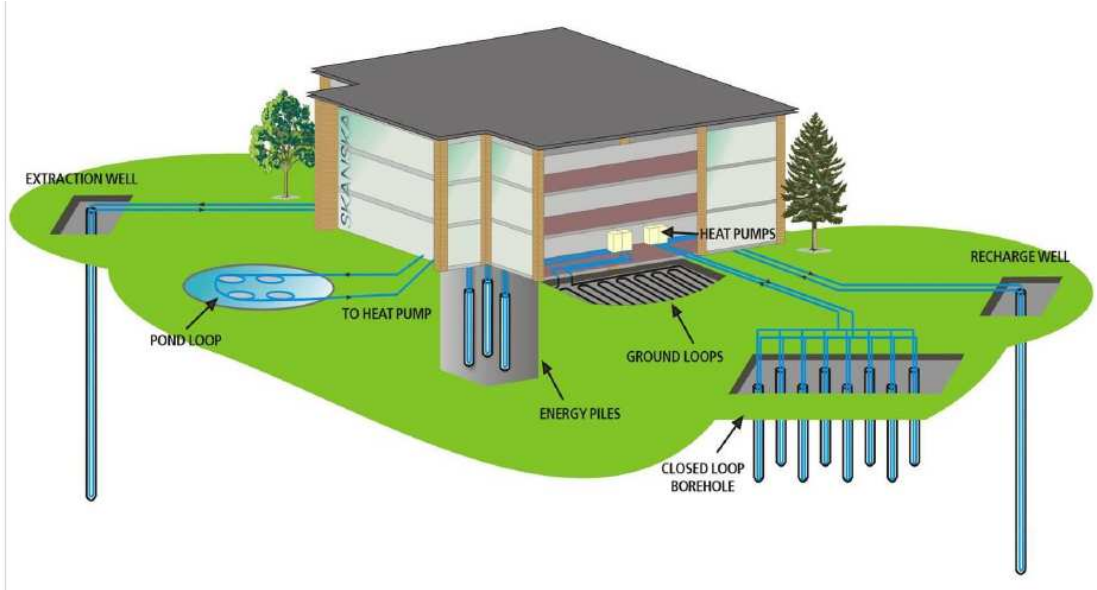


Figure 48 – schematic diagram of potential heat pump systems – high density developments at Shoreham Harbour via require boreholes to be drilled

Heat loss calculations (taking into account the application of energy efficiency measures) for the residential blocks and contact with heat pump manufacturers Kensa[15] indicates that a heat pump system with a total thermal output of 375kW (consisting of 5x75kW pumps) would be appropriate for residential development blocks at Shoreham Harbour. Such a system could provide CO_2 savings of ~40% with respect to baseline regulated CO_2 emissions.

Based on estimates provided by Kensa and benchmark costs for large scale ground source heat pump systems identified during industry consultation to inform the recent Element Energy microgeneration study[16], the installed cost of such a GSHP system is estimated at ~£400,000-£450,000 installed.

A large fraction of this cost results from the length of boreholes required to provide for the peak heating demands of the proposed apartment blocks. Kensa estimates that ~8,000m of borehole depth would be required at a cost of ~£280,000.

At present costs and coefficients of performance, GSHPs (like ASHPs) represent an expensive method of saving carbon and are not competitive economically with respect to block biomass heating strategies (despite the fact that avoided gas boiler installation costs may reduce the block capital on cost of GSHPs).

4.2.2.4 CO_2 emission reductions achievable

The following graph outlines the CO_2 emissions reductions achievable through the application of basic fabric efficiency measures and the deployment of the technological strategies outlined in the previous section:

[15] Kensa heat pumps - http://www.kensaengineering.com/
[16] The growth potential for microgeneration in England, Wales and Scotland – Element Energy

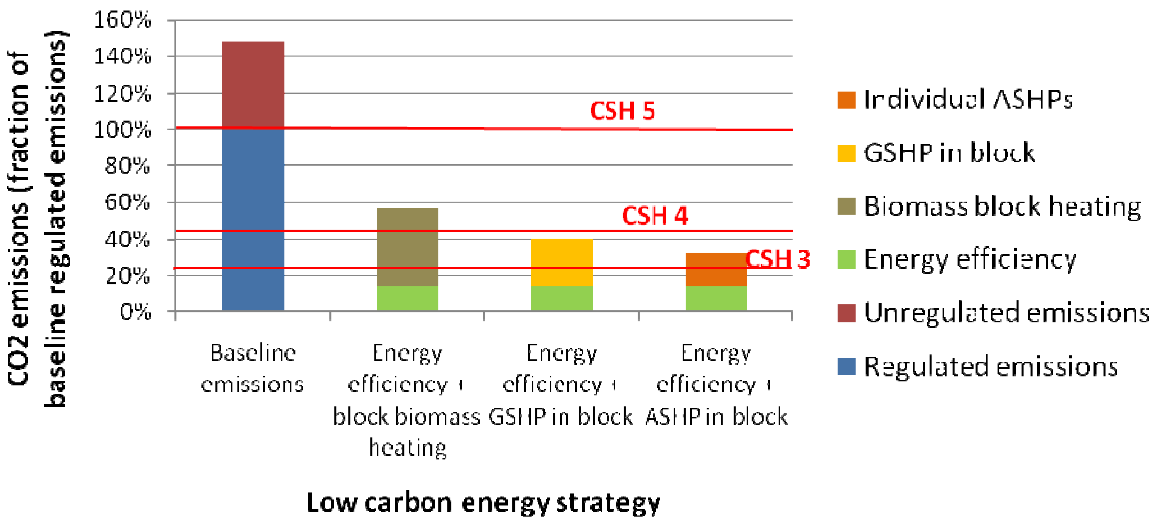


Figure 49 – CO_2 reductions achievable through deployment of a range of block based low carbon energy strategies

It is clear from the graph that biomass block heating strategies allow for the greatest CO_2 saving with respect to baseline regulated emissions (~55%). This reduction standard is sufficient to achieve level 4 of the code for sustainable homes. GSHP and ASHP dominated strategies facilitate significantly smaller CO_2 savings of ~40% and 32% respectively (with respect to baseline regulated emissions). These reduction standards allow compliance with CSH level 3.

4.2.2.5 Overview of block based low carbon energy strategies

Low Carbon energy strategy	Carbon reduction achievable (% of baseline regulated emissions)	Capital on-cost (£)
Basic fabric efficiency and biomass heating	56%	£ 275,000
Basic fabric efficiency and air source heat pumps	44%	£ 625,000
Basic fabric efficiency and ground source heat pumps	32%	£ 500,000

Figure 50 – CO_2 emissions reductions achievable and associated capital on-costs of a comprehensive range of block based low carbon strategies (note capital costs include the additional cost of the fabric efficiency package, compared to meeting current Part L standards).

At current capital costs and performance levels biomass block heating outperforms heat pump based strategies on both a capital cost and CO_2 saving basis.

Several other factors also favour the deployment of biomass block heating strategies:

1. **Greater carbon emissions savings**

   The air source and ground source heat pump strategies outlined above do not allow residential development blocks to achieve a CO_2 reduction of 44% with respect to baseline regulated CO_2 emissions – equivalent to CSH level 4 - through the deployment of onsite low carbon measures.

   A 44% emissions reduction from current Part L is likely to become the regulatory minimum standard from 2013. Only the biomass boiler strategy meets this level of emissions reduction without requiring further measures. This level of emissions reduction may also be adopted as the carbon compliance level in the definition of zero carbon homes (the level of emissions reduction to be achieved through onsite measures), however, it is perhaps more likely that a higher level will be set (70% or 100% levels are proposed in the consultation).

2. **Spatial considerations**

   Although a biomass boiler system is bulky and will require additional storage capacity for bulky wood pellets or chips, the whole system can be located in a self-contained outhouse or basement plant room.

   In the case of ASHPs, units must be attached to individual dwelling facades or placed on dwelling balconies for dwellings above the ground floor. Fixing units to facades can be costly, difficult and aesthetically displeasing.

   The central pumping equipment of a GSHP can be contained within a dedicated plant room, however, the quantity of boreholes required for a 150 dwelling residential block is significant (80x100m deep boreholes), and these boreholes must be separated by a minimum of 6m. This produces an extended area of >100m^2 which must be found on or adjacent to the development site. Preserving space is a key concern when building to the high densities planned at Shoreham Harbour.

Based on the expected predominant building form within the harbour developments and the comparison of cost and performance of block and dwelling scale low carbon technologies, biomass heating is expected to provide the most favourable alternative to a site-wide system for provision of low carbon heat in the Shoreham Harbour developments.

4.2.2.6 Potential future advances

The UK energy market is expected to change rapidly over the coming decade and these changes may have implications for the comparative assessment of biomass and heat pump based heating technologies. The key factors that could influence the choice between technology in the future are highlighted below:

1. **Technological cost variations**

   Technology capital costs are likely to decrease over the coming decades, especially as UK government low carbon legislation drives the uptake of low carbon technologies. These changes could impact on the relative cost effectiveness of the block energy strategies presented above.

However, although heat pumps are not widely used heating technologies, particularly in the domestic sector, the core technology is well-known and large relative price shifts between heat pumps and biomass boilers may be unikely.

2. **Decreases in the CO_2 intensity of the national electricity grid**

UK government commitments to produce increasing fractions of grid electricity from renewable sources together with the potential commissioning of several UK nuclear power plants could result in a significant decrease in the CO_2 intensity of UK grid electricity. This decrease in CO_2 intensity reduces the CO_2 emissions produced by the electrical consumption of heat pumps - whilst the associated heating CO_2 savings remain constant (incumbent gas heating demand is displaced). Therefore, the CO_2 savings derived from heat pumps increase significantly and heat pumps could become a very low carbon heating technology. The high thermal efficiency of heat pumps (i.e. COPs of 3 to 4) with respect to biomass boiler could make heat pumps an increasingly attractive option in future decades.

3. **Security of biomass fuel supply**

In order for a biomass boiler plant to operate efficiently and reliably, a constant supply of biomass fuel is required. In order to keep CO_2 emissions (derived from transport of fuel) to a minimum, a suitable local biomass supply chain must be maintained. Biomass supply chains could be interrupted by years of poor growth, changes in biomass fuel price, local competitors for the biomass resource and a host of other factors. Heat pumps systems simply require an electricity grid connection and do not depend on fuel delivery.

KEY CONCLUSIONS

- CHP and district heating systems serving the Shoreham Harbour developments are unlikely to represent attractive investments to the private sector (e.g. energy supply companies, ESCOs) without an element of public funding.
- An alternative to site-wide energy systems is to address the carbon emissions of dwellings and commercial buildings at the individual building level.
- It is assumed that residential development at Shoreham Harbour will be built to a high density and concentrated into modern blocks of mostly 2-3 bedroom apartments.
- Analysis indicates that biomass block heating strategies (incorporating biomass boilers and a block wide heating network) could provide the most cost effective CO_2 savings of any building integrated low carbon energy strategy. A reduction of ~55% with respect to baseline regulated emissions could be achieved by use of biomass block heating.
- Low carbon energy strategies incorporating air and ground source heat pumps currently require significantly higher capital expenditures and offer lower CO_2 savings (ASHP – 32%, GSHP - 40%)
- Future electricity grid de-carbonisation and reductions in the cost of heat pumps could however improve the CO_2 saving efficacy and decrease the capital costs associated with heat pump systems

4.2.3 Energy strategy – comparative analysis

The preceding analyses have demonstrated that significant CO_2 savings can be delivered by both site-wide and block-scale energy systems, particularly where a biomass fuelled system is used. The greatest CO_2 emissions reductions are provided by the site-wide district heating system with biomass CHP, which is predicted to reduce domestic emissions by 80% from Part L 2006 baseline (i.e. regulated emissions) and deliver approximately a 60% reduction on total non-domestic CO_2 emissions.

A convenient means of comparing a range of low carbon energy strategies is on the basis of how cost-effectively they reduce CO_2 emissions. In the figure below, the cost of saving CO_2 is shown for the site-wide system and block strategies, where cost of CO_2 saving is calculated over the technology lifetime (including capital and revenue costs).

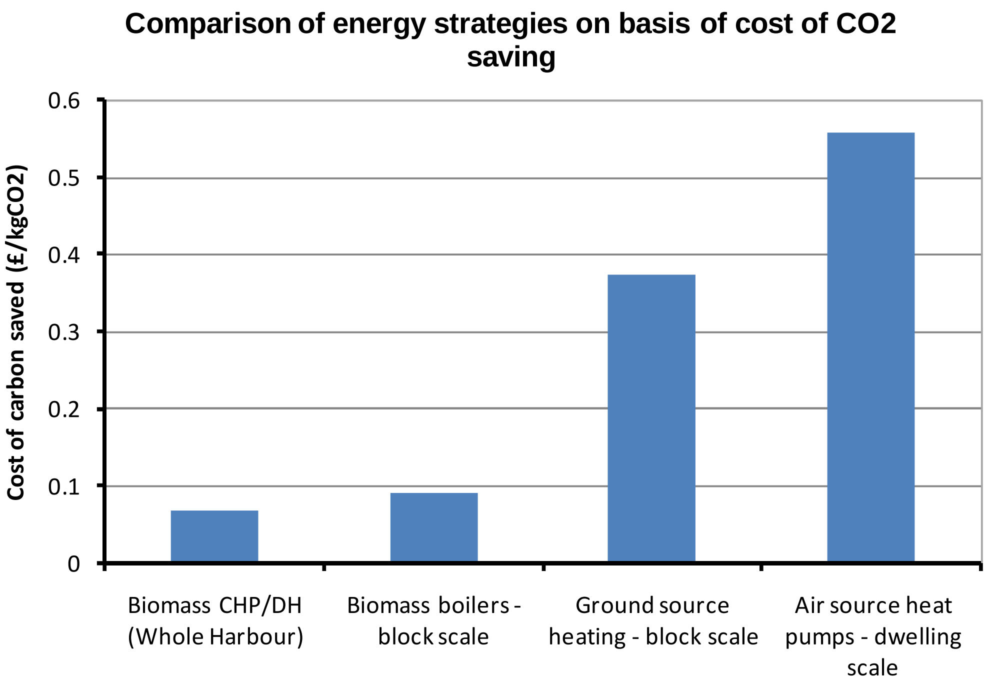


Figure 51, Comparison of the whole life cost of carbon saving for site-wide and block-based energy strategies

The biomass CHP and district heating system and biomass boiler system deliver significantly more cost-effective CO_2 saving that the heat pump systems. It should be noted that the calculation of CO_2 savings in this analysis assume current grid electricity CO_2 intensity. If, as is expected to happen, the carbon intensity of grid electricity falls over time, as more renewable electricity generation comes on stream, the CO_2 benefit of the electrically powered heat pumps will improve as will their cost-effectiveness.

The site-wide biomass CHP and block biomass heating strategies are closely matched in terms of cost of CO_2 saving (note that the above analysis includes the value of ROCs in the CHP case, but does not factor in any benefit from a renewable heat incentive (RHI), which is expected to be offered in the near term – this would benefit both biomass CHP and boiler strategies to varying extents). The analyses are performed over the period of the technology lifetime (assumed to be 15 years), although in the case of the site wide system a large part of the capital cost is in the district heating system, which has a useful lifetime of considerably longer than this.

There are also some practical advantages of the site-wide system, in that the plant is centralized and therefore biomass delivery and storage is also centralized. A large number of individual biomass boilers in residential and potentially commercial blocks would be logistically more complicated, in terms of fuel deliveries.

There are, therefore, a number of advantages of the biomass CHP & district heating system that combine to make it the most attractive solution for the Shoreham Harbour redevelopment. In summary these are:

- Large and relatively cost-effective CO_2 reductions
- Simple logistics of fuel supply

- Infrastructure that will facilitate low carbon heat supply over a long life-time
- Capacity to connect low carbon heat supply to further developments in the harbour area, that may be brought forward by the market.
- Simplicity for property-owners and tenants, who are not involved in operation or maintenance of unfamiliar or innovative energy systems
- Scale of project that may attract involvement from private energy service companies (know-how, access to finance etc).

4.2.4 Zero carbon energy strategies for Shoreham Harbour

Deployment of centralized CHP engines and district heating networks can promote substantial CO_2 savings with respect to baseline emissions, however such systems cannot facilitate the attainment of zero carbon status at Shoreham Harbour in isolation. To achieve zero carbon status will require further mitigation of residual CO_2 emissions using cost effective offsite energy generation (for example MW-scale wind turbines) or more expensive onsite microgeneration technologies (e.g. roof-mounted solar photovoltaic arrays).

The upfront capital costs associated with installation of renewable and low carbon energy systems to achieve net zero carbon for a development of the scale of Shoreham Harbour are very substantial. Capital costs are shown in the chart below for gas and biomass-fuelled CHP/DH systems together with installation of either sufficient PV capacity to reach net zero carbon standard (onsite measures – provided sufficient roof space is available to accommodate the PV area) or sufficient MW-scale wind turbine capacity (offsite measure).

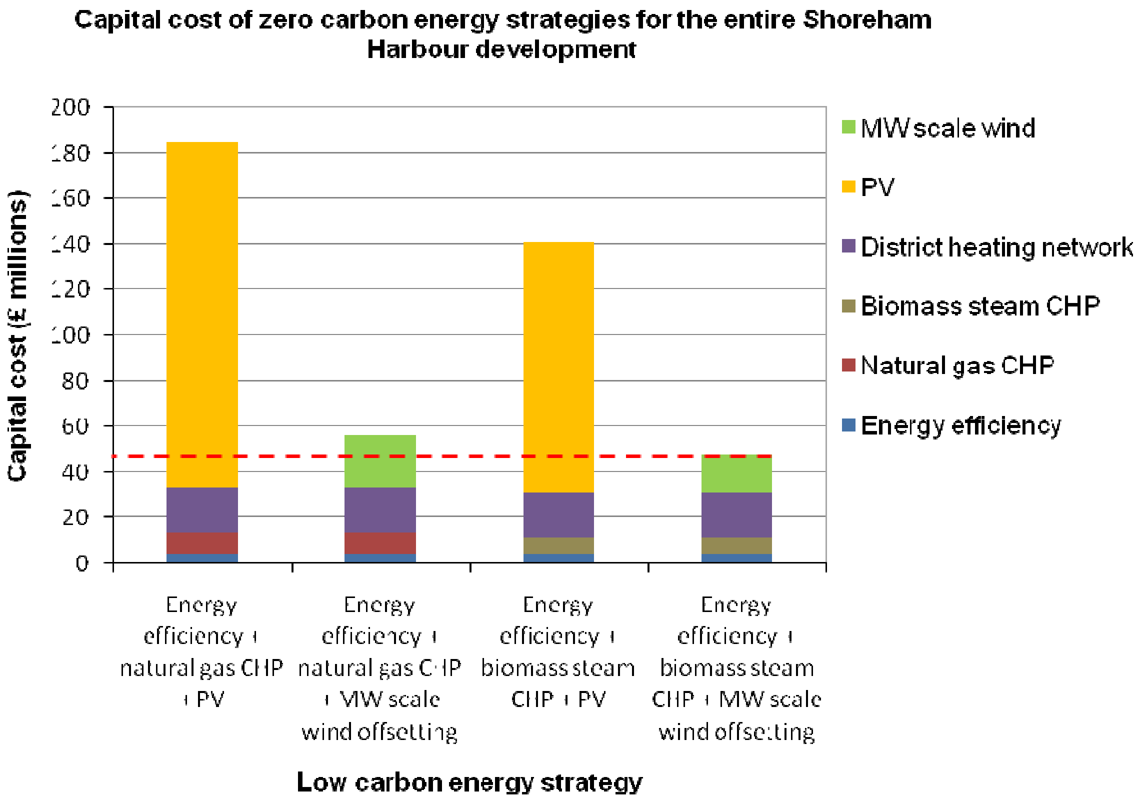


Figure 52 – capital cost of a comprehensive range of low carbon strategies at Shoreham Harbour. N.B strategies incorporating building integrated renewables e.g. PV are extremely expensive

Several points should be drawn from the analysis carried out above:

1. Zero carbon energy strategies which incorporate building integrated low carbon technologies e.g. roof mounted solar PV are significantly more expensive than strategies which allow developers access to (at least in part) offsite low carbon "allowable" solutions e.g. the installation of MW-scale wind turbines in locations remote from a site.

   The current drafting of the Code for Sustainable Homes demands that all CO_2 mitigation technologies must be incorporated into the buildings of a site, or provide electricity or heat via a direct electrical connection or heating network. In order to comply with the highest levels of the Code, developers would be forced to implement the more expensive on-site measures.

   However, the recent UK government Definition of Zero Carbon Homes and Non-Domestic Buildings consultation suggests that central government low carbon policy will allow developers to access more cost effective "allowable" low carbon solutions having met a mandatory onsite CO_2 reduction standard (see section 2.2.2.1). As detailed, the onsite contribution is currently under consultation, however, allowing developers to offset residual CO_2 by e.g. installing offsite MW scale wind turbines, or contributing capital to energy efficiency refitting in the existing build stock, could reduce capital costs at Shoreham Harbour significantly.

Low carbon energy strategies which utilize offsite MW-scale wind offsetting could represent as little as a 1/3 of the capital cost of more expensive strategies which utilize building integrated microgeneration technologies.

2. Low carbon energy strategies which utilize centralized CHP engines and district heating networks could be relatively cost effective (in terms of capital pounds spent per tonne of CO_2 saved) at Shoreham Harbour. However, it should be noted that the capital cost of these zero carbon energy strategies is still extremely large. The lowest cost biomass CHP and MW wind offsetting based energy strategy for the entire Shoreham Harbour development is estimated to incur at upfront capital cost in excess of ~£45 million. The components of this lowest cost approach are shown in the table below.

Component of energy system	Capital cost (undiscounted)
Energy efficiency measures (extra-over cost compared to meeting Part L 2006)	£ 4.5 million
Biomass CHP energy centre (3.5 MWe)	£ 7.2 million
District heating network (Whole harbour)	£ 19.7 million
MW-scale wind turbines	£ 16.9 million

Figure 53, Capital cost components (undiscounted) of Shoreham Harbour zero CO_2 strategy involving offsetting of residual emissions using MW-scale wind generation

The costs tabulated above do not account for any offset costs, for example the costs of avoided boilers and gas connections. It should also be noted that the energy efficiency costs are extra-over costs to improve fabric packages to deliver approximately a 20% improvement on Part L 2006 standards. At least this level of CO_2 reduction will be mandated by Building Regulations post-2010.

KEY CONCLUSIONS

- Deployment of centralized CHP engines and district heating networks cannot facilitate the attainment of zero carbon status at Shoreham Harbour in isolation. Mitigation of residual CO_2 emissions using additional active low carbon energy generation technologies would be required.
- Mitigation of residual CO_2 emissions could be achieved through deployment of building integrated renewable technologies e.g. PV or through a range of low carbon allowable solutions e.g. offsite MW scale wind carbon offsetting.
- Low carbon energy strategies which incorporate building integrated renewables are far more expensive than strategies which take advantage of allowable low carbon solutions such as MW scale wind carbon offsetting.
- Attainment of zero carbon status at Shoreham Harbour will require significant capital expenditure (~£45 million minimum).
- Resorting to low carbon allowable solutions e.g. offsite MW scale wind carbon offsetting is not allowed under the current drafting of the CSH (all CO_2 mitigation must be the result of generation technologies directly connected to the site), but is expected to form part of the zero carbon buildings definition

4.3 Implementation of a Shoreham Harbour district heating system (Whole Harbour network)

The delivery of large-scale energy systems of the type discussed above is likely to involve a specialist energy service provider, such as an existing utility or an energy services company (ESCO). There are a variety of potential models for delivery of such energy projects, including:

- An existing ESCO or utility provides a full Design, Build, Finance and Operate (DBFO) contract.
- An ESCO is established to deliver the project through a joint venture between a private ESCO partner and local partners (such as a City Development Company).
- A fully community-based ESCO is established with local investment (e.g. Local Authority, Regional Development Agency) and potentially with an element of community-ownership.

The opportunity for each of these financing and operation models for the Shoreham Harbour energy system are discussed below.

4.3.1 Private sector ESCO

The first of these options is the simplest and involves least risk and requirement for investment from local partners. The private ESCO or utility will also bring the expertise to deliver the system and run it efficiently. However, the potential for capturing benefits for the local economy is sacrificed, as are the benefits of local control over the future development of the system.

A private sector ESCO will require a healthy return on investment in order to be attracted to invest in the energy system. An IRR of 10% over a 10 year period is typical of the minimum required return on an investment. The capital contribution that the private ESCO would be willing to make can therefore be estimated from a calculation of the present value of operating revenues over the first 10 years' of operation, as shown below.

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Costs											
O&M cost	£0	£3,977	£11,347	£22,082	£32,816	£47,229	£60,800	£74,371	£89,628	£104,884	£116,259
CHP fuel cost	£0	£31,298	£89,296	£173,770	£258,243	£371,664	£478,457	£585,250	£705,312	£825,374	£914,888
Boiler fuel cost	£0	£6,986	£20,003	£39,068	£58,270	£84,165	£108,738	£133,486	£161,445	£189,599	£210,907
Revenues											
Heat sale - domestic	£0	£18,711	£73,440	£128,421	£183,654	£287,791	£380,420	£473,456	£566,899	£660,698	£736,048
Heat sale - commercial	£0	£26,862	£62,199	£132,370	£202,977	£276,089	£351,956	£428,286	£522,698	£617,681	£684,297
Electricity sale	£0	£14,122	£40,536	£79,562	£118,946	£171,914	£222,621	£272,311	£329,554	£385,329	£428,908
ROCs	£0	£24,475	£69,830	£135,888	£201,946	£290,641	£374,153	£457,666	£551,554	£645,443	£715,443
Net revenue	£0	£41,909	£125,358	£241,322	£358,194	£523,377	£681,156	£838,612	£1,014,320	£1,189,293	£1,322,641
Discounted revenue	£0	£38,099	£103,601	£181,309	£244,652	£324,976	£384,495	£430,341	£473,188	£504,376	£509,935
Cumulative revenue	£0	£38,099	£141,700	£323,009	£567,661	£892,637	£1,277,131	£1,707,472	£2,180,660	£2,685,036	£3,194,972

Figure 54, Calculation of the present value of net profits from operation of the Whole Harbour district heating system (before payment of capital costs).

On this basis, the capital contribution to the investment in the energy system is estimated at £3.20 million. It is likely that the private sector ESCO would be contracted to run the energy system for a longer period than 10 years, for example a 20-year period may be more likely, during which time it would continue to collect revenue. Beyond the initial 10-year period, further investment in replacement of equipment is likely to be required and maintenance costs of existing equipment may increase. A further contribution from the ESCO could be negotiated at this point, based on the projected economics of continued operation of the system.

Based on the investment required in the Whole Harbour system, as shown in Figure 35, this capital contribution is only a relatively small component of the overall investment required.

The site developers will be expected to cover a portion of the cost of the district heating system. This should be at least equivalent to the value of the plant costs that has been avoided due to the installation of the district heating system, which is individual boiler plant in each property and individual connections to a site-wide gas infrastructure. The total value of the costs covered by the developers estimated in this way is £ 8.6 million.

The total capital contribution from the site developers and from a private sector ESCO amounts to £ 11.8 million. The total present value of capital investment in the Whole Harbour system has been estimated at £18.95 million. This leaves a funding gap of £ 7.15 million, which would need to be filled in order to attract a private ESCO to deliver and operate the Whole Harbour energy system across Shoreham Harbour.

4.3.2 Public Private partnership ESCO

Local stakeholders may wish to invest in the development of the energy system. This offers potential benefits, insofar as positive revenues from the energy system are retained in the local economy and local stakeholders have some control over the activities of the ESCO, which they can direct towards meeting local policy objectives. The element of local ownership can also improve the acceptance of the energy system among the local public. However, it is advantageous to form a partnership with a specialist ESCO company, which brings expertise in delivering and running energy systems, shares the risk and has access to finance that may not be open to local investors.

A large energy system, such as a Shoreham Harbour district heating system (Whole Harbour system) would be operated by a single dedicated ESCO – the operational ESCO. The purpose of the operational ESCO would be to run the energy system and to maintain a positive cashflow in order to service loan finance and to provide a return to investors. The private sector investor in the operational ESCO would still require a healthy return on their investment, of the order of a 10 to 12% rate of return. However, local investors and particularly public sector investors may not require a commercial rate of return on their investment and may prefer to see any dividends from the operational ESCO re-invested in further schemes in the area (which could involve setting up further operational ESCOs to run further energy initiatives). In this case it is practical to establish a holding company, such as a Shoreham Development Company, to own the shareholding in the operational ESCO (or ESCOs) and handle any profits that accrue. This principle is described schematically in the diagram below.

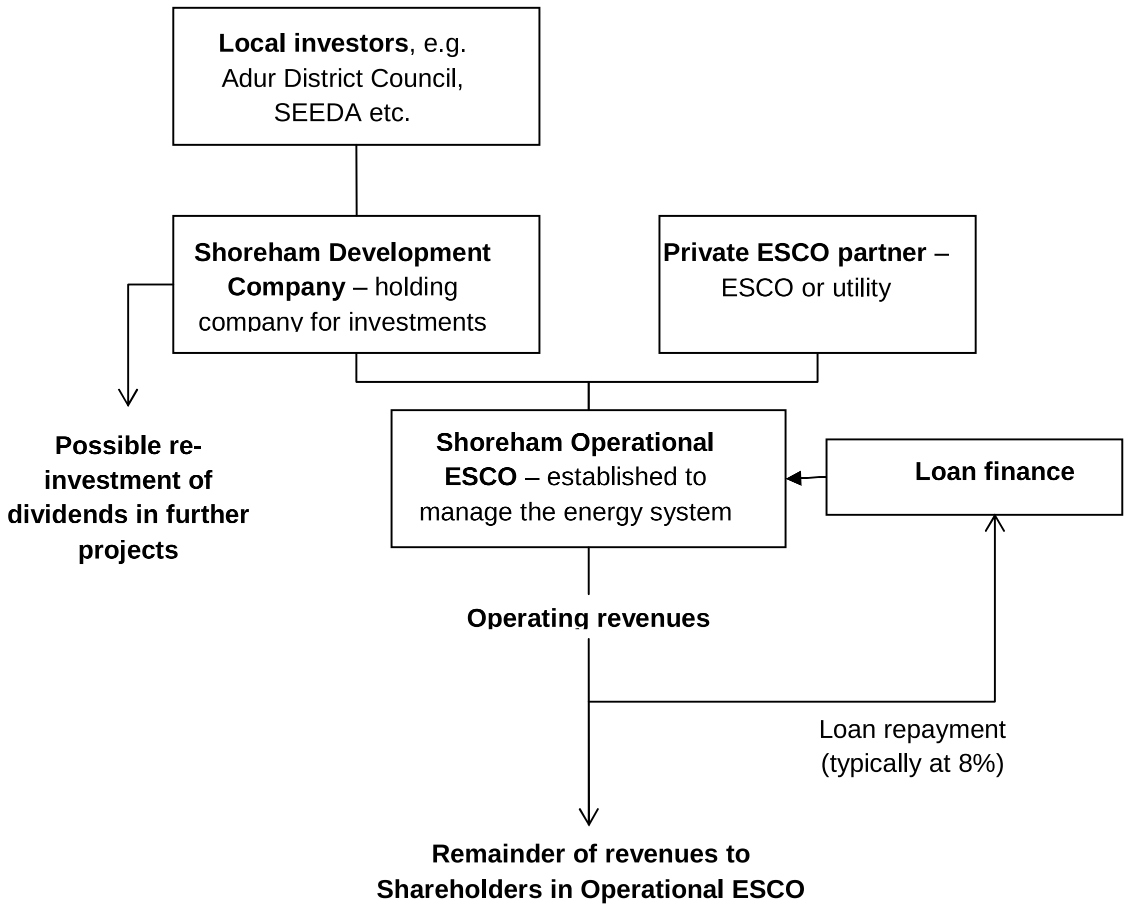


Figure 55 Schematic of the possible configuration of a joint public-private investment in an operational ESCO to manage the Shoreham Harbour energy system

Local authority partners in the Shoreham Harbour development have expressed an interest in developing a City Development Company (CDC) to take an interest in energy projects developed in the area. However, the finance structure above is contingent on the operational ESCO providing a positive cashflow, in order to service the loan finance and provide a return to the shareholders. In order to attract the initial investment a bankable project is required, i.e. a project on which a business plan can be based that demonstrates sufficient expected return to attract the interest of a private ESCO partner, allows loan finance to be secured and also attracts local investment into the Shoreham Development Company. The preceding economic analysis of the Shoreham Harbour district energy system does not demonstrate a sufficient return to form the basis of a public-private venture of this type. A more profitable initial project would be required, which ensures a healthy return to the private investors and also to the local development company. The profits generated to the local company could then be used to fund higher risk ventures, once a stable cashflow has been developed.

4.3.3 Waste heat from Shoreham power station

The siting of Shoreham power station adjacent to Shoreham Harbour presents an opportunity for providing affordable, low carbon waste heat to local consumers through a dedicated district heating system. Local consumers would benefit from competitively priced heat, and the power station operators would benefit from the sale of heat which is currently dumped to the ocean. A similar network is being developed at the Barking power station in East London[17].

The Shoreham power station is an existing, single shaft gas turbine of 400 MW electrical capacity. There are currently no plans for extending the power station, e.g. adding a new turbine, and so the extraction of waste heat to generate a supply for the district heating system would require modification of the existing turbine. The implications and costs associated with doing this would need to be explored through a detailed feasibility study.

The power station was commissioned in the year 2000 and has a 25 year design life, so is expected to be decommissioned in 2025. However, despite this, it could provide a convenient, low carbon and potentially low cost source of heat over the first 10 years of the Shoreham Harbour regeneration, while the developments and the district heating system is built up. One of the key issues that undermines the economic viability of developing district heating systems is that a large capital investment is required at the outset, i.e. in the heating network and in the energy centre, while revenues build up slowly over the phasing of the developments as heat customers connect. Private ESCO partners, for example, will be deterred from providing large upfront capital investments in systems that do not realize their full revenue potential until many years later. In the case of Shoreham Harbour, the majority of the developments will be completed and occupied by 2025 and a good business case would exist at that stage for investment in a new energy centre, financed through sale of heat and power, to replace heat supply from the power station.

Extraction of waste heat could provide low carbon heat over the first 10 years and delay the large investment required in the biomass CHP energy centre to a time when the heat load and therefore potential for revenue had developed. However, significant capital investment would still be required in the earlier years of the project in installation of the district heating system, the connection between the power station and the network, which is not straightforward due to the location of the power station across the harbour from main development areas, and installation of heat-only boilers (HOB) to provide back-up for the power station. The cost of heat from the power station will be determined by the need to pay-off the investment required in modification of the power station turbine and other equipment necessary to extract heat (providing a commercial rate of return on this investment) and to compensate for the loss of electricity generation resulting from extraction of heat from the turbine. To assess the heat sale price

[17] http://www.denmark.dk/en/servicemenu/News/Environment-Energy-Climate-News/Archives2008/LondonDrawsOnDanishDistrictHeatingKnowhow.htm

required by the power station would require a detailed assessment of the turbine technology and the requirement for modifications and additional plant to extract high grade heat.

Depending on the costs associated with modifying the power station's turbine to allow extraction of high grade heat, it could provide a low cost source of heat while the Shoreham Harbour developments are built out. There are however a number of challenges and uncertainties regarding the use of waste heat from the Shoreham Power station:

1. Complex infrastructure requirements

   Shoreham power station is sited across open sea relative to the proposed new build developments at Shoreham Harbour. Submerging district heating pipes is possible or, alternatively, it is possible to directionally drill beneath the harbour floor. The costs and feasibility of each of these options will be dependent on the harbour depth, among other factors and would require a detailed investigation.

2. Power station configuration

   Significant reconfiguration of plant systems would be required to extract waste heat (which is currently dumped to the ocean) and distribute it via the district heating system. A number of the key issues that will necessitate reconfiguration of the power station are summarized below:

   a. The waste heat that can be taken from a power station without unacceptable loss of electrical generation is likely to be very low grade heat, i.e. 40 to 50 ℃, which is not ideal for a district heating system. To extract higher grade heat without too much reduction in electrical efficiency will require modifications of the power station turbine.

   b. There are space constraints on the Shoreham power station site. Any additional equipment, pumps etc would need to be located off site.

   c. If sea water were no longer to be used for cooling of the station, essential redundancy pumps and cooling apparatus would need to be installed to ensure the power station continues to operate safely and efficiently

   Reconfiguration of the turbines and installation of the additional infrastructure required to extract waste heat is likely to incur a significant capital cost. The cost of these modifications would need to be recouped by the power station through the tariff charged for supply of heat. The heat supply tariff would also need to compensate the power station for the loss of electricity generation incurred due to extraction of high grade heat.

3. Security of heat supply

   There are a number of key uncertainties surrounding the security of heat supply from the power station, as follows:

   a. Shoreham is a single shaft unit and any repairs/reconfigurations require the whole station to shut down, both for routine maintenance and for unscheduled repairs. Recently, for example, the power station has been offline for a period of 55 days due to a technical fault.

b. The normal operating cycle of Shoreham Power Station allows the plant to run for 350 days per year. However, every third year the station only operates for ~300 days to allow for planned repairs.

c. The operating schedule of the power station is heavily dependent on the gas and electricity prices, e.g. in 2009 Scottish Power are currently planning to take the station off line for approximately120 days due to the present commercial situation. Scottish Power may chose to take the power station offline at any time, and are required to provide a notice period of only 1 day. During offline periods, the heat for properties at Shoreham Harbour would need to be provided from an alternative source.

d. Shoreham Power station is due to be decommissioned in 2025. An alternative source of low carbon heat would be required to serve the district heating system customers beyond this date.

The operation of the power station and therefore availability of waste heat is quite uncertain, with a high risk of interruption. If the power station were to be utilised as a source of heat for the district heating system, an efficient back-up supply would be required, sized to meet the peak system heat loads.

Clearly there are a significant number of challenges to be overcome if the power station is to provide a source of heat for a district heating system at Shoreham. The use of power station heat should be assessed more fully by assessment of the likely costs involved in (i) submerging heat pipes to provide a connection into a Shoreham Harbour district heating network and (ii) modifying the gas turbine to allow extraction of suitable high grade heat to serve the network. This would allow the cost of heat supplied from the power station to be assessed and facilitate a full analysis of the economic viability of using waste heat to serve the district heating network over the period to 2025.

4.4 Shoreham Harbour – Conclusions & Recommendations

Shoreham Harbour is the flagship development in the Adur district and a development of national significance, having achieved Growth Point Status. There is a clear vision among local partners to ensure that an exemplar of sustainable coastal living is created at Shoreham Harbour. Part of this vision must include creation of a model of very low carbon development.

Due to the timescales of much of the development at Shoreham Harbour and government's intention to tighten the Building Regulations concerning CO_2 emissions from new buildings, legislation alone will drive substantial improvements in CO_2 emissions standards compared to present standards. However, the aspiration is to exceed the regulatory minimum standards at Shoreham Harbour as far as is technically and economically feasible.

A detailed analysis of energy system options for Shoreham Harbour has been performed. The key conclusions and recommendations drawn from this analysis are summarized below:

1. At least a 20% reduction in CO_2 emissions (compared to Part L 2006 baseline) should be achieved in domestic properties through energy efficiency measures (i.e. demand reduction). A target of a 15% improvement should be adopted in the non-domestic sector. It should be noted that the Building Regulations are expected to be revised in 2010, 2013 and 2016 and, as part of these amendments, an *energy efficiency backstop* level may be introduced (a minimum amount of the regulatory requirement for carbon emissions reduction that must be achieved by energy efficiency measures). Requirements for energy efficiency standards set out in the Shoreham Harbour JAAP should be revised if they fall below the regulatory minimum standard.

2. The majority of the residential development at Shoreham Harbour will be built at high density, largely in the form of apartment blocks. This form of development invites the potential for site-wide energy systems, consisting of centralized energy plant and district heating networks. In developments where the heat density is sufficiently high, these types of system can provide a more economical means of delivering carbon emissions reductions than addressing emissions at the individual dwelling or block scale, e.g. by installation of microgeneration technologies.

3. In order to deliver very large CO_2 reductions, a low carbon source is required to supply heat to the district heating system. Biomass CHP technology has been selected as the most appropriate choice for Shoreham Harbour.

4. The optimum configuration of a district heating system is one that extends throughout the whole harbour area, connecting each of the major development sites – the Whole Harbour system. This large-scale system has been shown to:
   - Provide the scale of heat load necessary to justify investment in a biomass CHP system based on well-proven steam turbine technology (which is not commercially available at scales below 3.5MWe).
   - Provide superior economic performance, compared to less extensive systems.
   - Provides the opportunity to connect further developments in the harbour area that may be brought forwards by the market in the future.

5. The economics of the Whole Harbour system are not likely to prove sufficiently positive to attract a private sector ESCO partner to finance and operate the system without a substantial element of

public sector funding. Based on private sector investment at a required IRR of 10% over 10 years and capital contributions from developers to the value of the avoided plant (boiler plant and gas connections), a funding gap of around £7million remains.

6. A number of factors may improve the economics: (i) Further development sites may be delivered that could be connected to the heat distribution system. This additional heat load would increase the revenue generated by sale of heat and electricity and improve overall project economics. (ii) Government is currently considering two new subsidy schemes to support investment in renewables in the UK – *feed-in tariff* for renewable electricity and the *renewable heat incentive* for renewable heat. Both of these incentives could be relevant to a 3.5 MWe biomass CHP plant at Shoreham Harbour and would be expected to provide an enhanced level of financial support compared to that offered by the Renewables Obligation.

7. A site-wide biomass CHP system provides an 80% reduction on regulated emissions in the domestic sector (compared to a Part L 2006 baseline). This is sufficient to achieve the energy standards of Code level 4 of the Code for Sustainable Homes (a reduction of 100% of regulated emissions is required to achieve Code level 5). This level of CO_2 reduction will, however, be sufficient to comply with the definition of zero carbon homes adopted after 2016 (a 70% reduction on regulated emissions through onsite measures). The remaining emissions could be mitigated by investment in offsite measures.

8. The site-wide biomass CHP system also delivers approximately a 60% reduction on total CO_2 emissions relating to the non-domestic developments.

9. In order to reach the zero carbon standard, the remaining emissions will need to be offset either by investment in further onsite renewables, such as photovoltaics, or by investment in offsite measures. Investment in offsite measures, such as large-scale wind generation, will provide much the lower cost means of dealing with these emissions. The total capital cost of a zero carbon energy system comprising energy efficiency, biomass CHP & district heating and investment in sufficient large-scale wind capacity (offsite) is estimated at £45million. Note that this is the additional cost relative to meeting the existing Building Regulations. Much of Shoreham Harbour developments will occur after 2016, when the zero carbon standard will be in force for domestic properties. Much of this cost additional cost is therefore related to meeting Building Regulations and not an additional cost due to the particular requirements at Shoreham Harbour.

10. The power station at Shoreham Harbour may provide an alternative source of low carbon heat for a district heating system. Modification of the power station turbine will be required to extract waste heat of a sufficient grade (temperature) to supply a heating network. Supply of waste heat is further complicated by the separation of the power station from the main development areas by the harbour itself, requiring submersion of heating pipes. A detailed technical analysis would be required to understand the feasibility and costs associated with extracting waste heat from the power station and providing a connection to the district heating system.

5 LOCAL LOW CARBON ENERGY OPPORTUNITIES

5.1 Wind power – opportunities and constraints

5.1.1 Onshore wind

The Adur District has a significant land based wind resource. Average wind speeds as high as 7.6m/s are observed in Adur (GIS mapping of NOABL data at 25m height[18]). Large wind turbines installed in the region have the potential to represent a viable economic opportunity and could deliver highly cost effective CO_2 savings in the Adur district (see Figure 11)[19].

5.1.1.1 Technical potential

The technical potential for wind turbine installation is the capacity that could be installed on the available land, before economic considerations and planning issues are taken into account. Data on the area of green space in each of Adur's census wards has been taken from the Generalised Land Use Database. An estimate of the amount of the available green space in any ward that could be used for installation of turbines of 5% has been applied. The capacity of wind turbine that could be installed in that area has then been calculated, assuming installation of mid to large scale wind turbines. The technical potential in each of Adur's census wards based on this assumption is tabulated Figure 56.

On the basis of green space availability, the potential for wind turbine installation in Adur is high, around 90 MW. This is due to a relatively high fraction of green space in several wards across Adur. However, there are key constraints to wind turbine installation that will mean that the actual potential for installation of wind turbines in the district is much lower. The key constraints are the South Downs National Park, which encompasses much of the green space, and the proximity to Shoreham airport. These constraints are discussed in the following.

[18] NOABL database provided by the Department for Business Enterprise and Regulatory Reform.http://www.berr.gov.uk/energy/sources/renewables/explained/wind/windspeed-database/page27326.html

[19] Caveat: Whilst the NOABL database takes into account the effects of air flow over topography on wind speed it does not allow for local thermally driven winds (e.g. sea breezes). In the case of a coastal district such as Adur, wind speeds close to the coastline may be underestimated. The wind speeds quoted are estimates and once a site is selected, an anemometer should be installed to measure the wind speed over a significant period of time.

Census ward	Technical potential (MW)
Buckingham	12.79
Churchill	0.24
Cokeham	5.79
Eastbrook	1.05
Hillside	15.31
Manor	23.15
Marine	0.20
Mash Barn	5.54
Peverel	21.40
St. Mary's	0.82
St. Nicolas	0.00
Southlands	0.18
Southwick Green	0.86
Widewater	3.03
TOTAL	**90.37**

Figure 56, Technical potential for onshore wind turbine installation. Note that this is based solely on an assumed usage of available green space, it takes no account of land ownership, planning or economic viability.

5.1.1.2 Constraints on onshore wind resource

A simple analysis of the technical potential for onshore wind turbines in Adur based on availability of green space has identified a large potential capacity. However, there are key constraints that will mean the realistic potential for wind in the district is very much less. The principal constraints are introduced below:

1. The site of the South Downs National Park (which occupies much of the open green field space to the North of the Adur District).

   The siting of a large turbine in the National Park is likely to meet with significant local resistance. A large turbine was installed at Glyndebourne to the north of Brighton and within the Downs, but met with significant hostility and was only reluctantly accepted[20] .

2. Wind turbine restriction zones surrounding Shoreham Airport,

   Radar restriction zones are enforced around active airports as large wind turbines can interfere with aeroplane navigation systems. A 2,000m exclusion zone is active around Shoreham airport, and structures with a height of >45m are unlikely to receive planning permission.

3. The presence of an active Gatwick flight corridor over the region,

   Gatwick airport utilizes a flight path which passes over the Adur District (see Figure 57). Installation of any wind turbine along the flight path would require consent from the airport authority.

[20] Environmental Sustainability Options for Shoreham Redevelopment Project – James Robinson, SEEDA

The figure below highlights the active flight corridor (light blue jagged corridor):

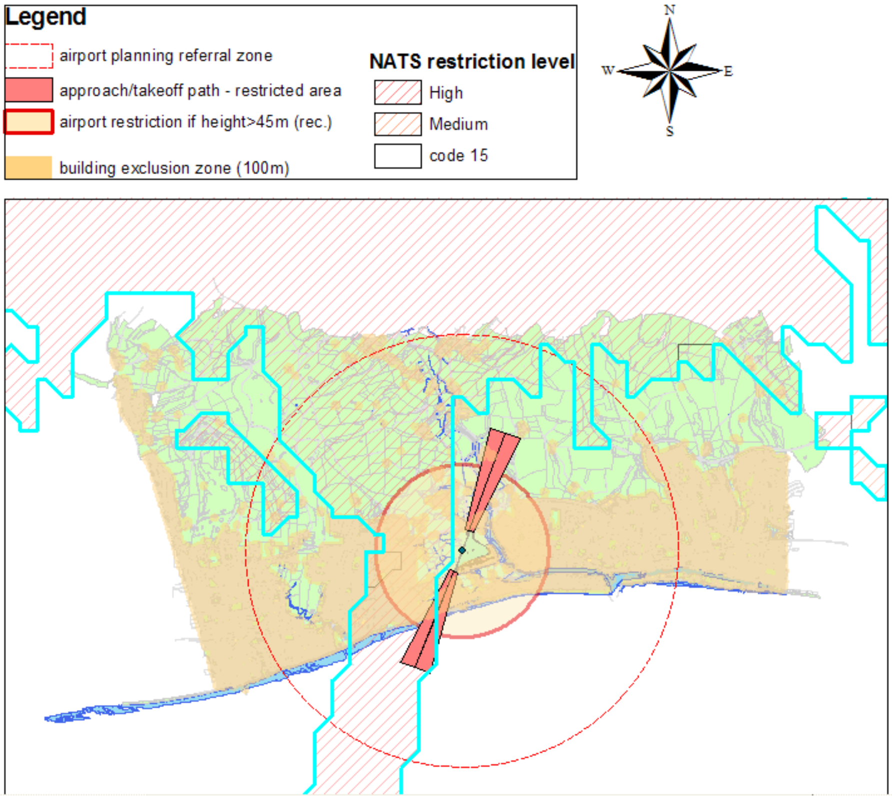


Figure 57, National Air Traffic System (NATS) restricted areas for wind turbine installations.

4. Benchmarks governing the suitable separation distance of wind turbines from existing buildings.

Wind turbine installations must be sited away from existing buildings, railways and overhead power lines.

The following exclusion zones were assumed around existing structures:

	Distance
All buildings	100m
Residential buildings	400m

Figure 58, Wind turbine exclusion zones as used in this study

Exclusion distances of 100m from residential buildings are required for safety – to allow for the topple height of a large turbine. This exclusion zone is marked in solid red on the maps below.

Factors such as visual impact, noise, flicker and blade glint increase the recommended separation distance to 400m from residential buildings.

These exclusion zones have a major impact on the availability of suitable large wind sites in the Adur District.

The figures below illustrate the severe restrictions on the installation of large wind turbines which exist within the district as a result of the local built environment:

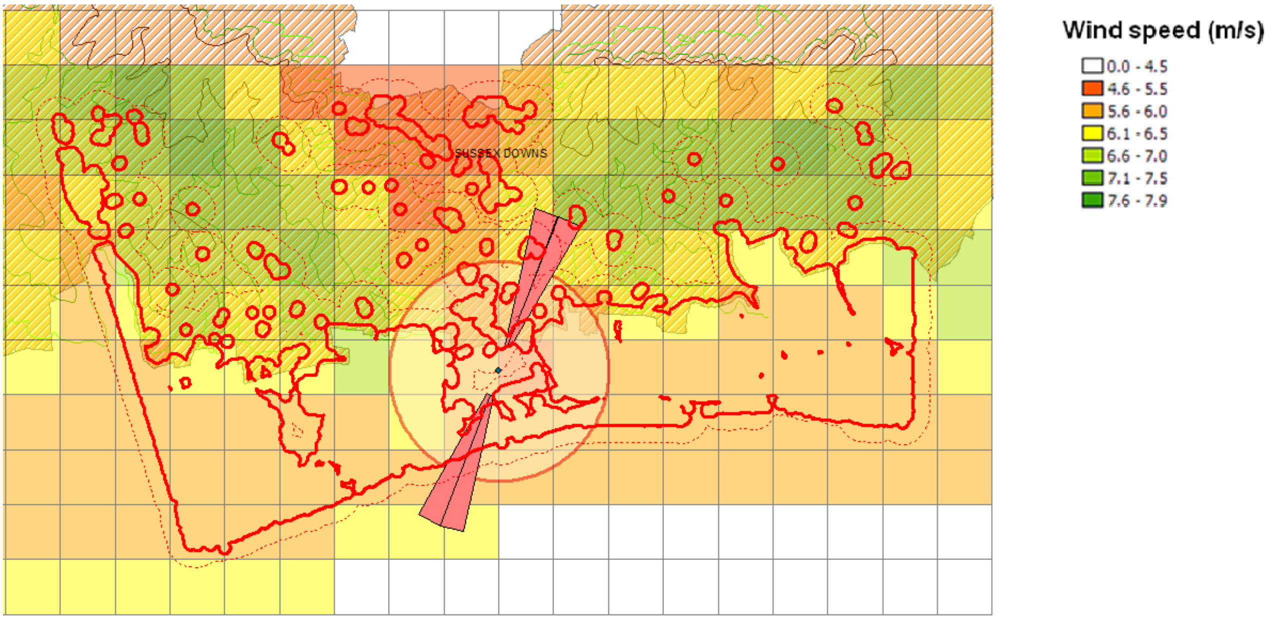


Figure 59, Map of wind speed variation across the Adur District. Solid red lines indicate 100m exclusion zones around buildings (dotted red lines indicate 400m exclusion zone). Red shaded blocks are exclusion zones due to Shoreham Airport flight paths. Note that the majority of high wind speed areas (green shaded) are located within the South Downs National Park, where planning restrictions will apply.

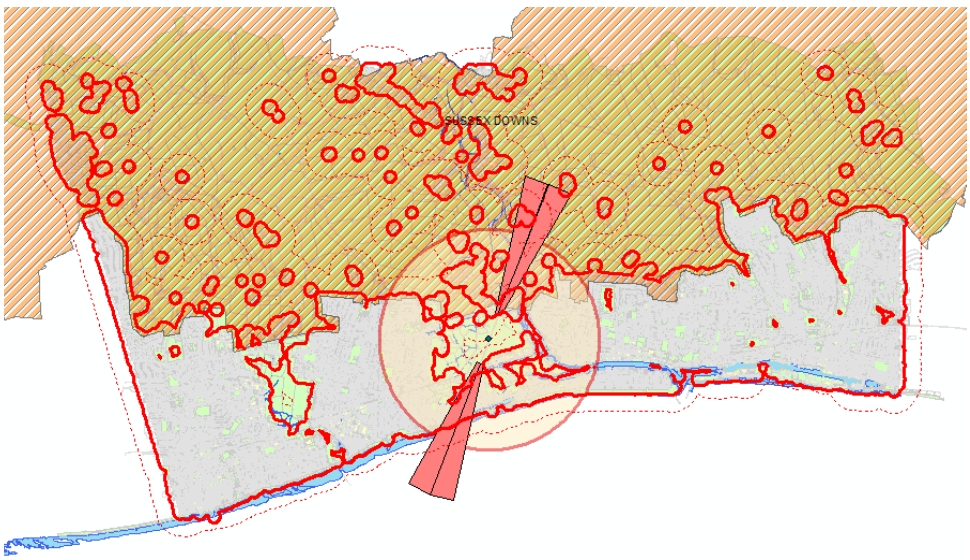


Figure 60, Map identifying restrictions on wind turbine deployment due to built environment. Solid red lines indicate a 100m separation distance from buildings (typical for a small scale turbine < 100kW). Dotted red lines indicate a 400m separation distance (typical for MW-scale turbines).

Of the technical potential shown in Figure 56, nearly 80% is concentrated in four census wards – Manor, Peverel, Hillside and Buckingham. In each case, the green space is virtually all within the South Downs National Park boundary and therefore the installation of wind turbines is expected to be heavily restricted and, potentially, ruled out altogether. The other areas with significant potential for wind turbines are Cokeham, which again lies mainly in the National Park in terms of green space, Mash Barn and Widewater. The latter two wards are outside of the National Park, but are directly south of the airport and so are unlikely to be suitable for installation of medium to large-scale turbines.

Adur's other wards lie to the south of the district and are mainly urban in character. As shown in Figure 60, the exclusion zones around buildings practically eliminated the potential for large turbines in these areas. There may be areas where smaller mast height turbines could be installed, e.g. less than 30m height, but the economics of these small turbines are less attractive, particularly when it is considered that the higher wind speed areas in the district are in the North (over the National Park area).

If a view is taken that installation of wind turbines in the National Park is not likely to be permitted, then the real potential for onshore wind turbines in Adur is small – potentially a few MWs, provided by a number of small-scale turbines distributed around the district. On this basis, wind is only likely to make a minor contribution to delivering the CO_2 reduction required in Adur's new developments (less than 10%).

5.1.2 Offshore wind

The offshore wind resource has been mapped by BERR[21]. The abundant wind resource in the English Channel has led the Crown Estate to earmark an area just off the coast near Brighton in their round 3 offshore wind programme. Plans for development of an offshore wind farm at the site are currently at an early stage and it is not clear what interest in such a development local stakeholders in the Adur District might play. It is feasible that a mechanism could be established such that developers could invest in the offshore wind array as part of an 'allowable solution' (as defined in the zero carbon consultation – Section 2.2.2.1) to mitigate the CO_2 emissions of developments. Alternatively, there may be scope for a local ESCO to invest in the array or purchase the renewable electricity for supply to local customers.

The figure below illustrates the abundant wind resource in the English Channel:

[21] BERR offshore wind resource data
http://www.berr.gov.uk/whatwedo/energy/sources/renewables/policy/offshore/sea/page22508.html

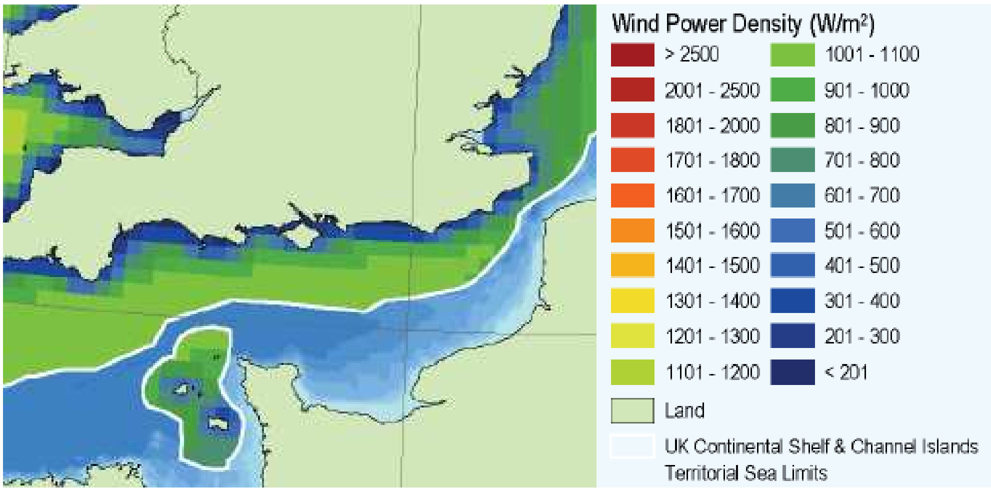


Figure 61 – Offshore wind resource (Source: Atlas of marine renewable energy resource, BERR, 2008)

The installation of offshore wind arrays has several advantages and disadvantages with respect to the installation of large onshore turbines:

Advantages

1. Offshore wind resource

   Offshore turbines near Adur have the potential to generate far more renewable electricity than onshore turbines as the wind speeds in the English Channel are so much higher than those observed on land. The energy output of turbines scales as the cube of the wind speed, therefore the higher wind speeds in the Channel result in large increases in the energy production capacity (and therefore CO2 mitigation potential) of wind turbines.

2. Planning restrictions and visual intrusion

   Offshore turbines represent a lower level of visual intrusion, and are less likely to be strongly resisted by local residents. The port authority has already acknowledged that the proposed offshore array near Brighton would not interfere with local shipping lines.

Disadvantages

1. Higher capital costs

   The installation of offshore turbines would incur higher capital costs than the installation of onshore turbines. Offshore turbines require large piles and long lengths of submarine cabling to connect the turbines to the national electricity grid.

2. Grid connection and private wire

   The current drafting of the Code for Sustainable homes requires that a wind turbine must provide electricity to a site directly, in order for the energy generation of the turbine to contribute towards onsite carbon emissions mitigation. However, it is likely that any offshore array near Adur would be connected directly to the electricity grid and not to new build developments in the Adur District e.g.

Shoreham Harbour (as any proposed array would likely provide far more renewable electricity than would be required by any of the new build sites planned in Adur).

Fortunately the recent UK government consulatation on the definition of zero carbon homes and non-domestic buildings could allow such an arrangement to facilitate compliance with future building regulations.

5.2 Biomass Resource assessment

The South East is England's most wooded region with more than 270,000 ha of existing woodland. However, much of the woodland is currently poorly managed due to the lack of markets for traditional wood products, with consequent deterioration of the woods. Wood fuel projects provide a potential growth market for wood that could increase the economic potential of the woods, encouraging better woodland management and, in turn, improving woodland habitats and protecting biodiversity. In addition to the environmental benefits, the growth of a wood fuel supply chain will generate employment in woodland management, harvesting and fuel supply and in the management, operation and maintenance of the biomass plants.

The opportunities and benefits of a growing wood fuel market have been recognized by the Forestry Commission, which is actively involved in supporting wood fuel projects in the South East region and facilitating development of a sustainable wood fuel supply chain. As part of this, the Forestry Commission is developing a South East Wood Fuel Implementation Plan with the ambition of generating a wood fuel market of approximately 500,000 m^3 per year (equivalent to nearly 400,000 tonnes at 30% moisture) in the South East region. The establishment of a substantial wood fuel demand in the Adur district is well-aligned with these regional objectives.

Despite the heavily wooded nature of the South-East region, Adur is not itself home to a large quantity of woodland. The woodland area within Adur is highlighted in the following map of the region.

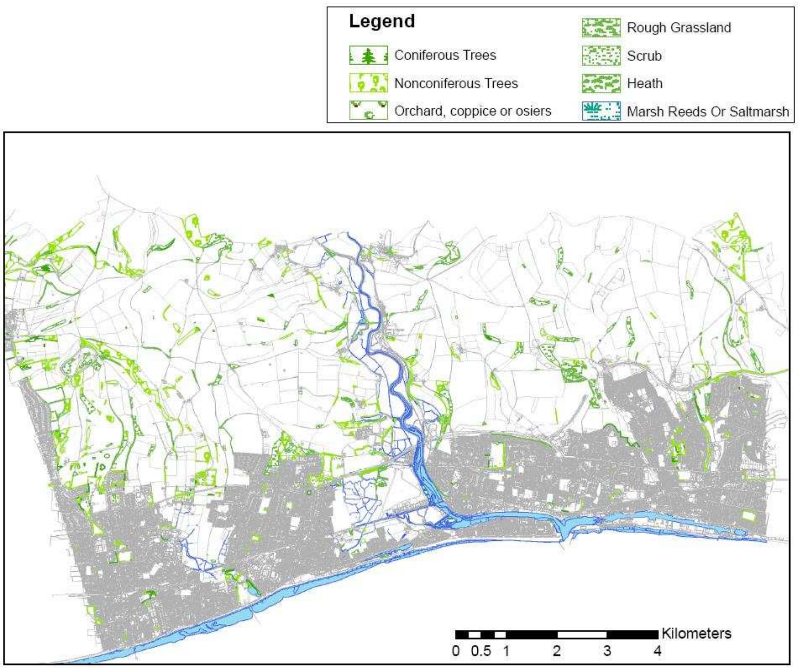


Figure 62, Map of woodland within the Adur District

Despite the scarcity of woodland within the Adur district, the more densely wooded areas to the North are well within range of Shoreham for transport of timber by road (timber can comfortably be transported 30 miles and possibly up to 50 miles, without adding to the carbon content of the woodfuel to an unacceptable level)[22].

The area of woodland within the counties of East and West Sussex are shown in the table below. The woodland is classified by ownership type.

	Area (ha)		
Ownership type	**W. Sussex**	**E. Sussex**	**Total**
Personal	20,888	19,526	**40,414**
Business	5,872	2,342	**8,214**
Forestry or timber business	0	0	**0**
Charity	4,507	1,910	**6,417**
Local Authority	1,052	1,691	**2,743**
Other public (not FC)	209	28	**237**
Forestry Commission (FC)	3,789	2,643	**6,432**
Community ownership or common land	0	659	**659**
Unidentified	272	0	**272**
Total	**36,589**	**28,799**	**65,388**

Figure 63, Woodland area in East and West Sussex by ownership type (taken from the National Inventory of Woodland and Trees, 2002)

It is uncertain how much of this woodland is currently under active management and how much is currently unmanaged (apart from assumptions regarding the Forestry Commission land, which can be assumed to be in management). However, at the time that this data was compiled (2002), none of the woodland was owned by forestry and timber businesses.

Woodland that is not currently managed will produce a high yield when it is initially thinned (i.e. when first actively managed), of up to 50 m^3/ha (for broadleaved woods). However, this level of yield is only available in the initial thinning cycle and is not sustainable. The annual growth increment (i.e. new growth) of broadleaved species, which dominate in the East and West Sussex woodlands, is around 4 m^3/ha/yr. However, not all of this is available for further thinning. A sustainable annual yield of 2 m^3/ha/yr is a reasonable approximation.

Based on a conservative assumption that around 50% of the non Forestry Commission woodland is under management and that a tenth of the unmanaged woodland is thinned each year during the initial thinning cycle, yield estimates have been made for woodfuel extraction from East and West Sussex woodlands over an initial 10 year period, tabulated below. The capacity of biomass-fuelled CHP systems that this annual woodfuel resource could support has also been calculated, based on some assumption

[22] Note that calculations of CO_2 emissions from biomass-fuelled systems throughout this report assume a CO_2 intensity of biomass of 0.025 kgCO2/kWh (taken from Defra's published figures).

on system run hours (6,000 full load hours per year) and efficiency (22% electrical efficiency for steam-cycle biomass CHP).

	Annual yield		Energy content	Capacity of biomass CHP *
	green m3	*Tonnes (30% moisture)*	*MWh/yr*	*MWe*
East Sussex	75,931	58,847	194,194	7.1
West Sussex	96,502	74,789	246,803	9.0
Total	**172,433**	**133,635**	**440,997**	**16.1**

Figure 64, Estimated annual yield of woodfuel from E. and W. Sussex woodland over a 10 year thinning cycle (based on assumption of percentage of woodland currently in management) and the capacity of biomass CHP that the resource could support.

The combined woodfuel resource from forestry in the counties of East and West Sussex has been estimated to be sufficient to support 16 MWe of biomass CHP capacity. On this basis, the proposal to install a 3.5 MWe system at Shoreham harbor would be a very significant load. Although Shoreham Harbour system would be likely to be the major potential biomass consumer in the Adur District, competition for this resource would be expected from biomass projects in neighbouring areas. However, despite this apparent resource constraint, it is known that there is a substantial further resource within the South-East, for example in Surrey.

5.3 Tidal and wave power

Tidal stream technologies:

Tidal Stream is a hitherto unexploited form of renewable energy that lies in moving bodies of oceanic and estuarial waters. Energy can be derived from the kinetic energy of ocean currents via a variety of technology types, most of which are currently at a pre-commercial stage of development. Tidal stream energy converters extract and convert the mechanical energy of the moving current into electricity using a rotor and gearbox (similar to a wind turbine).

Figure 65 – tidal stream electricity generators (operate in a similar fashion to wind turbines)

Cost-effective power generation using tidal stream technology requires:

1. A mean spring peak current velocity exceeding about 2.5m/s (5 knots)

2. A depth of water of >30m

Much effort has been put into tidal stream resource studies and the identification of sites meeting the criteria outlined above. UK centric studies include those completed by Black and Veatch[23] and BERR. These studies have identified the existence of an enormous worldwide resource, around 55,000 MW of installed capacity; of this resource, around 15% is located in and around UK waters. The UK is therefore in a unique position with regard to developing tidal stream energy technologies.

The analysis contained within existing published literature provides a useful picture of the tidal streams around the UK, based on extensive oceanographic modeling and in-situ tide gauge measurements. The figure below, taken from the BERR marine atlas data[24], shows the predicted mean spring peak current velocities around the UK:

[23] Phase II: UK tidal stream UK energy resource assessment – Black and Veatch
http://www.carbontrust.co.uk/NR/rdonlyres/19E09EBC-5A44-4032-80BB-C6AFDAD4DC73/0/TidalStreamResourceandTechnologySummaryReport.pdf
[24] Atlas of UK Marine Renewable Energy Resources
http://www.renewables-atlas.info/

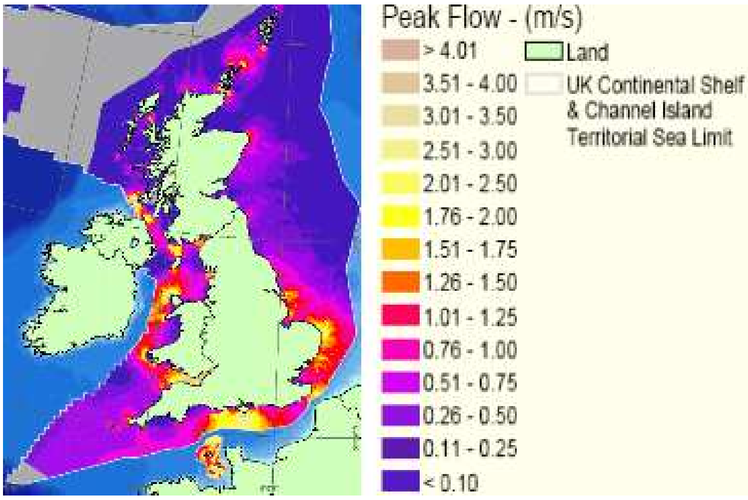


Figure 66 – Predicted mean spring peak current velocities in UK waters

Large mean spring peak current velocities are observed along the Scottish coast, near the Isle of Wight and at various other locations around the UK. Velocities in the vicinity of the Adur District are low and inappropriate for tidal stream technologies.

Potentially suitable UK tidal sites are onlined in the map below:

Figure 67 – potential sites for cost effective operation of tidal stream technologies in and around UK waters.

Potential UK sites for cost effective tidal stream installations are concentrated along the Scottish coast, however suitable south coast sites were identified near the Isle of Wight and along the Kent coast. These potential sites tally well with the high mean spring peak current velocity locations identified in Figure 66.

The poor tidal velocities and low seadepths which characterize the Adur District coast mean that no suitable sites for tidal stream installations were identified in the vicinity of the district.

Wave technologies:

Several methods can be used to extract energy from waves. The most common method uses the undulating motion of passing waves to drive a turbine and generate electricity.

The system works like a swimming pool wave machine operating in reverse. At a swimming pool, air is blown in and out of a chamber beside the pool, which makes the water outside bob up and down, causing waves.

At a wave power station, the waves arriving cause the water in the chamber to rise and fall, which means that air is forced in and out of the hole in the top of the chamber. If a turbine is placed in this hole, displaced air drives the turbine, turns a generator and produces electricity.

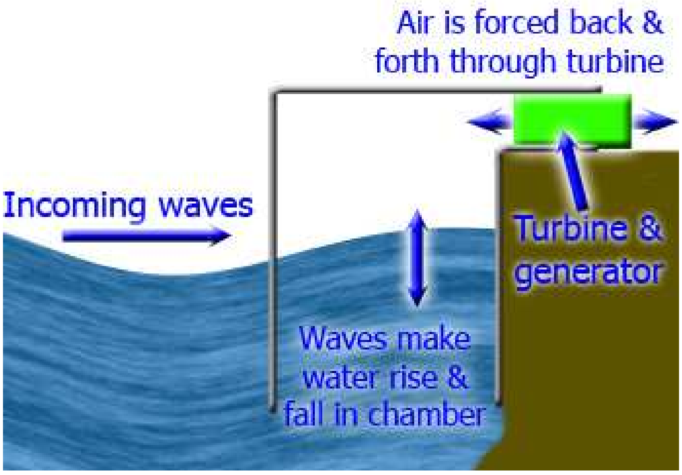


Figure 68 – Operation of a wave power generation unit

Successful and cost effective operation of wave electricty generation technologies requires consistent wave passage and high mean wave heights.

The BERR Atlas of UK Marine Renewable Energy Resources can be used to identify regions of high mean wave height in and around UK waters. The figure below – presented in the Environmental Sustainability Options for Shoreham Redevelopment Project[25] - indicates that mean wave heights and powers along the Adur coastline are amongst the lowest around the UK:

[25] Environmental Sustainability Options forShoreham Redevelopment Project – James Robinson SEEDA

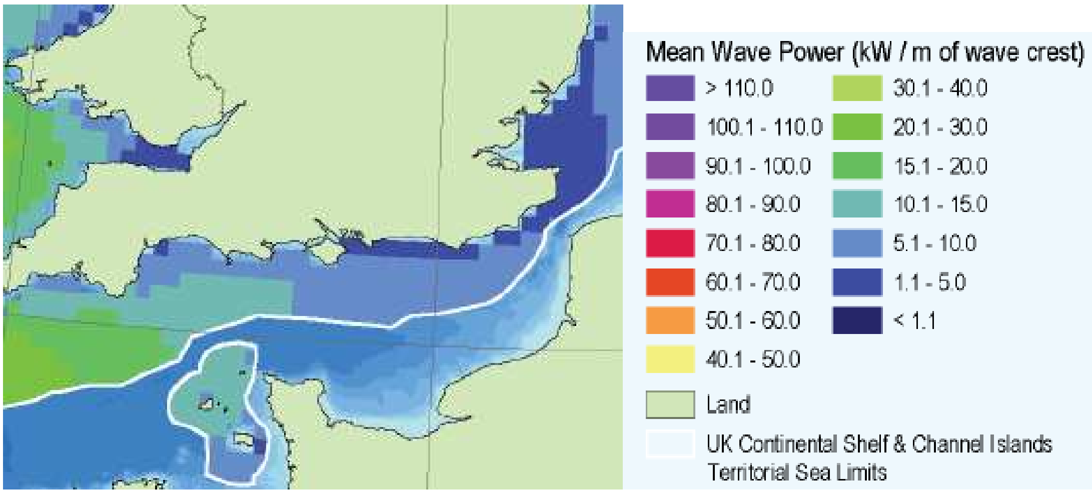


Figure 69, Mean wave power around the south coast (Source: Atlas of marine renewable energy resource, BERR, 2008)

Due to the poor wave resource, wave electricity generation technologies are not likely to be feasible or cost effective along the Adur District coast line.

KEY CONCLUSIONS

- The onshore wind resource in Adur is relatively good, however the opportunity for installation of large-scale onshore wind turbines is restricted by the land designations – the areas of highest windspeed are within the Sussex Downs AONB, where planning permissions for large turbines will be difficult to achieve – and air traffic restriction zones (due to Shoreham Airport and a flight corridor to Gatwick).
- Potential offshore wind sites have been identified in the Channel, just off the coast near Brighton. A mechanism whereby developers within Adur (including those involved in Shoreham Harbour) invest in offshore wind to offset the CO_2 emissions resulting from developments could be envisaged. However, the offshore wind plans are at an early stage and, if executed, are likely to involve large utilities and energy companies. The mechanism for investment from developers would need to be developed.
- The woodfuel resource within East and West Sussex (potential catchment area of Shoreham Harbour and other developments within Adur) is estimated to be sufficient to support biomass CHP plant of combined capacity of around 16 MWe (based on an estimate of sustainable harvesting of local forestry). Development of a substantial market for woodfuel is well-aligned with the Forestry Commission's objectives to develop a large woodfuel supply chain in the South-East.
- Due to the extremely poor tide and wave resource in the vicinity of the Adur coastline, tidal stream and wave powered energy generation schemes are not considered to be suitable in the region

6 ADUR PLANNING ADVICE

6.1 Planned developments and load growth

The wider Adur District is set in the largely rural area of West Sussex. The district covers some 41.5km^2 and incorporates the settlements of Shoreham by Sea, Lancing, Southwick, Sompting and Coombes. The district has an important role as a centre of economic activity and as a transport hub linking the city of Brighton and Hove to the east and the borough of Worthing to the west[26].

The Adur District must address several key concerns in the near future. The district is the most deprived in West Sussex. The average household size in the district is decreasing, whilst the South East Plan has set targets of 2,100 dwellings for the district up to 2026. Development pressures for more compact, affordable housing, and development of major local employment sites are therefore primary concerns for the local council.

A large proportion of the new build development planned in the Adur District will occur at Shoreham Harbour. However, smaller scale development will occur throughout the wider Adur District at identified residential, non-domestic and mixed use strategic development sites which are being investigated through the Core Strategy.

The following table summarises the currently available data on build form and phasing for potential strategic housing development sites identified in the wider Adur District (taken from the SHLAA / Draft Core Strategy):

Domestic developments	Number of dwellings	Dwelling mix assumptions	Programme
Mash Barn	450 - 550	Mix of flats & 2 - 4 bed houses	2013 - 2018
Old Salt's Farm	225-525	Mix of flats & 2 - 4 bed houses	post-2018
Sompting Fringe	30-335	Mix of flats & 2 - 4 bed houses	post-2018
Shoreham Town Centre	320	Largely flats with some townhouses	2013 - 2018
Sites in existing settlements	870	Mix of flats and townhouses	2008 - 2016

Figure 70 – Best estimate build form and phasing data for the residential strategic sites identified in the wider Adur district

The following table summarises the major commercial sites considered through the Core Strategy outside of the Shoreham Harbour Regeneration area, based on information provided by Adur District Planning Policy team.

Non-domestic developments	Non-domestic floor area	Floor area mix assumptions	Programme
Shoreham Airport	37,950 – 49,650 m^2	Office, light industrial and warehousing	2013-2016
Shoreham cement works	45,000m^2	Employment uses (industrial). Potential for energy from waste.	Post 2016
Eastbrook Allotments	15,000m^2	Offices	2013-2016
EWAR	30,000m^2	Offices	Post 2016
Mash Barn	23,875-39,175 m^2	Retail, office & community uses	2013-2018

Figure 71 - Best estimate build form and phasing data for the non-domestic strategic sites identified in the wider Adur district

The development of these strategic sites will result in significant growth in local energy demand and associated CO_2 emissions. The annual CO_2 emissions from the strategic sites are shown on the graphs below. The plots assume that the developments are built to current standards, i.e. to Part L 2006. Separate plots are shown for the residential and non-domestic developments:

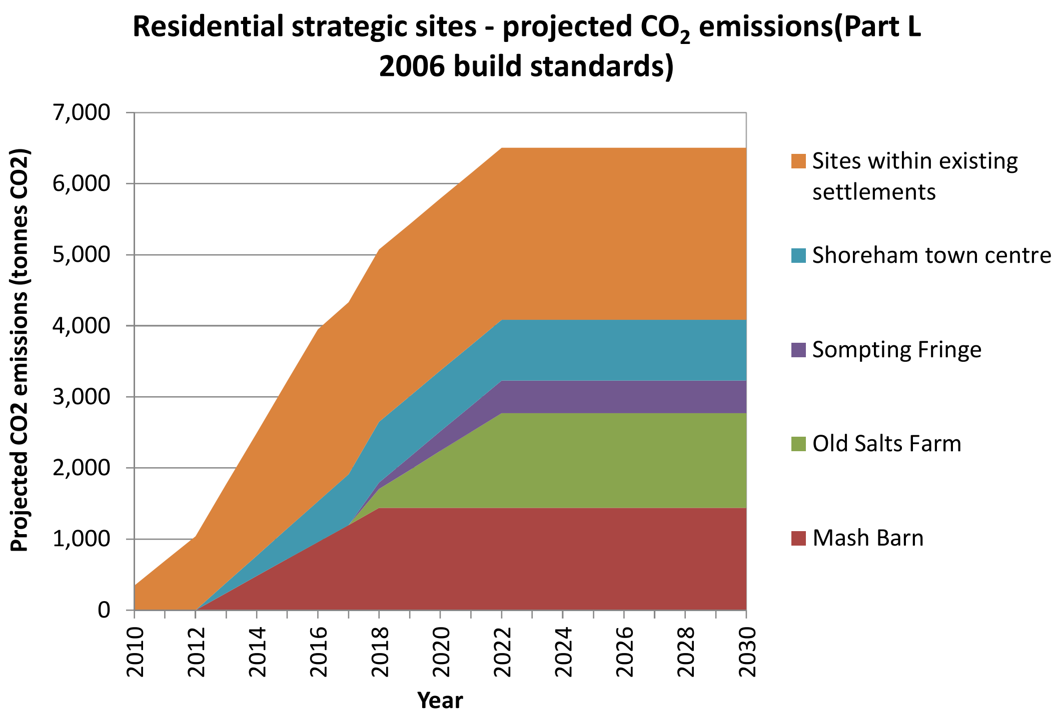


Figure 72 – Projected annual CO_2 emissions from the proposed residential strategic sites (contribution of each site to the cumulative total annual CO_2 emissions is shown).

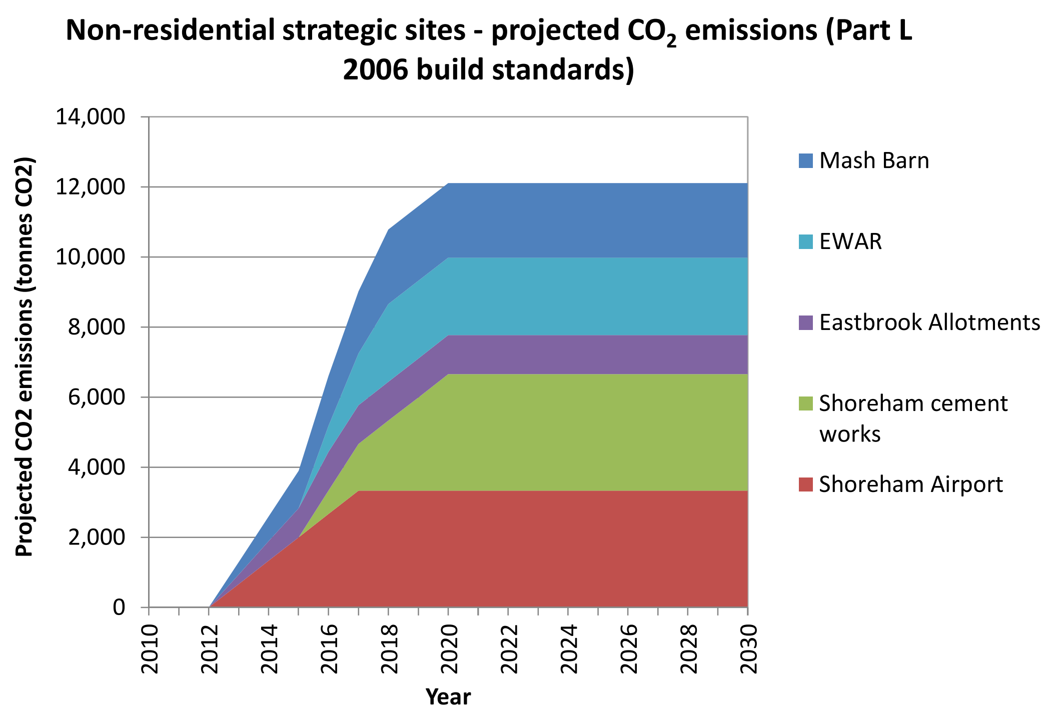


Figure 73 - Projected annual CO_2 emissions from the proposed non-domestic strategic sites (contribution of each site to the cumulative total annual CO_2 emissions is shown).

Annual CO_2 emissions from the potential strategic sites - post 2018 (proposed end date of construction) – would be expected to exceed 16,000 tonnes a year, if constructed to Part L 2006 standards.

Tightening of CO_2 emissions standards through revisions to Part L of the building regulations over the coming decade (in line with the energy and CO_2 targets set out in the Code for Sustainable Homes and Code for Sustainable Buildings) will demand significant CO_2 emissions reductions. The graph below shows the altered CO_2 emissions projection if the CO_2 emissions standards that are likely to be introduced through Part L of the Building Regulations are met (developments are considered to be constructed to the standard in force at the time of beginning on site). Note that as Sompting Fringe and Old Salt's Farm are expected to fall within the Zero Carbon Homes policy, the net CO_2 emissions impact of these sites is zero.

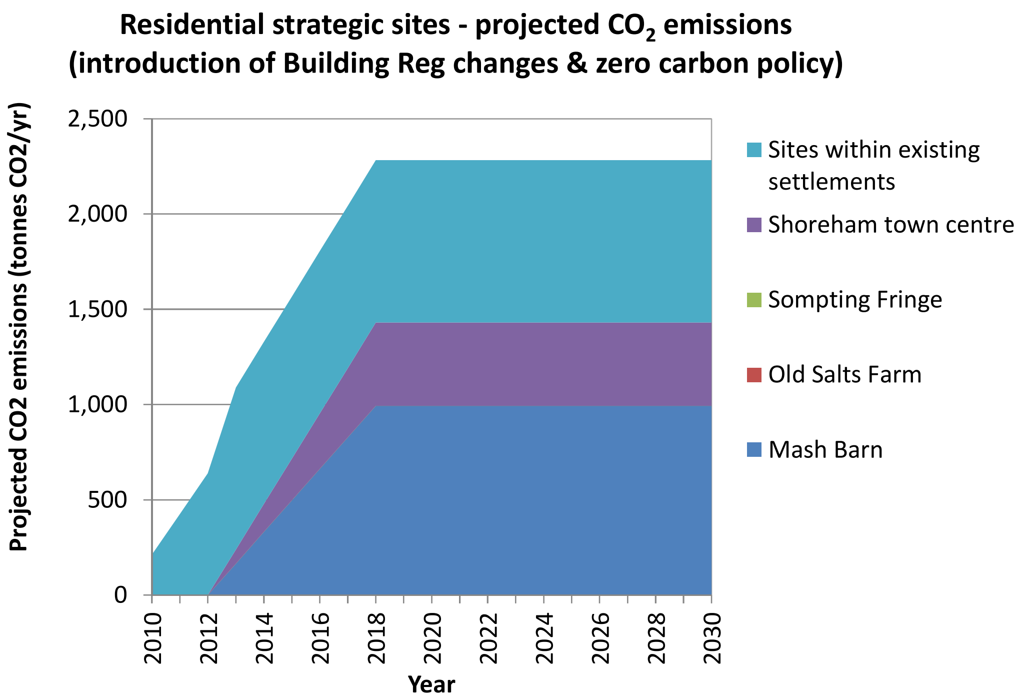


Figure 74 – Projected annual CO_2 emissions of the residential strategic sites if anticipated Building Regulation CO_2 standards are met (contribution of each site to the cumulative total annual CO_2 emissions is shown).

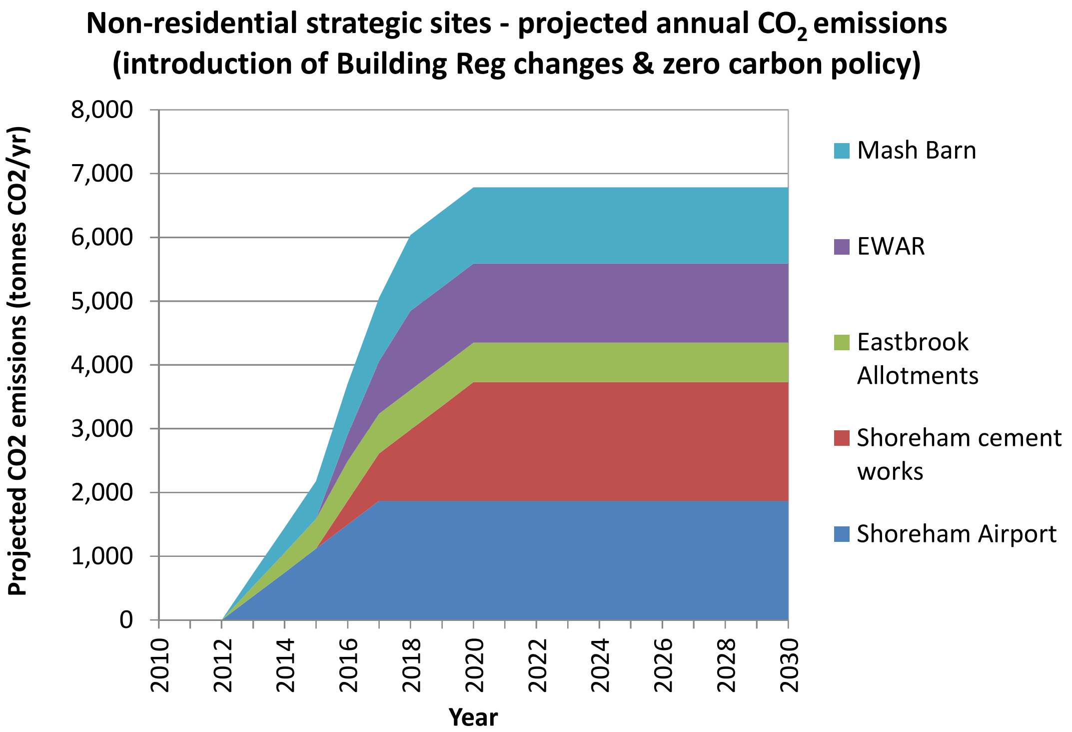


Figure 75 - Projected annual CO_2 emissions of the non-domestic strategic sites, based on assumptions on the tightening of Building Regulations with respect to non-domestic buildings

The reduction in annual CO_2 emissions from the strategic sites that changes to the Building Regulations and the introduction of zero carbon policy are expected to deliver (compared to building to Part L2006 construction standards) is summarized in the table below:

	Construction standard	
2020 annual emissions (tonnesCO_2/yr)	Part L2006	Building Reg & zero carbon policy
Residential developments		
Mash Barn	1450	994
Old Salts Farm	800	0
Sompting Fringe	275	0
Shoreham town centre	850	437
Sites within existing settlements	2,425	851
Non-resi dev elopments		
Shoreham Airport	3,335	1,868
Shoreham cement works	3,325	1,863
Eastbrook Allotments	1,100	621
EWAR	2,220	1,242
Mash Barn	2,130	1,192
TOTAL	**16,460**	**9,067**

Figure 76, Summary of the change in net CO_2 emissions from the strategic sites that changes to the Building Regulations and Zero Carbon policy are expected to require, compared to Part L2006 standards.

Overall, construction of the developments in line with the anticipated regulatory standards will deliver approximately a 45% reduction in CO_2 emissions (across residential and non-residential developments) compared to construction to Part L2006 standards.

6.2 Low carbon energy strategies

In order to achieve (and where possible exceed) the low carbon reduction standards required by tightening legislation on new build developments in Adur, local government policy must support and incentivize technically and economically viable low carbon technologies and strategies. To inform this policy formulation, an assessment has been performed to identify potentially appropriate energy solutions for the types of developments that are likely to be built in Adur.

The strategic sites identified in the previous section give an indication of the build form of developments that are likely to occur in the wider Adur District. Based on these developments, a number of generic development types have been developed that are thought to reflect the type of development likely in the Adur region. Note that the 'Large Urban' development type is representative of the type of development planned for the Shoreham Harbour Regeneration – large-scale, high density, predominantly flatted. This is included for comparison, although it is not expected that developments of this type will be replicated elsewhere in Adur.

Development Scenario	Scale	Density (dph)	Dwellling mix	Example development
Brownfield				
City Infill	10 - 50	> 100	80% flats	Sites within existing settlements
Small brownfield	10 - 50	80	40% flats	
Large urban	1000 - 5000	> 100	80% flats	Shoreham Harbour
Greenfield				
Small greenfield	10 - 50	40 - 50	20% flats	
Medium edge of town	500	40 - 50	20% flats	Mash Barn

Figure 77 –Development types which represent the likely build form of future developments in the Adur district

Having identified the representative development types, the costs of achieving various CO_2 reduction standards via a comprehensive range of low carbon energy strategies were assessed, in order to identify the most cost-effective low carbon solutions for different development types.

The graphs shown in Figure 78 present the capital costs of achieving the CO_2 standards required by various levels of the Code for Sustainable Homes and expected to be mandated through building regs for the representative build types defined above (note CO_2 reduction is shown in red and are relative to the Part L 2006 baseline).

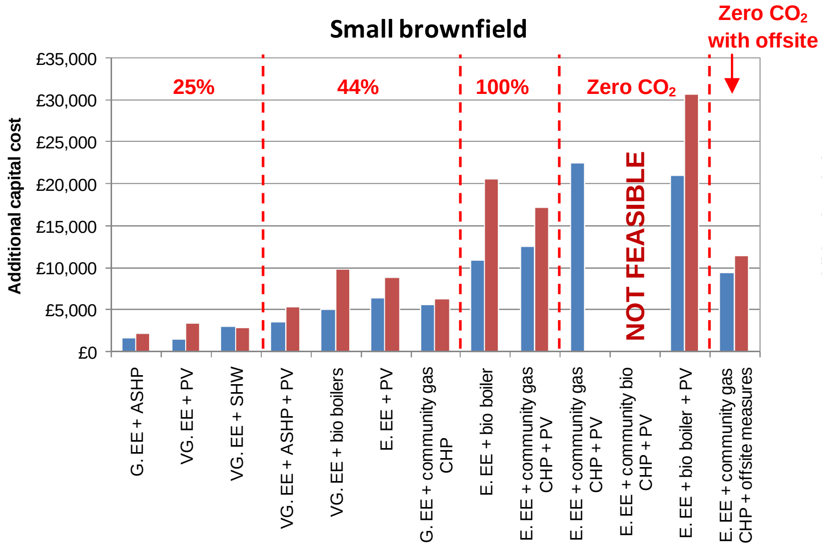
The analysis carried out supports several clear conclusions:

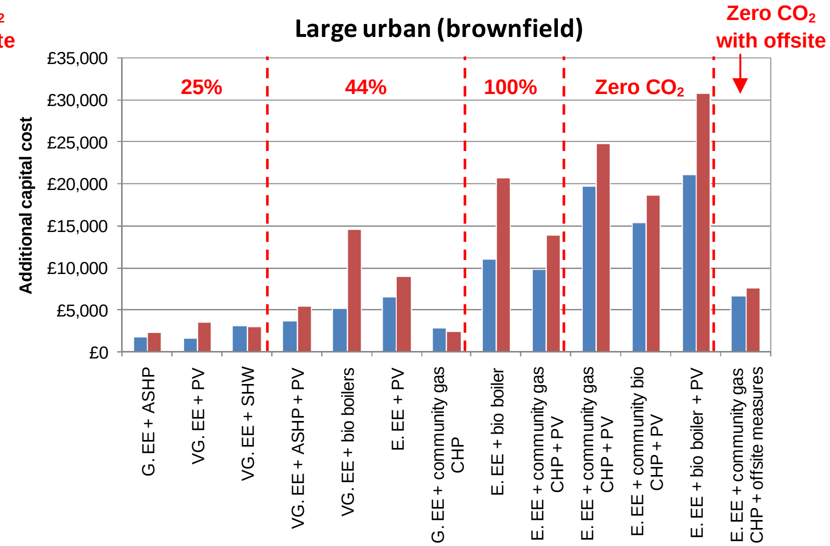
1. Due to the small scale of the representative development types, site wide biomass fired CHP systems are not likely to be viable for the majority of the sites in Adur. Such systems are only technically viable on large scale sites with significant heating demands (the smallest technically proven biomass fired CHP engines have an electrical output of in excess of 3MWe). The Shoreham Harbour development site may represent an opportunity for a large scale biomass CHP system (see Section 4.2.1), however development on this scale is highly unlikely to be replicated elsewhere in the Adur District.

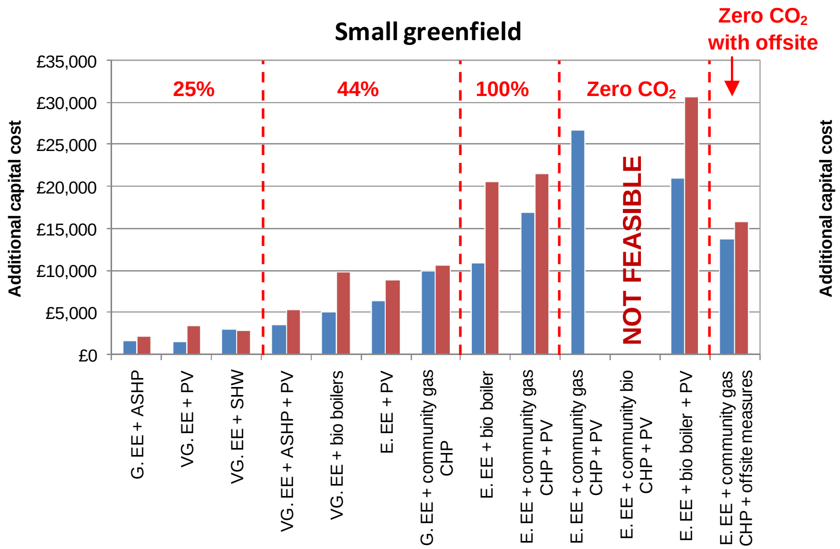
2. For all development types, achieving higher CO_2 reduction standards requires higher capital expenditure. Typically, achieving a 25% reduction in CO_2 emissions (Part L standard from 2010 and the requirement of Code Level 3 of the CSH) incurs an on-cost of around £ 2,000 to £ 4,000 per dwelling. To achieve a 44% reduction (Part L from 2013 and a requirement of Code Level 4) in most dwelling and development type combinations incurs an additional cost of in excess of £ 5,000 per dwelling. A notable exception to this is in the case of the Large Urban development type, where a target reduction of 44% can be achieved via a 'Very Good' level of energy efficiency and site-wide gas-fired CHP system for an on-cost of around £ 3,000 per dwelling (this low cost is contingent on a very high density, flatted development). This cost is comparable to the costs incurred to achieve the 25% CO_2 reduction level by measures implemented at individual dwelling scale. The Large Urban development type is representative of the Shoreham Harbour development, but is not likely to be replicated elsewhere in the Adur District.

This conclusion suggests that developers should be required to assess the technical and economic viability of site wide CHP/DH systems on all appropriate development sites (see policy recommendations below). Such systems could provide the most cost effective CO_2 savings on large high density sites – particularly on phased sites where later development parcels may be required to achieve higher carbon reduction standards.

3. At the 25% and 44% CO_2 reduction levels, the additional capital costs of low carbon energy strategies which utilize building integrated energy efficiency and microgeneration technologies (e.g. energy efficiency and PV) are economically competitive with those of site wide energy systems (e.g. community natural gas CHP) on the kinds of sites that are most likely to dominate development in the wider Adur district (i.e. small-scale and modest density).


Small brownfield
Zero CO_2 with offsite
Additional capital cost
£35,000
£30,000
£25,000
£20,000
£15,000
£10,000
£5,000
£0
25%
44%
100%
Zero CO_2
NOT FEASIBLE
G. EE + ASHP
VG. EE + PV
VG. EE + SHW
VG. EE + ASHP + PV
VG. EE + bio boilers
E. EE + PV
G. EE + community gas CHP
E. EE + bio boiler
E. EE + community gas CHP + PV
E. EE + community gas CHP + PV
E. EE + community bio CHP + PV
E. EE + bio boiler + PV
E. EE + community gas CHP + offsite measures


Large urban (brownfield)
Zero CO_2 with offsite
Additional capital cost
£35,000
£30,000
£25,000
£20,000
£15,000
£10,000
£5,000
£0
25%
44%
100%
Zero CO_2
G. EE + ASHP
VG. EE + PV
VG. EE + SHW
VG. EE + ASHP + PV
VG. EE + bio boilers
E. EE + PV
G. EE + community gas CHP
E. EE + bio boiler
E. EE + community gas CHP + PV
E. EE + community gas CHP + PV
E. EE + community bio CHP + PV
E. EE + bio boiler + PV
E. EE + community gas CHP + offsite measures


Small greenfield
Zero CO_2 with offsite
Additional capital cost
£35,000
£30,000
£25,000
£20,000
£15,000
£10,000
£5,000
£0
25%
44%
100%
Zero CO_2
NOT FEASIBLE
G. EE + ASHP
VG. EE + PV
VG. EE + SHW
VG. EE + ASHP + PV
VG. EE + bio boilers
E. EE + PV
G. EE + community gas CHP
E. EE + bio boiler
E. EE + community gas CHP + PV
E. EE + community gas CHP + PV
E. EE + community bio CHP + PV
E. EE + bio boiler + PV
E. EE + community gas CHP + offsite measures

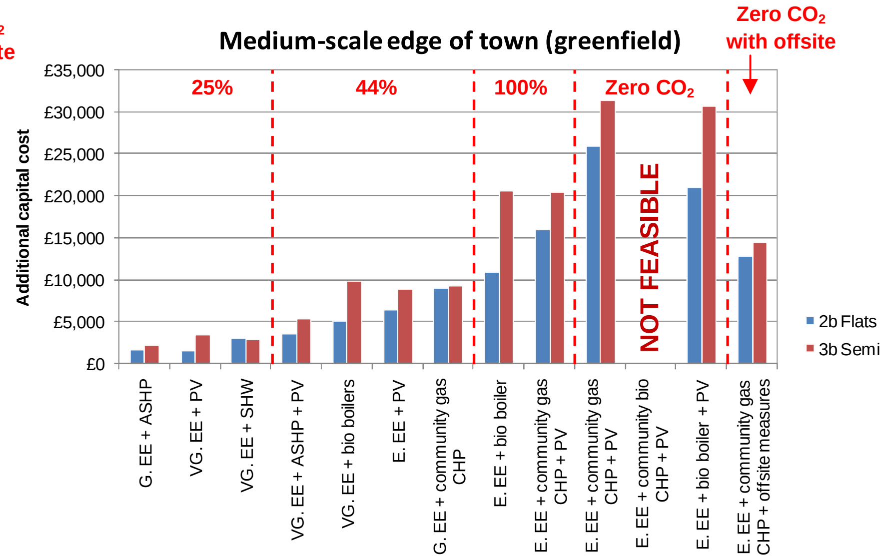

Medium-scale edge of town (greenfield)
Zero CO_2 with offsite
Additional capital cost
£35,000
£30,000
£25,000
£20,000
£15,000
£10,000
£5,000
£0
25%
44%
100%
Zero CO_2
NOT FEASIBLE
G. EE + ASHP
VG. EE + PV
VG. EE + SHW
VG. EE + ASHP + PV
VG. EE + bio boilers
E. EE + PV
G. EE + community gas CHP
E. EE + bio boiler
E. EE + community gas CHP + PV
E. EE + community gas CHP + PV
E. EE + community bio CHP + PV
E. EE + bio boiler + PV
E. EE + community gas CHP + offsite measures
2b Flats
3b Semi

Figure 78 – Capital cost of achieving varying CSH energy and CO_2 standards for a range of representative development types (Key to abbreviations: G – Good, VG – Very Good, E – Excellent, EE – Energy Efficiency package)

4. To achieve the higher CO_2 reduction standards associated with the higher levels of the Code for Sustainable Homes, low carbon energy strategies which rely on building integrated technologies become significantly more expensive than site wide low carbon systems (where viable). This becomes the case on a wider range of development types, e.g. site-wide systems become cost-effective even on fairly low density sites, due to the escalating costs of increasing levels of CO_2 reduction by individual dwelling measures.

5. Attainment of the zero carbon standard through onsite measures, which is required to achieve level 6 of the Code, requires very significant capital expenditure. This expenditure is likely to exceed £20,000 per dwelling if site-wide CHP systems are not technically viable.

   This capital expenditure can be significantly reduced if a range of offsite low carbon measures are allowed to contribute towards reducing the CO_2 emissions credited to a site. This has been recognized by policy-makers and is reflected in the recent government consultation on zero carbon homes, which introduced the concept of 'Allowable Solutions' to deal with a portion of a site's emissions. Under the zero carbon definition, it will be necessary for a 70% reduction of regulated emissions to be achieved using onsite low carbon technologies or connection to low carbon heat (i.e. to a district heat network), however thereafter the developer will be allowed to utilize a range of "allowable solutions", which may include offsite measures, to mitigate the remaining CO_2 emissions.

   The exact nature of these allowable solutions is under consideration, but could potentially include (but are not be limited to):

   - Contributing to a low carbon "buy-out" fund.

     This fund would be used to finance low carbon scheme elsewhere in the local area e.g. installing energy efficiency measures in leaky existing properties

   - Developing standalone offsite renewable technology projects

     e.g. MW scale wind turbines - these projects could be sited at technically viable offsite locations and contribute towards offsetting residual onsite emissions directly etc

   - Investment in community heating infrastructure – e.g. providing low cost finance to de-risk private sector investment in community heating projects.

Access to a range of low carbon offsite "allowable solutions" not only reduces the cost of compliance with the zero carbon standard significantly (and would also reduce the cost of achieving the highest CSH code levels if the Code's definition of zero carbon were to be brought into line with the Building Regulations), but could also result in increased and overall more cost effective CO_2 saving in the Adur District.

6.3 Adur district heating opportunities

The heat demands of the existing Adur District building stock were calculated based upon estimated floor areas and benchmark values of energy usage in domestic and non-domestic buildings.[27]. These estimates were compared with lower resolution data from BERR on actual local annual energy consumption[28]. The heat demand data was combined with GIS mapping of the local building stock to create heat density maps. These maps have been used to assess the potential for heat networks within Adur.

6.3.1 Extension of a district heating system from Shoreham Harbour

The scale and density of developments within Shoreham Harbour, combined with the aspiration to create a low carbon exemplar has led to a recommendation that a district heating system forms a central part of the Shoreham Harbour energy system. Heat density maps have been used to assess the potential for this heating system to be extended beyond the Shoreham Harbour, potentially to serve existing neighbouring developments.

The figures presented below highlight hotspots in heating demand in the existing building stock in the vicinity of the Shoreham Harbour Joint Area Action Plan Area (shown in red outline):

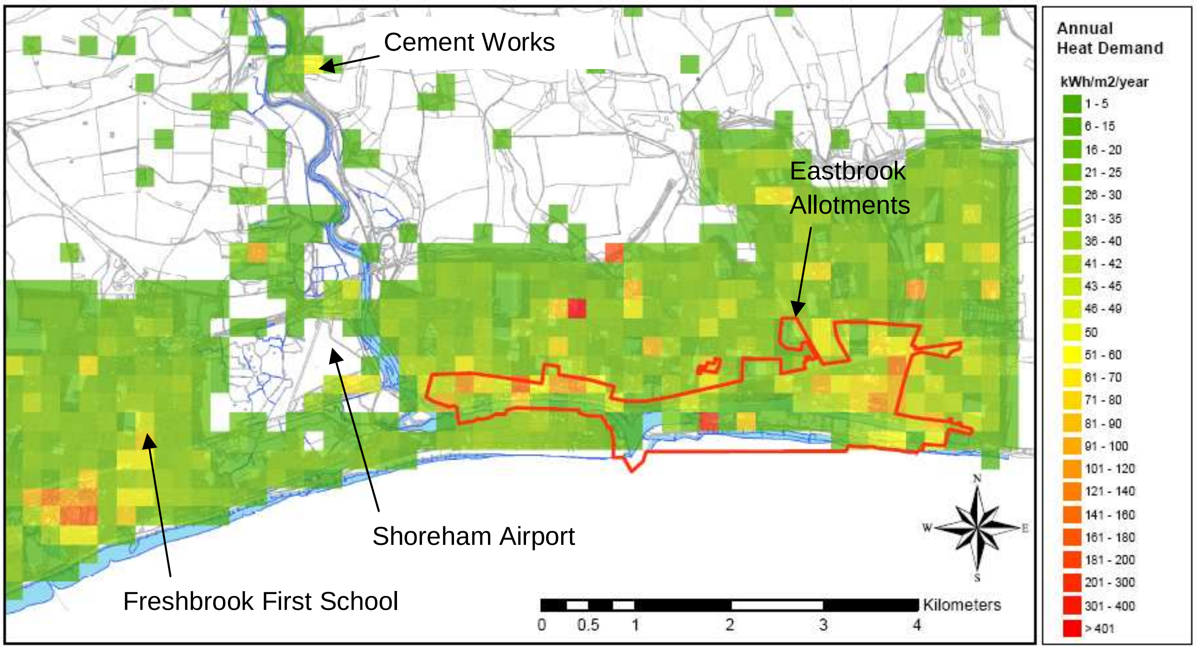


Figure 79 – heat demand density map of the Adur district. The Shoreham Harbour Area is highlighted with a red outline. A number of other strategic sites within Adur area also marked.

[27] ECON 19
[28] It was noted that maps produced from this data at lower resolution, often missed identifying some high-end heat consumers due to smearing of demand over a much greater area

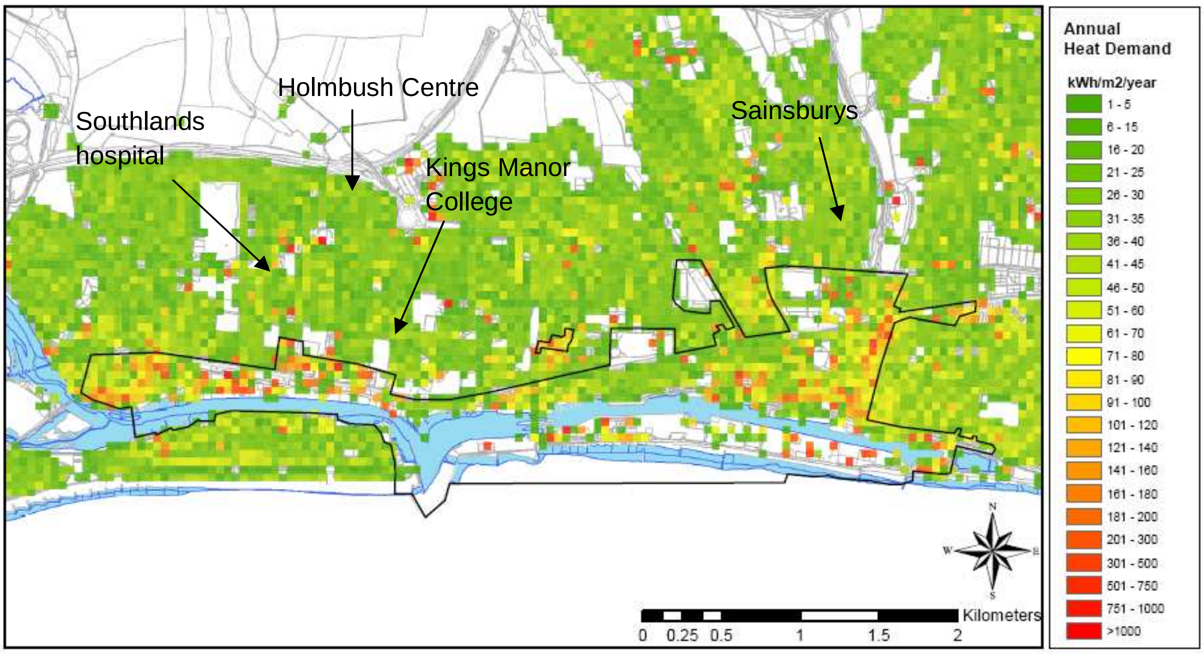


Figure 80 - Heat demand density map of the Adur district and surrounding region. The Shoreham Harbour Area Action Plan area is shown (black outline) and a number of high heat loads in the neighbouring area are shown.

Much of the existing development in close vicinity of the Shoreham Harbour developments is residential in nature and does not generate high heat demands. There are a number of point loads of high heat demand, as follows:

1. Southlands Hospital
2. Shoreham Airport
3. The Holmbush Centre
4. The Sainsbury's shopping centre

With the exception of the airport, these heat loads are relatively remote from the Shoreham Harbour development. The revenue generated from sale of heat to these high loads and to domestic customers along the route is unlikely to justify the capital investment in the additional district heating network. Therefore, although such an extension could deliver significant CO_2 savings to the nearby domestic properties (which may be hard to significantly improve in other ways), it is not likely to improve the economic proposition and would be unlikey to be attractive to a private energy company or ESCO).

An extension of a district heating system from the western end of Shoreham Harbour to the airport may be feasible, particularly given that this would traverse Shoreham Town Centre, with potential new build and retrofit connection opportunities. The railway bridge may provide a route for heat pipes that avoids the added complexity of submerging pipes to connect between Shoreham Harbour and the airport.

6.3.2 Adur strategic sites

Overall, and outside the Shoreham Harbour Action Plan Area, the Adur district is an area of relatively low density, primarily residential development. The existing heat density is accordingly fairly low – the highest areas of domestic demand are to the East of the study area, just west of Portslade, and in Sompting to the East of the District.

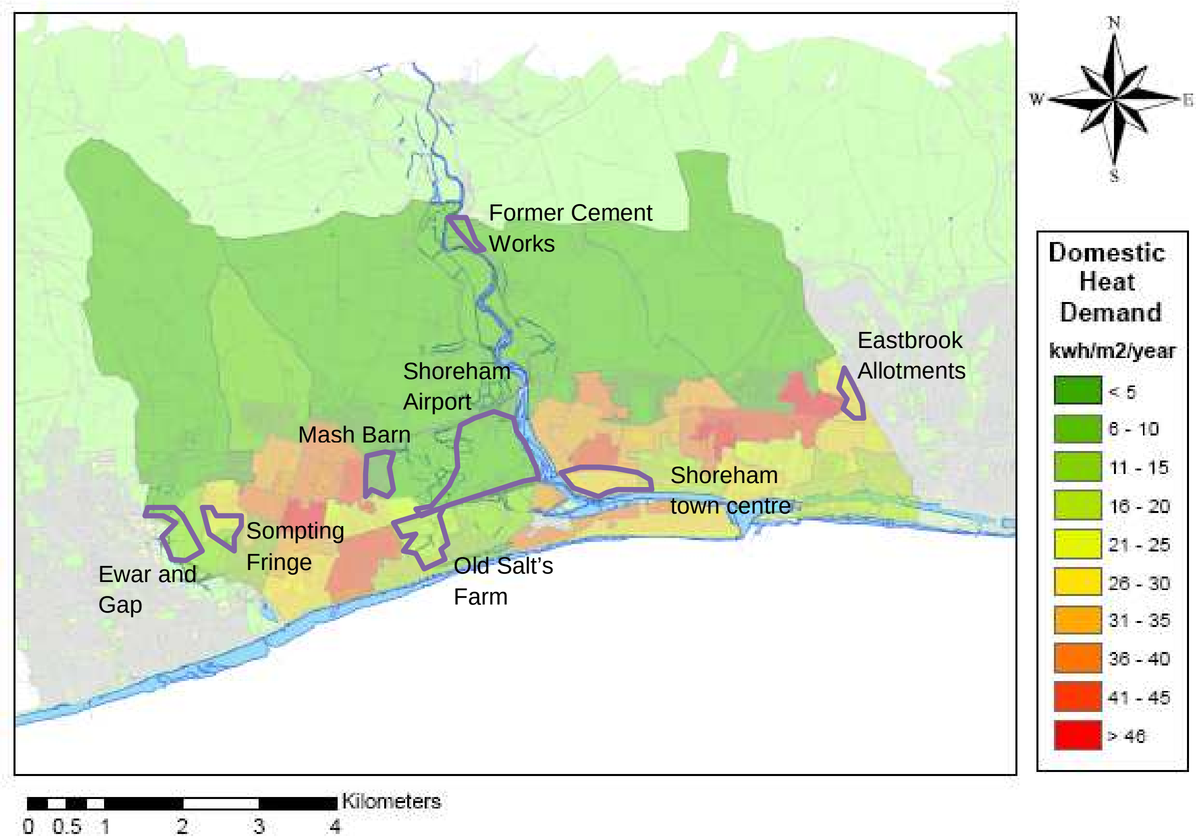


Figure 81, Heat demand map at Adur district level with proposed strategic sites marked

Additional housing in the Adur district over the period to 2026 is expected to be delivered in some of the strategic sites identified through the Core Strategy, including Mash Barn, Old Salt's Farm, Sompting Fringe and Shoreham Town Centre. These residential developments will be required to be built to high levels of energy efficient construction and low heat demand. Considered individually, these sites are unlikely to have the level of heat demand and heat density to make district heating systems an attractive alternative to dwelling scale low carbon generation technologies (see Figure 78 – only on the higher density brownfield sites do community heating systems become more attractive than solutions implemented in the individual dwellings). However, if the developments were located near an existing large heat user, or, if a new development were to be constructed in close proximity that had a high demand for heat, then this conclusion may change.

Potential non-domestic uses being investigated through the Core Strategy (outside of the Shoreham Harbour Action Plan area) include Shoreham Airport, the EWAR site, Eastbrook Allotments, and the Shoreham Cement Works, with potential further commercial development within Mash Barn.

Eastbrook allotments is being considered for the potential development of 15,000 m2 of primarily office use on a 4 ha site. The site is closely located to one of the areas of relatively high domestic demand around Portslade. This development is expected to generate an annual heat load of approximately 2,000 MWh/yr, which across a 4ha site is equivalent to a heat density of 50 kWh/m^2. In a commercial development, where the heat load is concentrated in fewer point loads than is typical in a residential development (fewer points of connection and fewer heat load results in lower network capital costs), this heat density is at the margin of what is required for a site-wide heating system to be attractive. Developers of the Eastbrook Allotment site should therefore be encouraged to consider the possibility of using a site-wide network. However, it is unlikely that the economics of a site-wide system at Eastbrook allotments would be sufficiently attractive to finance the extension of the system into the surrounding residential area, where the cost of retrofitting a heat network would be substantial.

The Mash Barn development may provide a more interesting opportunity. Potential development of approx 550 dwellings is being investigated through the Core Strategy (flats and 2 – 4 bed houses). Given the nature of the area (currently greenfield) and surrounding settlement at Lancing, it is unlikely that the Mash Barn residential development will be built to very high density (current masterplan information suggests a density of around 50 dwellings per hectare). However, there is also the potential for around 25,000 m^2 commercial development at what is a relatively constrained infill site. This commercial development, which could provide an additional heat load of around 3,800 MWh/yr, is expected to significantly increase the heat density in this development. As both the commercial and residential development are to be built on a currently undeveloped site, district heating infrastructure could be installed early in the development process, potentially in conjunction with other ground works, reducing the overall installation costs for the network. The scale of the heat load is insufficient to justify biomass CHP, however gas CHP and biomass heat-only boilers linked to a district heating system should be investigated for this site.

Depending on which strategic development options are progressed through the Core Strategy, a further opportunity may exist for extension of a district heating system established at Mash Barn to be extended to Old Salt's Farm. Old Salt's Farm site is similar in nature to Mash Barn, but is not expected is not expected to be required until post-2018. By this time, the zero carbon homes standard will be enforce, requiring the developers of Old Salt's Farm to achieve high levels of CO_2 saving compared to current standards. The most cost-effective way to achieve a substantial part of the required CO_2 saving would be to connect into a district heating system established at Mash Barn.

It should be noted that the Mash Barn and Old Salt's Farm developments are both located in close proximity to Shoreham airport, where there is potential for business park development. These three developments – Mash Barn, Old Salt's Farm and Shoreham Airport – present a potential opportunity for a common community heating system (this does not rely on all three developments being taken forward, for example opportunities for Mash Barn to be connected to the airport, in the absence of Old Salt's farm, should still be considered). A detailed analysis of the potential of such a system should be undertaken once further details of the planned development are available.

EWAR and Sompting fringe are similar in the respect that they represent a relatively closely located new build commercial and residential development on greenfield land, albeit that Sompting fringe is considerably smaller than the combined opportunity of Mash Barn and Old Salt's Farm. Also, there is no equivalent new build commercial development of the scale of the airport planned nearby. Sompting is relatively close to the Lancing Business Park, which could act as a heat load anchor for a heat distribution system, however for a small greenfield development such as Sompting Fringe, individual dwelling-scale solutions are likely to be a more cost-effective means of meeting the required CO_2 standard (likely to be a 44% improvement on current Part L standards).

6.4 Renewable energy supply targets

In line with the supplement to PPS1, ‘Planning and Climate Change’, :local planning authorities are required to set a target percentage for the level of CO_2 reduction in new development to be achieved through supply of renewable energy. These targets should have regard for the local opportunities and constraints on potential for exploitation of renewable energy and shouldn’t place an undue burden on developers.

In Section 6.2, the capital cost implications of a range of energy strategies were considered. These strategies were devised to meet the various CO_2 reduction targets set out in the Code for Sustainable Homes. Through changes to the Building Regulations in 2010 and 2013 and the introduction of zero carbon policy, these CO_2 reduction standards will progressively be introduced into national regulations. In this section we assess what additional cost implications a local planning requirement for a certain level of CO_2 reduction through renewable energy provision will have on developers in Adur.

The assessment of renewable resource in Adur has shown that the potential is somewhat constrained (see Section 5 for a discussion of constraints around renewable resources). The opportunity for installation of large-scale wind turbines is limited by the exclusion zones around the built environment and the South Downs National Park. Certainly the opportunity for onsite wind turbines at the new development sites is highly constrained. The nature of the proposed developments, which for the most part outside of the Shoreham Harbour Area Action Plan are relatively small and low density, is not suitable for community-scale biomass CHP systems, as there is a lack of commercially available systems at low thermal capacity (this situation may change as new technologies are developed to address the current gap in the market). In the absence of biomass CHP, which delivers the highest CO_2 reduction, there may still be opportunities for biomass heating (i.e. heat-only boilers) at a community-scale (linked to a district heating system).

Since local planning requirements for renewable energy supply in new developments were first introduced by Merton Borough Council, the ‘Merton Rule’, the nature of the policy has evolved. The Merton Rule required developer’s to provide 10% of a development’s energy demand from renewable sources. The South East Plan incorporates a similar policy, NRM11, requiring major developments to deliver a 10% of the site’s energy demand from renewable energy[29]. More recently, local authorities adopting a similar policy have set the requirement in terms of a percentage reduction of a development’s CO_2 emissions, typically either a 10% or, increasingly, a 20% reduction. In the London Plan, the requirement for CO_2 reduction through renewable energy supply is set within a hierarchy of demand

[29] It is noted that recent thinking at regional level suggests a shift from specifying percentages of energy demand from renewables. The South East England Partnership Board guide ‘Climate Change within Local Development Frameworks’ (June 2009) states:

“The strengthening of building regulations, as set out in the Code for Sustainable Homes, will mean that on site renewables will be required to meet carbon compliance standards on new residential developments. Therefore LPAs should specify energy requirements in accordance with the Code rather than specifying a percentage of energy generated to come from renewable and low carbon sources.”

reduction, efficient energy supply and renewable energy provision (the ‘be lean, be clean, be green’ hierarchy). The London Plan approach to ensuring CO_2 reduction at new developments is illustrated in the diagram below:

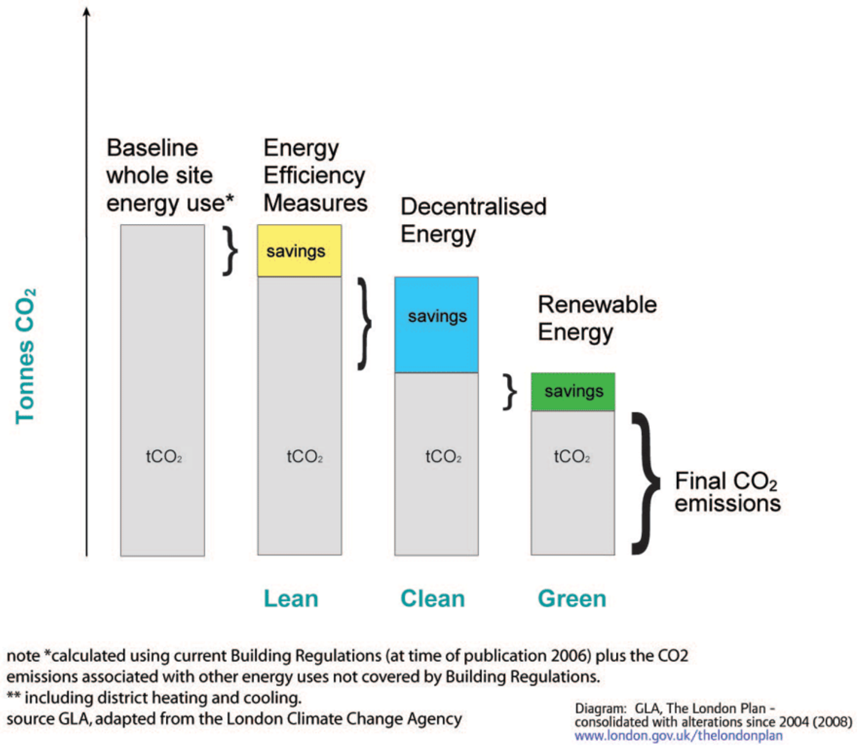


Figure 82, Approach to reduction of a development’s CO_2 emissions as set out in the London Plan, following the ‘Be Lean, be clean, be green’ principle. (Source: The London Plan (Consolidated with alterations since 2004), February 2008).

In the hierarchical approach shown above, the reduction in CO_2 emissions is measured from a baseline of the total emissions of a development (i.e. both the Part L 2006 regulated emissions and the unregulated emissions). The percentage of CO_2 reduction to be delivered by renewable energy is then a reduction from a baseline that includes the effect of energy efficiency measures and any efficient energy supply technologies (such as CHP) that may be adopted. The benefit of this approach is that developers are incentivized to adopt sensible demand reduction measures and are rewarded for installing clean supply technologies with a reduced renewables target. The impact of applying a renewables target using this approach is considered in the following.

From the assessment of energy strategies in Section 6.2, a number of system options can be identified that might be relevant to developments in Adur, depending on the CO_2 reduction levels that need to be met (i.e. through Part L, zero carbon policy, or a commitment to achieve a certain Code for Sustainable Homes standard). These options are as follows:

% CO_2 reduction compared to Part L2006 regulated emissions	Relevant energy system options
25%	Energy efficiency improvement (VG EE) + PV
44%	VG EE + ASHP + PV VG EE + biomass boilers VG EE + Gas CHP/DH + PV
100%	VG EE + biomass boilers + PV VG EE + biomass boilers / DH + PV
Zero carbon standard	VG EE + biomass CHP / DH + PV

These options have been assessed further to understand the cost implications of meeting the anticipated Part L standards in 2010 and 2013 (equivalent Code Level 3 and 4) and also satisfying 10% and 20% CO_2 reduction by renewables targets (assuming that these targets are applied in the hierarchical fashion described above).

The impact of these targets is assessed below in the simple case of the energy efficiency improvement (the Very Good package) and addition of photovoltaics. The assessment has been carried out for the case of the 3-bed semi house type.

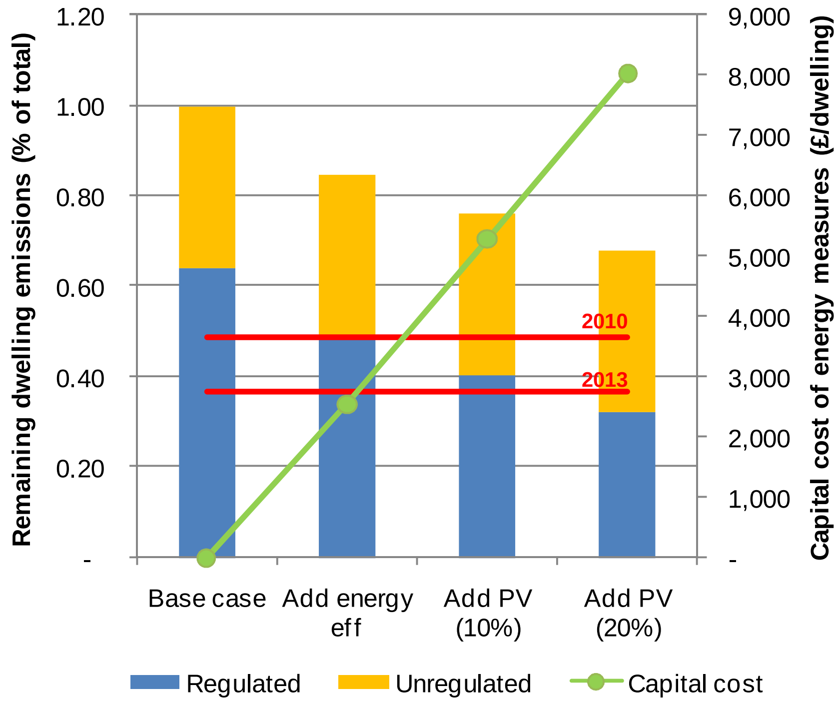


Figure 83, The progressive CO_2 reduction of a 3-bed semi as energy efficiency measures and then photovoltaics are added to the base case dwelling (Part L2006) is shown in the chart. The horizontal red lines indicate the CO_2 reduction standards expected to be introduced through the Part L in 2010 and

2013. Note that Part L relates only to regulated emissions, shown as the blue part of the bars in the chart above. The cumulative extra-over capital cost of the measures is also shown.

In the Figure above, the blue bars represent the regulated CO_2 emissions and the yellow bars the unregulated emissions. Part L is concerned only with the Regulated emissions. The horizontal red lines indicate the CO_2 reduction standards anticipated to be introduced through Part L in 2010 and 2013. When the top of the blue bar drops below these lines, the particular Part L standard has been achieved. The green line indicates the cumulative capital cost associated with the progressive addition of demand reduction or energy generating measures.

In this case, the Very Good energy efficiency package is sufficient to achieve the Part L 2010 standard of a 25% reduction of regulated CO_2 emissions. The additional capital cost compared to the Base Case house is around £2,800 / dwelling.

To also achieve the onsite renewables targets requires a further investment in PV and provides a CO_2 reduction beyond the 2010 Part L standard. Providing a further 10% CO2 reduction through renewables results in an overall CO_2 reduction that is between the Part L 2010 and 2013 requirements and has an additional capital cost associated with it of £2500. Hence, the overall on-cost for a 3-bed semi to meet the 10% onsite renewables target following adoption of energy efficiency measures is around £5,200/dwelling. To meet a 20% onsite renewables target takes the overall on-cost to around £8,000 per dwelling and pushes the CO_2 reduction beyond the requirement of Part L2013.

In the case described above, the implementation of a 10% onsite renewables target would likely result in developers providing an overall CO2 reduction that lies between the Part L2010 and 2013 standards. The implementation of the 20% onsite renewables target would result in developers exceeding the Part L 2013 target, although this energy system option is unlikely to provide the most cost-effective route to this level of improvement.

In Figure 84 below, similar charts are shown for energy systems based on air source heat pumps (ASHP), dwelling-scale biomass boilers, community gas CHP and community biomass heating systems. In each case, the Very Good energy efficiency package is applied to the dwelling, which in the case of the 3-bed semi achieves the Part L2010 standard of emissions reduction.

In the case of the ASHP system, the energy efficiency package and ASHP provides a CO_2 reduction that comfortably exceeds the Part L2010 standard and also provides a 10% reduction of CO_2 through renewables (although electrically powered, the ASHP extracts renewable energy from the surroundings). To achieve a 20% onsite CO_2 reduction through renewable energy systems (RES) requires addition of PV. This also reduces regulated CO_2 emissions to below the standard that will be required by Part L 2013, at an extra-over capital cost of around £6,500/ dwelling. This is the least cost effective method of achieving the Part L 2013 and a 20% CO_2 reduction by onsite RES target of the systems assessed. A system comprising energy efficiency improvement and a dwelling-scale biomass boiler achieves Part L2013 standard and provides a 20% CO_2 reduction through RES, by virtue of the biomass heat. However, the cost of the biomass boiler means this is a relatively expensive solution for the 3-bed semi house type. If this system were applied to a block of flats, where a single centralized boiler supplies all dwellings in the block, it would be a more attractive solution on cost grounds.

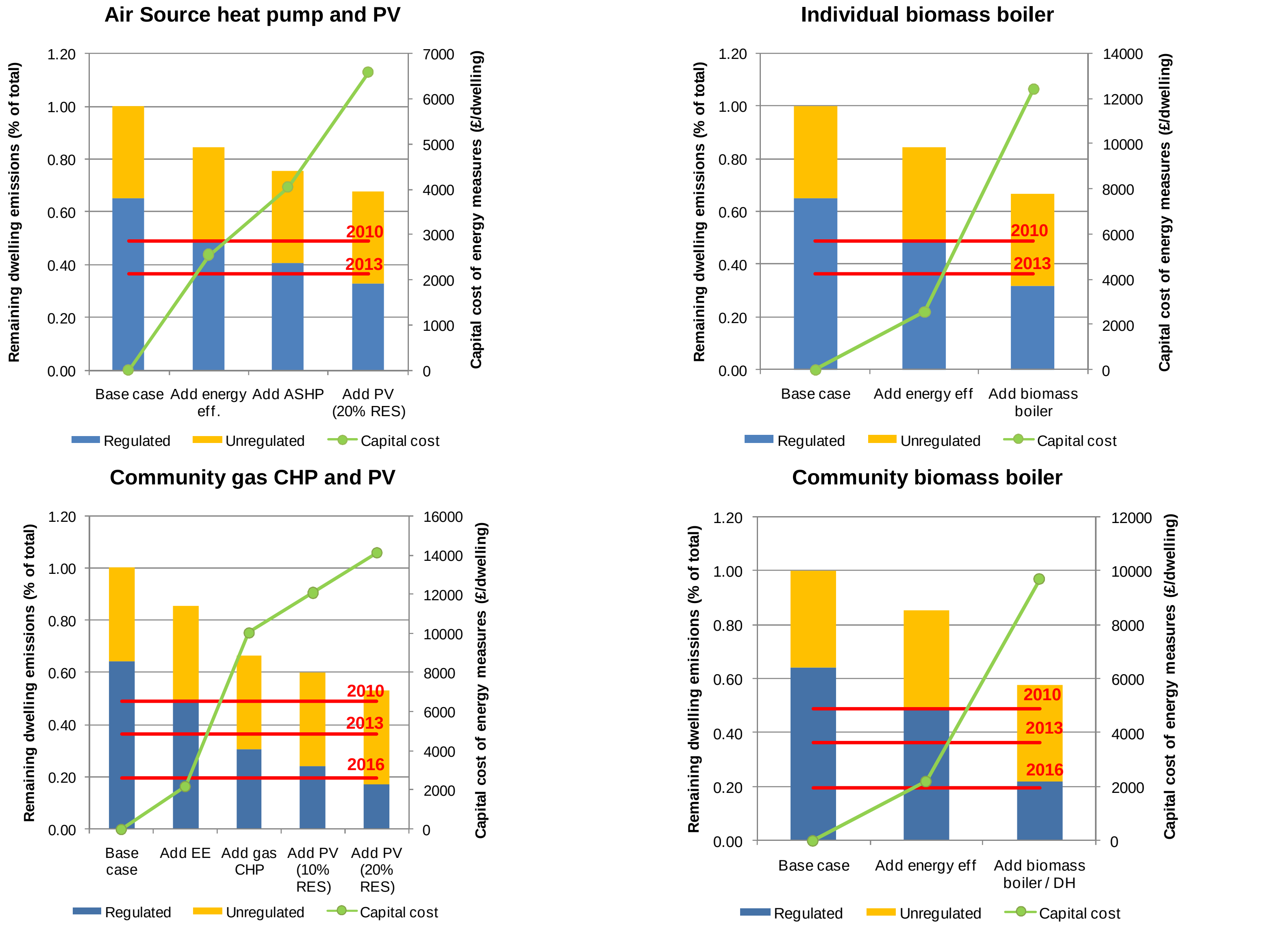


Figure 84,Progressive CO_2 reduction and cumulative capital cost build up as components added to energy systems (based on a 3bed semi)

The community gas CHP system provides a large CO_2 reduction, in excess of the Part L2013 standard, but makes no contribution to an onsite renewables target. Photovoltaics (or another renewable electricity system) would be required to meet the onsite RES target. At the level of a 20% reduction of CO_2 emissions through onsite renewables, the overall reduction of regulated emissions exceeds the 70% level proposed for the 2016 zero carbon homes policy. The capital costs in this case are based on the assumption of a medium-scale edge of town development on a greenfield site. Due to the low assumed density, the capital cost of the district heating system on a per dwelling basis is relatively high and, as a result, this system is a more expensive means of getting to the Part L 2013 standard than some of the dwelling-by-dwelling strategies (such as the ASHP based system and the system of energy efficiency and PV). The level of CO_2 reduction delivered by the gas CHP system does suggest that there may be a rationale for reducing the level of CO_2 reduction required through onsite renewables in cases where a gas CHP system has been installed.

Finally the case of the community-scale biomass boiler has been assessed. This system delivers in excess of the Part L 2013 standard (and close to the proposed 2016 carbon compliance level) and provides a 20% reduction of CO_2 emissions through renewables. The capital costs have been calculated based on the assumption of a relatively low density development scenario and, as a result, are higher than in the case of potential dwelling-by-dwelling strategies.

In general, the analysis above has suggested that a policy requiring a 10% reduction of CO_2 emissions through onsite renewables is likely to ensure that the overall standard of CO_2 reduction in new development is in advance of the Part L 2010 standard. This will particularly be the case where the onsite renewables policy is structured in a hierarchical fashion, as discussed above, and if the policy is combined with a further policy requiring a minimum level of CO_2 reduction through energy efficiency improvement. A policy requiring a 20% CO_2 reduction through onsite renewables is likely to ensure a standard that somewhat exceeds the Part L 2013 standard. If these policies were introduced progressively, i.e. a 10% target from 2010 to 2013 and 20% target from 2013 to 2016, then the extra-over cost on developers (in excess of the increasing cost of complying with Building Regulations) would be limited.

In the case where a developer has installed a community gas CHP system on a development, there may be a rationale for the onsite renewables target to be reduced. For example, the installation of a gas CHP system could be considered as equivalent to a 10% reduction of CO_2 emissions through renewables. This would mean that while a 10% CO_2 reduction through RES target is in force, a developer that installs a community gas CHP would not be required to install further renewables. If the onsite renewables target is at 20%, then a developer that installs a community gas CHP system would be permitted to make only a further 10% contribution through onsite renewables.

The case of the community gas CHP system is one where a high level of CO_2 emissions reduction is achieved without a contribution from a renewable generation technology. There may be other types of system that achieve this, which might be considered as special cases under an onsite renewables policy. For example, certain modern methods of construction (MMC) techniques can lead to high reductions of energy demand, due to high levels of insulation and air-tightness (the space heating demand is effectively eliminated). In these cases it may be possible to reach a standard very close to Part L 2013 emissions level without renewables. These types of construction are not standard practice at present, but may become more common as changes to the Building Regulations force developers to re-think standard housing designs and construction techniques. Core Strategy policies should not act to discourage this kind of innovative construction, and so a caveat in an onsite renewable policy to recognise very high levels of demand reduction may be appropriate.

KEY CONCLUSIONS

- Developments in Adur are expected to be relatively modest in scale and not built to high density (typically < 500 dwellings based on 2 – 4 bed townhouses and some flats). Commercial developments are expected to be 15,000 – 50,000 m^2 in scale.
- Based on the expected timescales of these developments, Building Regulations will require CO_2 emissions reductions of at least 25% and in many cases more than 44% from current Part L 2006 standards.
- In the absence of the necessary density for site-wide energy systems to be attractive, these reductions will be delivered by measures at the scale of the individual dwellings. This should include a 'Very Good' level of energy efficiency (see Section 3.3 for a definition of the 'Very Good' energy efficiency package), which has been shown to be a cost-effective way of reaching in excess of a 20% CO_2 emissions reduction in most dwelling types.
- Air and ground source heat pumps and biomass boilers should be considered to achieve further emissions reductions necessary to comply with regulations.
- Where very high levels of CO_2 emissions reduction are required, e.g. by the zero carbon homes legislation post-2016, then CHP and community (district) heating systems may be the most cost-effective strategy even in relatively modest density developments.
- A specific opportunity for a district heating system should be considered at Mash Barn. The district heating system served by biomass boilers (heat-only) or gas CHP could provide significant CO_2 reductions. Potential for extension of a district heating system from Mash Barn to the airport and Old Salt's Farm should be investigated.
- Targets for CO_2 reduction through onsite renewable energy provision should recognise the lack of opportunity for large-scale wind and biomass CHP in Adur's developments (excluding the JAAP).
- A hierarchical approach to implementing an onsite renewables target is recommended, which recognizes a developer's efforts to reduce demand or to reduce CO_2 emissions through use of CHP.
- A progressive implementation of a 10% onsite renewables target from 2010 to 2013 and a 20% target from 2013 to 2016 would ensure that developers were pushed to provide a standard that exceeds the Part L standards in force at the time, but without very onerous additional cost burden.
- Developers that install community gas CHP (or a very high standard of demand reduction) could be exempt from part of the onsite renewables target, for example installation of gas CHP could be considered equivalent to a 10% renewables contribution.

7 RECOMMENDED SUSTAINABILITY POLICY STATEMENTS: ADUR CORE STRATEGY

Under PPS1 and PPS22, there is an obligation on local planning authorities to ensure opportunities for renewable and low carbon energy sources are maximized and to set local targets for renewable energy generation. In developing their Core Strategies, planning authorities are required to:

- assess opportunities to extend existing or create opportunities for new decentralized energy systems based on renewable or low carbon technologies
- consider allocating sites for renewable and low carbon energy sources and supporting infrastructure
- ensure that a significant proportion of the energy supply of substantial new development is gained on-site and renewably and / or from a decentralized, renewable or low carbon energy supply

Planning authorities must ensure that any stipulation on the proportion of a development's energy use that is supplied from renewable or low carbon sources is feasible given the nature of the development (e.g. its type, location, size etc), does not place an undue burden on developers and does not adversely affect the development needs of the community (e.g. by rendering key sites for housing supply unviable).

Planning authorities must also frame policies that are consistent with the improving CO_2 emissions standards that will be mandated through tightening of the Building Regulations and the over-arching government policy to achieve zero carbon standards in new domestic and non-domestic buildings.

The trajectory toward the zero carbon standard in homes through tightening of building regs is likely to be along the following path:

Year	Percentage CO_2 reduction from Part L 2006 baseline (regulated emissions)
2010	25%
2013	44%
2016	Zero carbon (amount of CO_2 reduction through onsite measures is being consulted on. Options being considered are 44%, 70% or 100%)

Figure 85, CO_2 emissions reduction standards expected to be introduced for domestic properties on the way to the zero carbon standard.

The zero carbon standard in new non-domestic buildings is likely to be introduced in 2019. The trajectory toward this standard is currently uncertain. It is likely to involve a 25% improvement in 2010, but beyond this the interim levels to zero carbon are yet to be decided.

The definition of zero carbon for both domestic and non-domestic buildings is currently under consultation, but is likely to include a recognition that off-site measures may in many cases provide a more cost-effective means of mitigating a proportion of a development's CO_2 emissions than measures applied within the confines of the development (these offsite measures are termed 'Allowable Solutions' in the current consultation document and could, it is suggested, include offsite renewable energy generation projects, supply of renewable heat to surrounding developments or investment in improving the energy efficiency of building in the local area). The potential contribution of offsite measures or 'Allowable Solutions' to mitigation of development's CO_2 emissions, particularly post 2016, should also therefore be a consideration as planning authorities devise Local Development Documents.

It is against this background that policies included in Adur District Council's Core Strategy document must be developed. The following policy statements are intended to ensure that opportunities for low carbon and renewable energy supply in Adur are optimized and that any site specific opportunities for advanced targets with respect to renewable energy generation or reduced CO_2 emissions are identified and exploited. This analysis undertaken in the current study provide the evidence base on which policy recommendations are made.

Note that the following policy recommendations are specific to the Adur Core Strategy and are not directly applicable to the Shoreham Harbour Joint Area Action Plan. Specific energy strategy recommendations relevant to the JAAP are given in Section 4.4.

Policy Recommendation 1: Energy Efficiency targets

Developers will be encouraged to minimise the energy consumption and CO_2 emissions of development. In all developments, consideration should be given to how energy consumption can be reduced through appropriate building layout and orientation, building form and design, use of natural ventilation and accounting for the micro-climate.

Developers of domestic properties should achieve a reduction of at least 15% of Part L2006 regulated emissions, i.e. of the Target Emissions Rate (TER), through application of energy efficiency measures. Developers of larger family houses (e.g. 3 or more bedrooms), should seek to exceed this minimum. The minimum reduction of CO_2 emissions through energy efficiency measures may be updated from time-to-time in response to changes to Part L of the Building Regulations.

It is recommended that developers of non-domestic buildings should adopt energy efficiency standards capable of delivering at least a 10% reduction of CO_2 emissions from a Part L 2006 baseline and make an assessment of the optimal level of CO_2 reduction through energy efficiency on a case-by-case basis.

Evidence base

CO_2 emissions reductions will be mandated through amendments to the Building Regulations. These targets are likely to be met through a combination of improved energy efficiency standards and provision of low carbon and renewable energy generation. Although it is not recommended that Adur Core Strategy is prescriptive regarding the level of CO_2 emissions reduction that should be delivered by energy efficiency improvements, it should be recognized that there are benefits to ensuring a high standard of building fabric performance. These benefits include:

1. **Decreased consumption of natural resources and fuel bills**

   Improved building thermal performance decreases the consumption of resources and reduces the running costs of a property for the home-owner or tenant. This is a particularly important advantage in a deprived District such as Adur. Fabric performance improvements also typically have a long lifetime, thereby locking in the benefits of reduced energy consumption for future occupants and ensuring ongoing CO_2 emissions benefits.

2. Future-proofing of domestic building designs

Future Building Regulations are likely to include a mandatory improvement in building fabric performance, i.e. an energy efficiency backstop. Early adoption of improved fabric standards future proofs building designs against these more stringent regulations. By adopting an optimized level of fabric performance at an early stage, developers can avoid constant updating of building designs as low carbon legislation becomes more stringent. This is likely to be more cost-effective for developers in the long-run.

3. Conservation of the local renewable resources

The potential for large scale renewable energy generation in Adur, such as large scale wind turbines, is constrained (see Section 5). Improvement of building's fabric performance will reduce energy demand and ameliorate reliance on offsite mitigation measures, such as large-scale renewables projects, in meeting high levels of carbon reduction.

The analysis in this study (see Section 3.3) supports recommendations of optimum levels of CO_2 reduction to be delivered through energy efficiency improvements, in terms of cost-effectiveness of CO_2 saving.

It is recommended that developers of domestic properties seek to achieve CO_2 emissions reductions of 15 to 20% from a baseline of Part L 2006 through energy efficiency measures. These levels of emissions reduction have been shown to be achieved relatively cost-effectively in a range of dwelling types (additional capital costs of < £1,000 per dwelling, depending on the dwelling type).

Similar recommendations are more difficult to apply to the non-domestic sector, due to the great variety of building forms and usages. Based on the analysis of commercial and retail properties, a recommendation that at least a 10% CO_2 emissions reduction should be provided by energy efficiency improvements is reasonable. Developers should assess whether further reductions of CO_2 emissions should be delivered through energy efficiency on a case-by-case basis.

Policy Recommendation 2 – Supporting combined heat and power systems and heating networks

A strategic policy is recommended that:

Ensures that local, existing heating and cooling networks are identified and safeguarded.

Maximizes the opportunities for providing new networks that are supplied by decentralized energy (including renewable generation).

Ensures that developers evaluate the technical and economic viability of combined cooling, heat, and power (CCHP) and combined heat and power (CHP) systems on all new developments, and where a new CCHP/CHP system is installed as part of a new development, examine opportunities to extend the scheme beyond the site boundary to adjacent areas.

Ensures that developers study the technical and economic viability of the following heat and cooling network strategies before submitting a planning application:

- connection to existing CCHP/CHP distribution networks
- site-wide CCHP/CHP powered by renewable energy
- communal heating and cooling fuelled by renewable sources of energy
- natural gas-fired CCHP/CHP

Ensures that it is feasible for new developments to connect to existing heating and cooling networks.

The Mash Barn (New Monk's Farm) development should identify the opportunity for a district heating system. The developers of this site should be required to provide an assessment of district heating fed by gas CHP or biomass heat-only boilers as a means of meeting or exceeding minimum CO_2 emissions reductions required by the Building Regulations. The developers should also be required to assess the potential for extension of a district heating network to the adjacent airport and Old Salt's Farm developments.

Developers at EWAR and Sompting Fringe should also be required to assess the potential for heat networks, including potential extensions to existing commercial districts, such as Lancing Business Park.

Evidence base

CHP/DH systems can provide highly effective CO_2 savings (see Section 4.2.3) and are likely to be an important component of the low carbon energy strategy in the district. Promotion of CHP/DH systems falls in line with the policy amendment NRM12 of the South East plan and hence fits well within a wider regional policy framework.

Developers should therefore be required to assess the technical and economic feasibility of CHP/CCHP and DH systems on their sites when submitting proposals, even if such systems are not required to achieve the CO_2 reduction targets required of a site.

Where there is an obvious opportunity to extend heat and cooling networks beyond the boundary of a site (and hence promote further highly cost effective CO_2 savings), developers should make this point clear. There may be a possibility of combining heat networks or including local high heat demand sites and increasing the cost effective CO_2 savings which can be attained (and reducing capital installation costs).

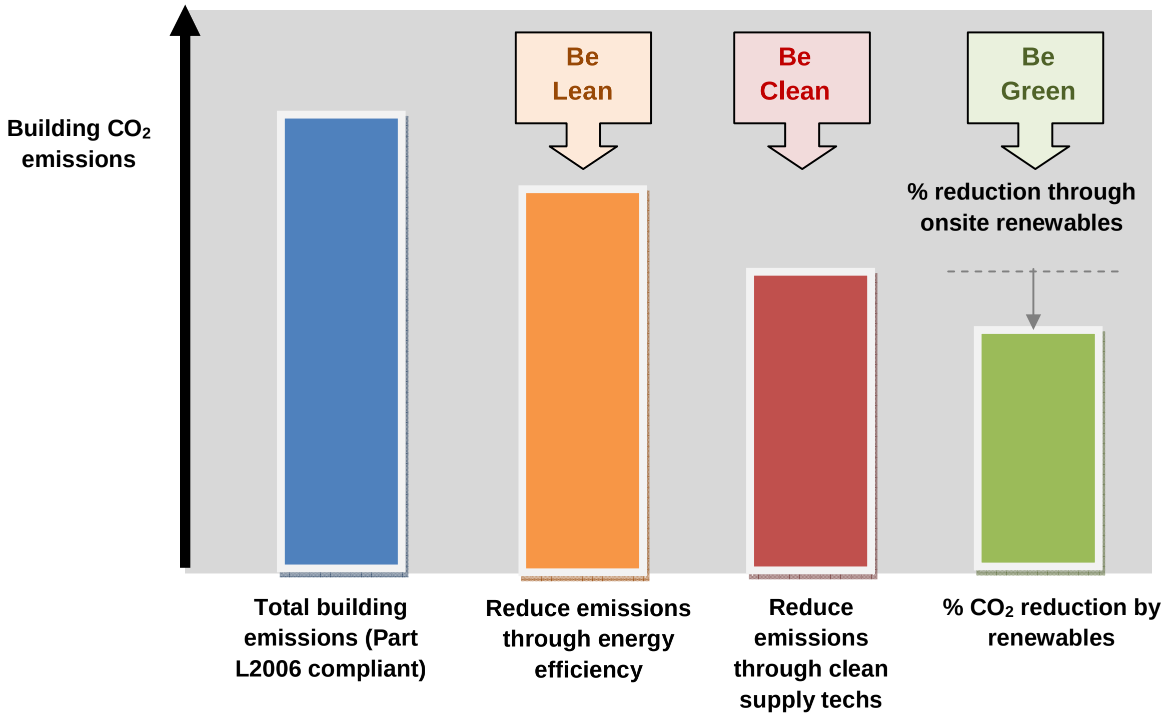
A site specific opportunity for a heat network can be identified at Mash Barn, with potential extensions to other sites such as the airport and to Old Salt's Farm. Developers at Mash Barn should be encouraged to coordinate with those involved at other sites at an early stage (see section 6.3.2).

Developers at EWAR and Sompting Fringe should also be required to assess the potential for heat networks (preferably combined, although networks should be considered in isolation if a network spanning the two developments cannot be delivered), including potential extensions to existing commercial districts, such as Lancing Business Park (see Section 6.3.2).

Policy Recommendation 3 – Onsite renewable energy supply

A policy is recommended that requires developers of all major developments[30] to provide a percentage reduction of CO_2 emissions through supply of renewable energy. The percentage reduction shall be based on a calculation of the residual emissions, where the residual emissions are those remaining following application of policies 1 and 2 and include calculation of both regulated and unregulated CO_2 emissions. The sequential reduction of building CO_2 emissions by application of policies 1 to 3 is illustrated schematically in the figure below.

[30] A major development is more than 10 dwellings or 1000 m^2 GFA for non-residential development



The percentage reduction of residual CO_2 emissions to be delivered through supply of onsite renewable energy shall depend on the date of submission of a detailed planning application, as follows:

1. Prior to 2013, at least a 10% reduction of residual CO_2 emissions shall be delivered by onsite supply of renewable energy.
2. Post 2013, at least a 20% reduction of residual CO_2 emissions shall be delivered by onsite supply of renewable energy.

If a good quality[31] community gas CHP system has been installed on the site, this should count as equivalent to a 10% CO_2 reduction through onsite renewable energy generation.

Evidence Base

The policy is in line with the requirement of supplement to PPS 1 on Planning and Climate Change for local authorities to set a target for renewable energy provision in new developments.

The renewable resource analysis for Adur has not identified exceptional opportunities for renewable energy installation that would justify particularly challenging targets for CO_2 reduction through onsite renewable energy generation (see Section 5). Outside of the Shoreham Harbour Area Action Plan, the majority of the proposed new development is at relatively small-scale and modest density. The opportunity for installation of wind turbines is constrained and, with the possible exception of Mash Barn (and the neighbouring airport development), the development type is unlikely to present opportunities for biomass CHP.

[31] The CHP system has been certified as good quality under the CHPQA accreditation scheme.

In response to the local circumstances, the onsite renewable energy policy is intended to ensure that developers provide a level of CO_2 reduction that exceeds the anticipated Part L standards in 2010 and 2013 (i.e. as set out in the government's '*Building a Greener Future*' policy statement), but that will not create an excessive additional cost burden (in addition to the increasing cost of meeting regulation). See Section 6.4 for a discussion of these targets.

Policy Recommendation 4 – Code for Sustainable Homes

Requiring developers to achieve Code for Sustainable Homes and BREEAM standards will ensure that broad principles of sustainable construction are adopted in domestic developments within the region.

The CO_2 emissions standards of increasing Code Levels will become mandatory through revisions of the Building Regulations, however, the Code will remain voluntary unless required as a planning condition.

BREEAM only sets mandatory CO_2 emissions requirements at the highest levels, however a BREEAM requirement will encourage developers to reduce CO_2 to achieve credits toward the required rating.

Adur District Council should require developers of new build domestic developments to achieve the following standards of the Code for Sustainable Homes, unless developers can demonstrate that to do so would adversely affect the viability of a particular site.

- Post 2010 – CSH level 3
- Post 2013 – CSH level 4

Developers of non-domestic buildings should be required to achieve a minimum BREEAM 'Very Good' standard.

Evidence base

This policy statement is in line with the broader aims of cross-cutting policy 4 (CC4 Sustainable Housing) of the South-East plan.

Research into the cost implications of achieving Code for Sustainable Homes[32] levels has shown that for a wide range of development types more than 70% of the additional cost of meeting the Code (compared to a cost of constructing a 2006 Building Regulations compliant dwelling) is related to meeting the energy and CO_2 emissions standards. Therefore, once the emissions standards have become a mandatory requirement of Building Regulations, the additional cost of reaching the Code Levels stated above are significantly reduced (potentially to an on-cost of < £1,000 per dwelling to achieve Code Level 4 in 2013). The additional capital costs of achieving the standards required of Code Levels 5 and 6 remain substantial and so it is not recommended that they be required by planning conditions.

Policy Recommendation 5 – Development of low carbon allowable solutions

Incorporate a strategic policy which supports:

1. **Standalone renewable energy schemes**

Proposals for renewable energy developments, including any ancillary infrastructure or building will be favourably considered if:

[32] Code for Sustainable Homes: A cost Review, Element Energy and Davis Langdon, 2009

1) Their scale, form, design, materials and cumulative impacts can be satisfactorily assimilated into the landscape or built environment and would not harm the appearance of these areas; and

2) They would not impact adversely on the local community, economy, biodiversity or historical interests.

2. A local Adur low carbon buy-out fund

Adur District Council will explore the option of a local Adur-wide low CO_2 buy-out fund.

The buy-out fund could provide a potential route for developers to directly invest in 'Allowable Solutions', in line with the government's proposed definition of zero carbon homes and buildings.

Access to the buyout option will only be granted for those sites where it has been demonstrated that the required level of onsite CO_2 mitigation (i.e. the 'Carbon Compliance' level – expected to be 70% of regulated emissions) has been achieved.

The tariff level of any CO_2 buy-out will be determined following further evidence base work, but will be set at a level which encourages developers to explore all relevant onsite clean/renewable energy generation technologies in the first instance. The level of the buy-out tariff will be informed by government policy on zero carbon homes, specifically the capped level for investment in Allowable Solutions.

Capital contributions to the CO_2 buy-out fund will be used to fund major low carbon projects in the Adur District. These projects may include (but are not limited to):

1. Installation of stand-alone renewable schemes in suitable locations
2. Energy efficiency retrofitting in the existing build stock
3. Development of district heating schemes and potential expansion of district heating network to serve the existing build stock

Evidence base

The analysis undertaken in Section 6.2 indicated that the attainment of high CO_2 reduction standards (consistent with CSH levels 5 and 6) through onsite low carbon measures incurs significant capital expenditure. This capital expenditure can be significantly reduced if a range of offsite low carbon measures are allowed to contribute towards reducing the CO_2 emissions credited to a site.

In the recent Definition of Zero Carbon buildings consultation, the government suggested that future building regulations will require developers to reduce CO_2 emissions on a site to a certain level using onsite low carbon technologies (a 'Carbon Compliance' level of 70%, i.e. a 70% reduction of CO_2 emissions through onsite measures, is proposed), however thereafter the developer will be allowed to utilize a range of offsite "allowable solutions" to mitigate the remaining CO_2 emissions.

Access to a range of low carbon offsite "allowable solutions" not only reduces the cost of compliance with the zero carbon buildings standards (and potentially the highest CSH code levels), but could also facilitate further and potentially more cost effective CO_2 savings in the Adur District.

Adur District Council should assess the operation and funding of a local low carbon trade body which would administer the buy-out fund and ensure that individual sites attain or exceed required CO_2 reduction standards.

The buy-out tariff of any fund will need to be set at a level that is sufficient to support local renewable / low carbon energy or carbon saving projects. The level of tariff will be capped at the level of the capped cost of Allowable Solutions under the zero carbon homes and non-domestic buildings policy.

The application of these policies to specific developments sites is summarized in the following section.

Site specific policy recommendations

Residential sites

In all the residential developments identified below, a reduction of Part L 2006 regulated emissions (i.e. the Part L 2006 Target Emissions Rate) of at least 15% shall be achieved through application of energy efficiency measures (see Policy Recommendation 1).

The recommended energy strategies and policies to be applied to the currently identified residential sites are summarized in the table below:

Site	Scale	Density (dph)	Programme	Anticipated Regulation	Recommended Energy Strategy	Policy
Mash Barn	450-550	40	2013-2018	Mix of Part L2013 and ZCH	Potential for district heating with biomass HOB (unlikely to be sufficient demand for biomass CHP, unless smaller technology develops). Photovoltaics or site wind[33] required to meet ZCH standard in later stages.	1. Investigate feasibility of a district heating system served by a biomass-fuelled heating technology. 2. Provide a 20% reduction of total residual residential CO_2 emissions through supply of renewable energy
Old Salt's Farm	25-525	40	Post-2018	ZCH	Potential for connection to Mash Barn DH system. PV or site wind potentially required to reach ZCH standard. Alternative strategy individual biomass boilers or ASHPs and PV / site wind.	1. Investigate the feasibility of connection to local DH schemes. 2. Provide a 20% reduction of total residual residential CO_2 emissions through supply of renewable energy

[33] Site wind refers to medium to large-scale wind turbines installed within the site. It does not refer to building integrated wind turbines.

Sompting Fringe	30-335	40	post-2018	ZCH	Individual biomass boilers or ASHPs and PV or site wind	1. Investigate the feasibility of connection to local DH schemes. 2. Provide a 20% reduction of total residual residential CO_2 emissions through supply of renewable energy
Shoreham Town Centre	320	40	2013-2018	Mix of Part L2013 and ZCH	Potential for connection into Shoreham Harbour district heating system. Alternative strategy individual biomass boilers or ASHPs and PV/site wind.	1. Investigate the feasibility of connection to local DH schemes. 2. Provide a 20% reduction of total residual residential CO_2 emissions through supply of renewable energy
Sites in existing settlements	870	> 40	2008 - 2016	Part L2010 and Part L2013, depending on time of construction	Variable depending on timing.	1. Investigate the feasibility of connection to local DH schemes. 2. (i) For major developments developed prior to 2013, provide a reduction of total residual CO_2 emissions of 10% through supply of renewable energy. (ii) For major developments developed post-2013, provide a reduction of total residual CO_2 emissions of 20% through supply of renewable energy. 3. For smaller developments where targets for CO_2 reduction through onsite renewables are not achieved, an equivalent contribution to the Low Carbon Buy-Out fund will be required.

Non-residential sites

In all development below, achieve a minimum 10% reduction of CO_2 emissions from Part L 2006 regulated emissions through use of energy efficiency measures.

Site specific policy recommendations are given below:

Site	Use	Scale	Programme	Anticipated Regulation	Energy Strategy	Policy
Shoreham Airport	Aviation/ office	37,550 - 49,650 sqm	2013-2016	Part L 2013	Consider the feasibility of a common district heating system with the Mash Barn mixed-use site. Consider a CHP system with site-wide district heating.	1. Investigate feasibility of a district heating system served by a biomass-fuelled heating technology. 2. Provide a 20% reduction of total residual CO_2 emissions through supply of renewable energy
Shoreham cement works	Leisure / office	45,000 sqm	post 2016	Part L 2013 / zero carbon buildings	Consider the feasibility of a site-wide district heating system with CHP or boilers fuelled by renewables. Site wind or photovoltaics may be required to meet the Building Regulations.	1. Investigate the feasibility of site wide district heating and renewable-fuelled CHP or boilers. 2. Provide a 20% reduction of total residual CO_2 emissions through supply of renewable energy
Eastbrook allotments	Office	15,000 sqm	2013-2016	Part L 2013	Renewable fuelled boiler plant or air source heat pumps.	1. Provide a 20% reduction of total residual CO_2 emissions through supply of renewable energy

EWAR	Office	30,000 sqm	post 2016	Part L 2013 / zero carbon buildings	Consider potential for district heating systems extending to Sompting Fringe or neighbouring commercial / Industrial uses. Consider renewable fuelled boilers or CHP to feed heat network. Potential requirement for photovoltaics or site wind to meet zero carbon buildings policy.	1. Investigate feasibility of a district heating system served by a biomass-fuelled heating technology. 2. Provide a 20% reduction of total residual CO_2 emissions through supply of renewable energy
Mash Barn	Retail, office & commu nity use	23,875 - 39,175 sqm	2013 – 2018	Part L2013/2016	Consider potential for district heating, potentially linked to Old Salt's Farm and/or Shoreham Airport. Consider renewable fuelled boilers or CHP to serve the heat network	1. Investigate feasibility of a district heating system served by a biomass-fuelled heating technology. 2. Provide a 20% reduction of total residual CO_2 emissions through supply of renewable energy.