16 Energy

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16.1 Introduction

This chapter of the Environmental Statement reviews the likely energy consumption of the Hayle Harbour proposal, the likely environmental impacts of that consumption and the methods proposed for mitigation of these impacts. The sustainable use of energy is a major consideration in the design of this scheme - the proposals respond both to the requirements of ING ltd and SWRDA, while reflecting national, regional and local energy policies.

This chapter summarises the results of studies into the likely energy usage and carbon emissions resulting from the proposed development. Comparisons are drawn between: the existing buildings on the site; an unmitigated scheme based on current regulations; and a mitigated scheme incorporating measures that to increase levels of sustainability and meeting the relevant planning policies.

16.1.1 Background

The site of the proposed development is located around Hayle Harbour on the north coast of Cornwall.

Key site issues that influence energy consumption and mitigation options include:

- The RSPB Reserve at Carnsew Pool adjacent to the site
- The surrounding residential areas and other buildings
- Cliffs from Hilltop down to North Quay
- Steep slopes from Riviere Fields down to Copperhouse Pool
- The proposed Wave Hub bringing energy ashore from a range of technologies which will be supported as part of the redevelopment and is key to the regeneration
- A history of industrial use
- The harbour and associated sluicing ponds and structures

The proposed development would consist of five distinct areas; North Quay, South Quay, East Quay, Hilltop and Riviere Fields. For this energy strategy we have considered these areas to be described as follows:

- North Quay is a mixed use area that incorporates industrial, leisure, business, retail and residential uses
- South Quay is a mixed use area that incorporates business, retail, residential, leisure, education and community facilities
- East Quay will include a landmark exhibition, conference and community building

- Hilltop and Riviere Fields are medium density residential areas

16.1.2 Structure of the energy chapter

This energy chapter is structured as follows:

- A review of legislation and planning policy guidance, with key elements identified
- Details of the methodology used for the assessment of energy consumption and the resulting emissions
- Estimate of existing energy use on the site
- The assessment of energy consumption and emissions for a standard unmitigated development
- Identification of mitigation targets
- Assessment of the strategies for mitigation of energy use and emissions
- Description of the proposed mitigated scheme
- Resultant energy consumption and emissions post mitigation
- Strategies for monitoring and reducing energy consumption for the completed development
- Conclusions and a summary

Technical appendices are used to support the results presented in this chapter, including a schedule of the relevant legislation and policy, and a detailed review of potential energy efficiency and renewable energy technologies.

16.2 Legislation and planning policy

This section introduces the importance of energy in international, national, regional and local planning terms.

16.2.1 Introduction

World energy production was predicted by the International Energy Agency (IEA) to be 10,579 million tonnes of oil equivalent in 2004 (IEA, 2005) with around 11.3% from renewable and waste sources, 6.5% from nuclear, 2.2% from hydro power stations and 80% from fossil fuels. Around 60% of this energy is used by industrialised countries, which make up only 20% of the population (Elliott, 2003).

One of the significant environmental impacts of energy generation is the production of carbon dioxide (CO_2) through burning fossil fuels, which is thought to play a key role in climate change (Elliott, 2003). The IEA (2005) estimated world CO_2 emissions from energy use as 24,983 million tonnes in 2004, with around 51% produced by Organisation for Economic Co-operation and Development (OECD) countries of which UK emissions

account for 540 million tonnes CO_2. Since 1760 the level of atmospheric CO_2 has increased from around 280 ppm to 368 ppm in 2000 (Elliott, 2003). This increase, fuelled by increased CO_2 emissions, has contributed to the greenhouse effect and the increase in average world temperatures. Over the last 140 years the best estimate is that the global average surface temperature has increased by 0.6 ± 0.2°C (IPCC, 2001).

In 1997 at the UN climate change conference in Kyoto, industrialised countries were set greenhouse gas emission limits. The targets set are for global emissions reductions of 5.2% below 1990 levels between the years 2008 and 2012, with the EU assigned a target of 8% reductions, which incorporates a 12.5% target for the UK (DTI, 2005). Beyond the initial Kyoto Protocol targets, the UK government has announced in the Energy White Paper an aspiration of reducing Carbon equivalent emissions by 60% by 2050 (DTI, 2003).

The UK government's chief scientist, Sir David King, stated "Climate change is the most serious problem that we are facing today-more serious than even the threat of terrorism" (Connect, 2004) - this approach has lead to the development of energy policies and strategies at both national and local levels. The principles set down by national government are applied by local and regional departments.

Hayle has a Town Council and is within the jurisdiction of Penwith District Council. Penwith is one of six districts in the County of Cornwall, and is part of the Southwest Regional Assembly in England.

Policies affecting energy policy for the proposed development are set by:

- National Planning Policy Statements (Energy White Paper, PP1, PPS 22)
- Government Office for the South West (GOSW)
- Cornwall County Council (CCC)
- Penwith District Council (PDC)
- Hayle Town Council

Other bodies which have influence over energy strategy in local policy and developments include:

- Cornwall Sustainable Energy Partnership (CSEP)
- Sustainability South West
- Regen SW
- Hayle Area Plan Partnership
- Cornwall Sustainable Building Trust (CSBT)

16.2.2 National targets

The UK produces 2% (DTI, 2003) of the world production of carbon dioxide, but the UK government has committed itself to show leadership in cutting its emissions by 20%, below the agreed 12.5% reduction, of such gases from 1990 levels as stated in the report "Climate Change -The UK programme 2006" (DEFRA, 2006). This target can only be achieved by significant efforts by all the involved parties.

The domestic energy consumption and its associated CO_2 emissions have been identified by the UK Government in the Energy White Paper 2003 published by DTI (DTI, 2003) as a major area in which improvements could be made. Moreover, recent changes to Building Regulations have imposed very tight limits on CO_2 emissions for residential and non-residential buildings which will prove challenging for these buildings to achieve the new regulatory targets. The Energy White Paper also signalled the Government's aspiration to further double the proportion of electricity supplied by renewables by 2020 with associated savings of around 9 million tonnes of CO_2 in 2010 according to DEFRA. The National Audit Office (DTI, 2005) suggest that doubling the proportion of renewable energy to 20% by 2020 would reduce CO_2 emissions by between 73 and 99 million tonnes of CO_2.

The Department for Communities and Local Government (DCLG) issued the Housing Green Paper, Homes for the Future: more affordable, more sustainable (DCLG, 2007a) in July 2007. The paper discusses the drastic demand for quality housing throughout the UK and the need to increase the standards imposed on the domestic sector through both adjustments to Building Regulations and the introduction of mandatory rating systems. In particular the use of The Code for Sustainable Homes (CfSH) (DCLG, 2007b), currently a voluntary rating, is proposed to be a compulsory requirement in the future.

Two key changes are predicted for the Building Regulations as part of the future housing strategy (DCLG, 2007c ,d); a reduction of emissions of 25% from 2006 levels (comparable to CfSH Level 3) in 2010 and 44% (comparable to CfSH Level 4) in 2013. The point of most contention is the 2016 target to design all new dwellings to be carbon neutral (comparable to CfSH Level 6). It has not yet been assessed whether this will be feasible.

The CfSH ratings and requirements have not yet been included in Government legislation and the suggested timeline for implementation still needs to consider the effect of commercial feasibility on the ability to achieve these goals in such a short timescale.

Planning Policy Statement 1 (PPS1) – Delivering Sustainable Development (2005) refers to energy as follows:

- Developers of renewable energy projects should engage in active consultation and discussion with local communities at an early stage in the planning process, and before any planning application is formally submitted

- Developers should consider the opportunity to incorporate renewable energy technologies in all new developments
- The visual effects should be sought to be minimised where possible
- Renewable energy developments should be located and designed in such a way as to minimise increases in ambient noise levels
- For biomass projects, the need to transport crops to the energy production site may lead to increased traffic. A potential source of fuel should be identified, and energy generation plant should be located as close as possible to this source
- The design of wind turbines should take into account airport operation, radar links, power lines, roads, railways, and the relevant authorities should be consulted with regard to separation distances

The objective of Planning Policy Statement 22 (PPS22) – *Renewable Energy* (2004) is to ensure that the planning system plays its part in delivering Government policy on energy as set out in the Energy White Paper. The key principles in the approach to planning for renewable energy are:

- Renewable energy developments should be accommodated throughout England in locations where the technology is viable and environmental, economic, and social impacts can be addressed satisfactorily
- Considerable weight should be given to the environmental and economic benefits of all proposals for renewable energy projects
- Regional and local bodies are to set targets for renewable energy generation to be expressed as the minimum amount of installed capacity. Local planning authorities may include policies in local development documents that require a percentage of the energy to be used in new residential, commercial or industrial developments to come from on-site renewable energy developments

16.2.3 Regional targets

In the Draft Regional Spatial Strategy for the Southwest 2006-2026 (SWRDA, 2006), the Southwest Regional Assembly lists overall policies. The Regional Spatial Strategy is still in draft and has not yet been adopted but will form part of the context for the Penwith Local Development Framework. The draft RSS is expected to be adopted in late 2007/early 2008

Key aspects relating to energy and the Hayle development are (SWRDA 2006):

- **Development policy G – Sustainable construction**

"Developers, local authorities, regional agencies and others must ensure that their strategies, plans and programmes achieve best practice in sustainable construction by:

Requiring that all new and refurbished buildings achieve the requirements of BREEAM and Eco-homes, very good standard, or at least Level 3 above minimum building standards in the emerging 'Code for Sustainable Homes' in order to minimise lifetime resource use, energy consumption, water use and waste production

Requiring that all larger scale developments, in particular, urban extensions, are designed and constructed to meet the top Level 5 of the emerging 'Code for Sustainable Homes', including carbon neutrality"

- **RE5 Renewable energy and new development**

"Larger scale developments will be expected to provide, as a minimum, sufficient on-site renewable energy to reduce CO_2 emissions from energy use by users of buildings constructed on site by 10%. Developers will be expected to demonstrate that they have explored all renewable energy options, and designed their developments to incorporate any renewable energy requirements. Individual Local Planning Authorities may use lower thresholds for what constitutes a larger-scale development and set higher percentages for on-site generation, taking into account the impact on initial and lifetime affordability of homes."

In addition the 'Regional renewable energy strategy' (Regen SW, 2003) was published with an overall vision to "maximise the social, environmental and economic benefits of renewable energy through the integration of renewable energy into mainstream policy and practice at all levels within the region." It outlines plans for "generating up to 15% of the region's power from renewable sources by 2010".

16.2.4 Local targets

Sustainable energy supply is high on the agenda in Cornwall. Cornwall currently has the highest per capita renewable energy production of any English county and is the location of the UK's first wind farm.

Cornwall County Council has five key aims. The first "Achieving a sustainable economy" includes "investigating ways of achieving the lowest possible carbon emissions for Cornwall's economy; encouraging companies to adopt sustainable business practices; maximising energy efficiency and renewable resources".

The Cornwall Energy Study (CSEP, 2006) reinforces the national and regional targets and priorities and adds a further goal of doubling renewable energy production between 2010 and 2020. It also highlights the long term aim for zero carbon emission buildings and emphasises the need to move from encouraging to requiring renewables and carbon reductions in planning.

Penwith District Council specifies in the Penwith Local Plan 2004 Policy GD-2 that "the design and layout of development should: (iii) maximise passive solar gain and utilise energy efficient building types."(Penwith DC, 2004). The document A Climate Change Strategy for Penwith (PDC, 2006) mentions the need to require a minimum percentage of predicted energy demand in developments to be supplied by renewable energy sources (B2.3).

These requirements are not yet in the Hayle local plan, but they are expected to form part of the context for the emerging Penwith Local Development Framework and Hayle area action plan. As such these requirements have not yet been formally adopted; however they are reflected in the mitigation proposals for this project set out in sections 16.5 and 16.6.

16.2.5 Proposed development commitments

In consideration of these planning policies, proposals and strategies and the commitment by the developer, three key energy related targets have been set for the proposed development.

- Meet and exceed Building Regulations Part L through passive and efficiency means to reduce energy consumption
- All buildings to achieve either a 'very good' BREEAM rating or a CfSH Level 4 as appropriate
- To provide, as a minimum, sufficient on-site renewable energy generation to reduce CO_2 emissions from building energy use by 10%

16.3 Methodology and assessment criteria

This section describes the methodology used for the assessment of the environmental impact of energy use, including: how the baselines have been identified, unmitigated impacts measured and mitigated scheme developed.

The methodology used takes in the following key steps:

1. The baseline condition is identified – the energy consumption and CO_2 emissions resulting from the existing mix of buildings on the site are estimated
2. The unmitigated scheme is described, including the mix of buildings proposed in this scheme, based on compliance with existing building regulations and energy supply from conventional sources
3. Energy use and CO_2 emission impacts for the unmitigated scheme are estimated, based on Building Regulations 2006 Part L (ODPM, 2006) Standard Assessment Procedure calculations and CIBSE Guide F (CIBSE, 2004) Best Practice Data
4. A mitigated scheme incorporating efficiency measures and alternative energy technologies is described
5. Residual impacts for the mitigated scheme are estimated based on the results of energy modelling using industry benchmark and quoted performance figures for alternative energy technologies

Detailed methodologies for the various elements of the assessment are set out in the Technical Annexes 16A to 16C and these are summarised in sections 16.3.2 to 16.3.5

16.3.1 Impact assessment methodology

This chapter considers the atmospheric emissions impacts from the consumption of energy. Other environmental impacts from gas exploration and supply or electricity generation are not included. Local air emissions as a result of on-site fuel combustion for energy supply are covered in the air quality chapter (Chapter 11). Noise impacts from energy generation are covered in the noise and vibration chapter (Chapter 6). The main measurable environmental impact from energy consumption is considered to be the generation of CO_2 emissions through the combustion of fossil fuels and generation of power in remote power stations.

Energy is used in buildings for a number of reasons. This report considers the breakdown of energy consumption between fossil fuel consumption (considered natural gas) and power consumption (from lighting, small power, cooling etc.).

Effective CO_2 emissions are measured based on carbon emission factors as shown in Table 16.1. Energy consumption is measured in kWh and includes the inefficiency of consumption (i.e. combustion losses). The energy consumption (or generation) is multiplied with the appropriate carbon emission factor to obtain an estimate of carbon dioxide emissions. The methodology employed for establishing the impact of the proposed development is shown in Figure 16.1.

Fuel Source	Conversion Factor
Natural Gas	0.194
Electricity Consumed	0.43
Electricity Generated	0.568

Table 16– 1 CO_2 emission conversion factors used for the assessment of the impact of energy consumption (CIBSE, 2004)

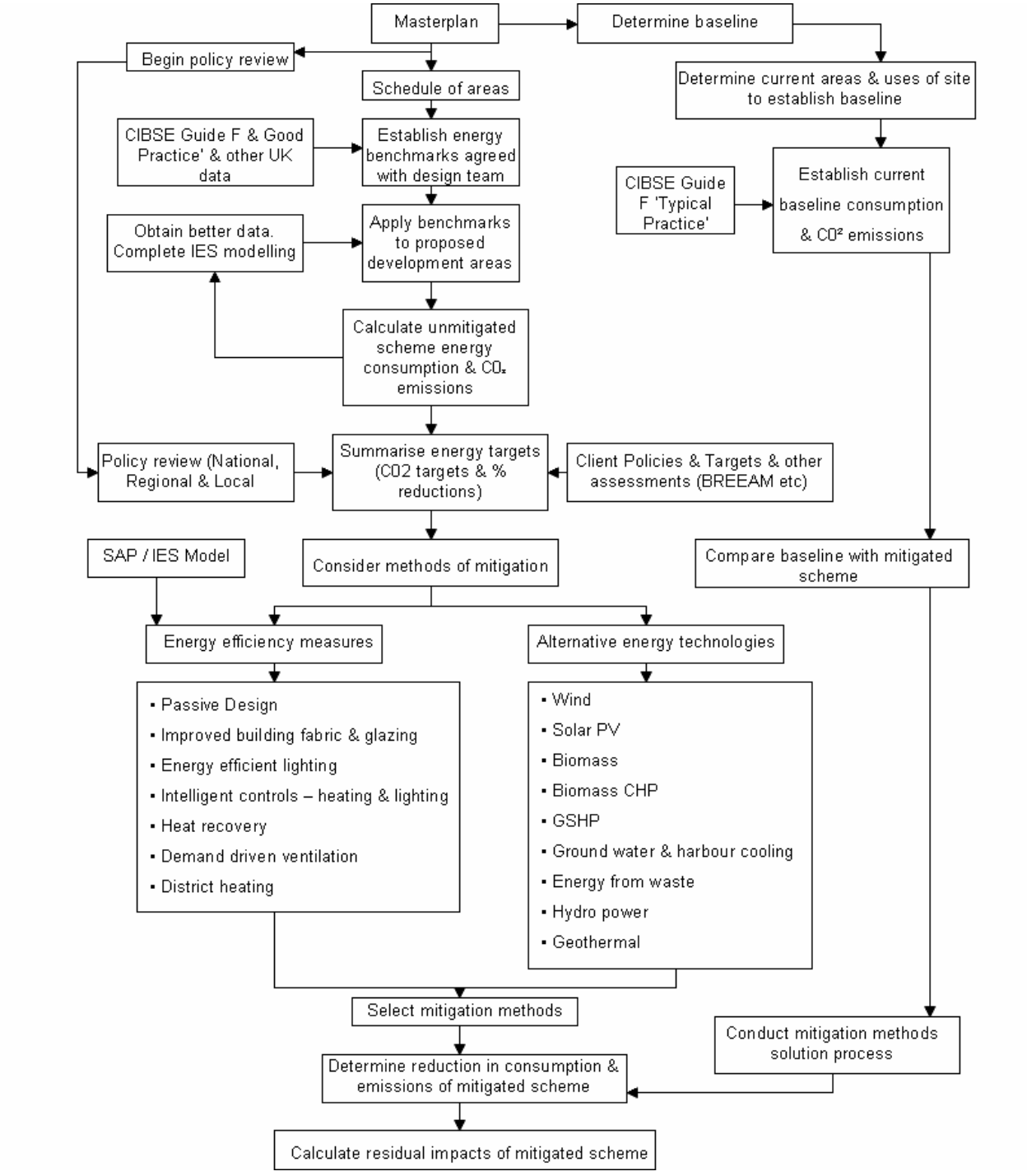

Figure 16—1 Energy chapter EIA process diagram

16.3.2 Baseline energy consumption estimate methodology

The baseline is a 'do nothing' scenario with the proposed development site continuing to operate as at summer 2007. This assumes that all buildings would remain as they are and would continue to be used in the same ways as at present. A number of other assumptions have been made as follows:

- Building footprint areas, building age/condition and type of usage were defined based on survey data (OS Map, 1999)
- Energy consumption was evaluated for buildings only; non-building related operational use of the site and movement of materials etcetera are not included
- It was acknowledged that buildings on the site and building use are likely to change over time under the 'do nothing' baseline scenario, perhaps with other new proposals put forward. However it was not possible to assess the relative impact of these unknowns
- Baseline energy consumption predictions are based on simple building type definitions and "*Typical Practice*" energy consumption benchmarks defined within CIBSE Guide F (CIBSE, 2004)

16.3.3 Unmitigated scheme impact assessment methodology

Energy consumption and CO_2 emission impacts for the unmitigated scheme (that is as described in Chapter 3) were calculated using the area schedule and mix of uses proposed for the current scheme (Table 16.2) constructed to comply with 2006 Building Regulations.

Energy consumption predictions were calculated using CIBSE Guide F (CIBSE, 2004) good practice for all of the non-residential buildings. The results of an IES Virtual Environment 2005 SAP calculation were used to assess the energy consumption of the residential buildings based on 2006 Building Regulation standards.

16.3.4 Residual impact from mitigated scheme assessment methodology

The energy consumption predictions for the unmitigated scheme have been used as the basis from which emissions reductions have been calculated and used to inform the selection of the resultant mitigation measures.

CO_2 emission reductions from energy efficiency measures and renewable technologies have been assessed using standard industry benchmarks together with manufacturer's data and measured performance data. Standard industry benchmarks, manufacturer's data and measured data have been used to assess the effective CO_2 emission reductions from applying mitigation methods.

	North Quay	South Quay	East Quay	Riviere Fields	Total
	Area (m2)	Area (m2)	Area (m2)	Area (m2)	Area (m2)
Residential	37164	19515	0	30925	87604
Retail	2613	10585	0	0	13198
Community	0	2000	5000	0	7000
Office	7355	5150	0	0	12505
Leisure	1055	0	0	0	1055
Hotel	2430	0	0	0	2430
Industrial	5575	0	0	0	5575
Total	56192	37250	5000	30925	129367

Table 16– 2 Total area breakdown approximations for each building type of proposed development

16.3.5 Methodology, limitations and assumptions

Some of the key limitations and assumptions of this study are considered to be as follows:

- Energy consumption estimates for the site are based on the latest illustrative master plan package. At this stage, detailed building designs are still to be developed for the building plots and only the building surface areas are available as well as the description of the intended use of the building. Therefore, energy consumption estimates have been produced taking into account types of building use rather than specific detailed design proposals for individual buildings
- Energy consumption of the existing buildings is estimated based on typical benchmarks rather than measured data
- Energy use related to transport is not covered in this environmental statement
- Energy use related to construction transport, the construction process and embodied energy is not covered in this chapter as this is not possible to quantify at this stage
- Local air emissions as a result of on-site fuel combustion for energy supply is not covered here; refer to Chapter 6

Within the limitations of the outline planning application, this report is regarded as a robust assessment of relative energy consumption implications although specific energy consumption figures will vary as the design develops.

16.3.6 Assessment methodology consultation

For validation of the assessment approach used the following bodies were consulted:

- Penwith District Council
- Government Office for the South West
- Cornwall Sustainable Energy Partnership
- The Hayle Area Plan Partnership
- The Cornwall Sustainable Building Trust
- South West Regional Development Agency

The consultation process focussed on checking that the methodology used to establish the energy strategy was satisfactory. This included consultation on the benchmarks used, types and extent of technologies considered and the anticipation of future legislation. The discussion dates and correspondence are listed in Technical Annex 16G.

16.4 Baseline conditions

16.4.1 History of energy use and generation on the site

There has been a history of significant energy use on the site:

- The two foundries on each side of the harbour, Harvey's Foundry and the Cornish Copper Company were significant users of fossil fuel energy in the form of coal and coke
- The ICI manufacturing facility developed fuel additives for use in aircraft
- The power station which closed in 1979 used coal delivered by ship from South Wales to meet the electricity needs of much of Cornwall
- Carnsew Pool was used for energy cooling of the power station

The tidal driven sluicing of water through the harbour from Copperhouse Pool and Carnsew Pool has been a significant historic application of a natural energy source on the site. The use of sluicing reduced the need for mechanical dredging which offset the use of fossil fuels that would otherwise have been consumed by mechanical dredges.

More recently the site has largely become disused, the remaining buildings are few in number and use of the site as a whole is at a very low intensity. However, it is proposed that soon Hayle will play a significant role in the development of a network of renewable energy sources, starting with wave power. The coast of Hayle is the proposed home of the Wave Hub which will bring renewable power ashore generated by a range of wave energy generation technologies. It is likely that this power will be transmitted by undersea cable and fed into the National Grid transmission system at Hayle, where a monitoring and demonstration centre could be located in the future.

16.4.2 Assessment of baseline energy consumption and emissions

At present the site is largely unoccupied brownfield land used at low intensity as shown in Figure 16.2. Baseline energy consumption and CO_2 emissions for the site have been aggregated from estimates for the following buildings which are currently in use:

- Chieftains Yard on North Quay
- ICI Octel Building Café
- Hayle Harbour Office in the former Customs House
- Farm buildings on Riviere Fields
- Boat builder and shellfish wholesaler on East Quay

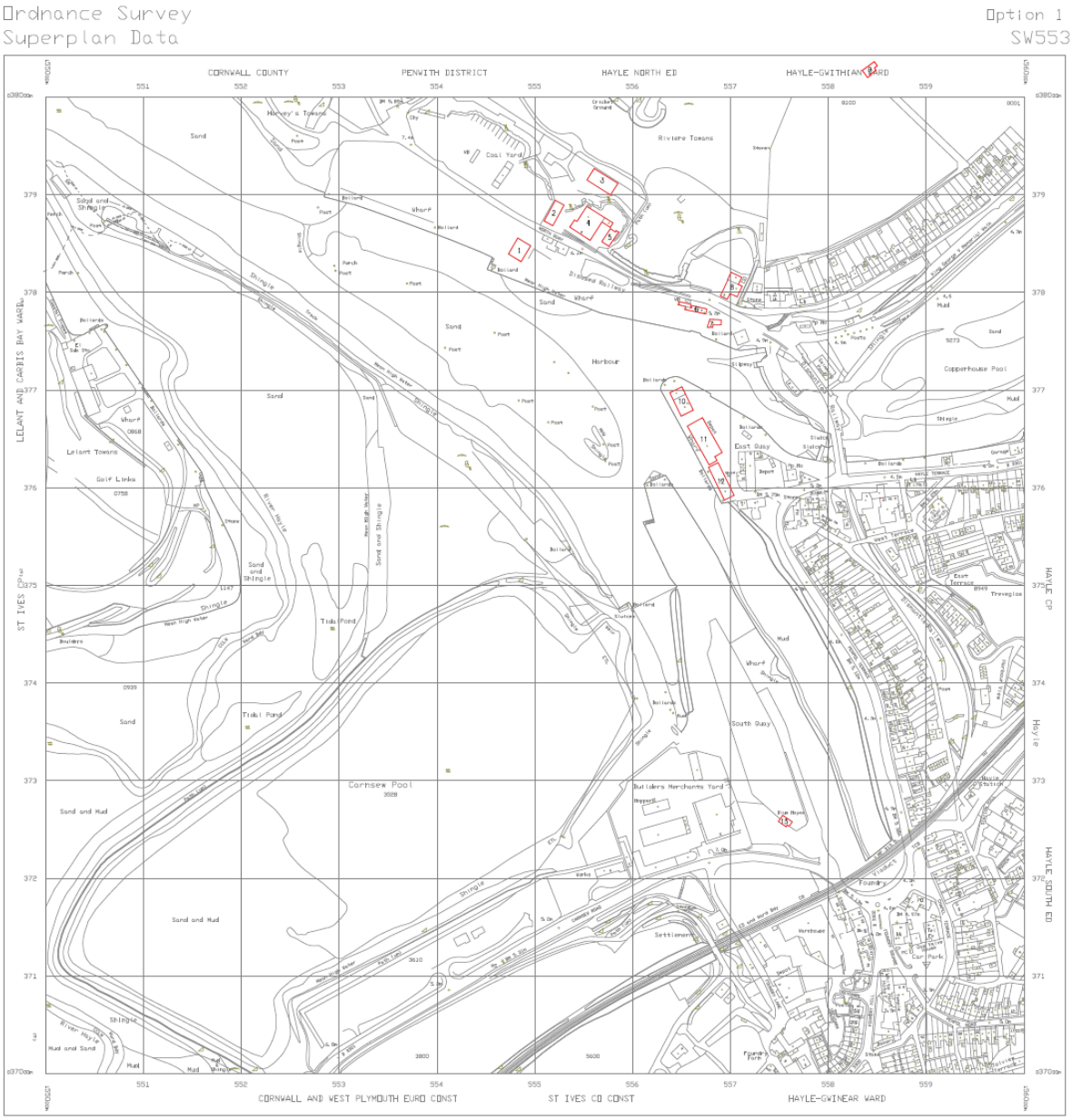

Figure 16—2 Ordnance Survey map of existing site and buildings

As set out in Technical Annex 16A, the estimated current annual CO_2 emissions from the existing buildings are summarised in Table 16.3 and 16.4.

	North Quay		South Quay		East Quay		Riviere Fields		Total	Total
	tonnes CO_2	% of total	tonnes CO_2	% of total	tonnes CO_2	% of total	tonnes CO_2	% of total	tonnes CO_2	% of total
Heating & Hot Water	97	23%	0	0%	41	10%	7	2%	145	34%
Electricity	193	45%	0	0%	87	20%	5	1%	286	66%
Cooling	0	0%	0	0%	0	0%	0	0%	0	0%
Total	290	67%	0	0%	129	30%	12	3%	431	100%

Table 16– 3 Baseline CO_2 emissions by end use

	North Quay		South Quay		East Quay		Riviere Fields		Total	Total
	tonnes CO_2	% of total	tonnes CO_2	% of total	tonnes CO_2	% of total	tonnes CO_2	% of total	tonnes CO_2	% of total
Residential	0	0%	0	0%	0	0%	12	3%	12	3%
Retail	102	24%	0	0%	0	0%	0	0%	102	24%
Community	0	0%	0	0%	0	0%	0	0%	0	0%
Office	103	24%	0	0%	0	0%	0	0%	103	24%
Leisure	0	0%	0	0%	0	0%	0	0%	0	0%
Hotel	0	0%	0	0%	0	0%	0	0%	0	0%
Ind.Facility	85	20%	0	0%	129	30%	0	0%	214	50%
Total	290	67%	0	0%	129	30%	12	3%	431	100%

Table 16– 4 Baseline CO_2 emissions by building type

The current annual energy related emissions for the site are estimated to be 431 tonnes of CO_2.

16.4.3 Regional and local baseline emissions

For comparison with the emissions from the proposed development gas and electricity consumption for Penwith district in 2005 is set out below (DTI, 2007):

Domestic gas use	247 GWh by 16,680 consumers
Commercial and industrial gas use	64 GWh by 290 consumers
Total gas use	311 GWh by 16,970 consumers
Domestic electricity use	172 GWh by 33,100 consumers
Commercial and industrial electricity use	128 GWh by 4,500 consumers
Total electricity use	300 GWh by 38,000 consumers

Applying the emission factors as set out in Table 16.1, the CO_2 emissions for Penwith District arising from gas and electricity consumption in 2005 were approximately:

Gas use	59,000 tonnes CO_2
Electricity use	129,000 tonnes CO_2
Gas and electricity	188,000 tonnes CO_2

The population of Hayle is 7,474; out of 63,000 in Penwith (Penwith DC 2007). Allocating gas and electricity use equally across the population gives an approximate estimate of 2005 CO_2 emissions for Hayle of:

Domestic CO_2 for Hayle	14,000 tonnes CO_2
Total CO_2 for Hayle	22,000 tonnes CO_2

16.5 Assessment of potential impacts for unmitigated scheme

As set out in Technical Annex 16B, the estimated annual CO_2 emissions for the development constructed to 2006 Building Regulations standards before additional mitigation measures are summarised in Table 16.5 and 16.6.

	North Quay		South Quay		East Quay		Riviere Fields		Total	Total
	tonnes CO_2	% of total	tonnes CO_2	% of total	tonnes CO_2	% of total	tonnes CO_2	% of total	tonnes CO_2	% of total
Heating & Hot Water	762	14%	634	12%	69	1%	360	7%	1,825	34%
Electricity	1,337	25%	1,435	27%	123	2%	479	9%	3,374	64%
Cooling	60	1%	29	0.6%	19	0%	0	0%	108	2%
Total	2,159	41%	2,099	40%	210	4%	839	16%	5,307	100%

Table 16– 5 Unmitigated scheme CO_2 emissions by end use

	North Quay		South Quay		East Quay		Riviere Fields		Total	Total
	tonnes CO_2	% of total	tonnes CO_2	% of total	tonnes CO_2	% of total	tonnes CO_2	% of total	tonnes CO_2	% of total
Residential	1,008	19%	529	10%	0	0%	839	16%	2,376	45%
Retail	291	5%	1,179	22%	0	0%	0	0%	1,470	28%
Community	0	0%	80	2%	210	4%	0	0%	290	5%
Office	440	8%	308	6%	0	0%	0	0%	749	14%
Leisure	123	2%	0	0%	0	0%	0	0%	123	2%
Hotel	172	3%	0	0%	0	0%	0	0%	172	3%
Ind.Facility	117	2%	0	0%	0	0%	0	0%	117	2%
Car Park	8	0%	3	0%	0	0%	0	0%	10	0%
Total	2,159	41%	2,099	40%	210	4%	839	16%	5,307	100%

Table 16– 6 Unmitigated scheme CO_2 emissions by building type

The values in Table 16.5 and 16.6 are calculated based on indicative floor areas. Hilltop areas are included within Riviere Fields and North Quay.

The unmitigated proposed development would generate approximately 5,300 tonnes CO_2, twelve times the current baseline CO_2 emissions of the site, and increase the total estimated Hayle CO_2 emissions by 19%. The total CO_2 emissions for Penwith District would be increased by approximately 3%. This is a minor detrimental impact in the local context and in consideration of the amount of new development in the UK. Such increases are to be expected as an inevitable consequence of any new development of this scale built to current standards.

16.6 Mitigation

In response to the key policy targets set out in 16.2.2 the design for the proposed development has the following objectives, against which the mitigated scheme will be developed as detailed design progresses:

- Meet and exceed Building Regulations Part L through passive and efficiency means to reduce energy consumption
- All buildings to achieve either a 'very good' BREEAM rating or a Level 4 rating in Code for Sustainable Homes as appropriate
- To provide, as a minimum, sufficient on-site renewable energy generation to reduce CO_2 emissions from building energy use by 10%

As detailed in Technical Annex 16C, to achieve BREEAM 'very good' ratings for the non-residential areas of the development a CO_2 emission reduction of approximately 27% over and above current Building Regulations is required.

To achieve Code for Sustainable Homes Level 4 requires a compulsory 44% reduction in CO_2 emissions beyond Building Regulations requirements using the SAP method. This can be achieved via the application of a range of efficiency measures and/or the use of renewable technologies.

The mitigated scheme would use a combination of passive energy, energy efficiency and alternative energy technology techniques to reduce CO_2 emissions. Specific passive and efficiency design measures have not been included in the illustrative masterplan; however realistic targets are set beyond 2006 Building Regulations. The scheme would be designed to meet the relevant Building Regulations when construction begins. These are either likely to be the same or more onerous than the 2006 standards. As the design of each element of the scheme develops a comprehensive energy strategy for each element and the development as a whole would emerge harnessing the most appropriate blend of energy sources and technologies.

The Hayle Wave Hub inter-connector is proposed to come to shore in Hayle and is likely to be supported and serviced from Hayle Harbour. However the energy from the Wave Hub and other 'off-site' renewables is not considered in this assessment. Should eventual occupants/users choose to procure energy supplies from the Wave Hub and/or other off site renewable source, the resulting CO_2 savings would be in addition to those resulting from the mitigation measures set out in this report. The site boundaries as shown in Chapter 3 are taken as the boundaries for site energy generation to qualify as 'on-site'.

16.6.1 Review of passive energy reduction measures

The first measure that would help to reduce carbon emissions from any buildings or group of buildings is an efficient design. A low energy, low carbon design is a key starting point to minimise energy use. It is the role of the building designer to simplify the building and make it more energy efficient. To ensure the low carbon principles are maintained the buildings would incorporate the following low energy characteristics wherever practical:

- Orientation - Maximise south facing glazing to make most of solar radiation in the winter
- Shape – A low volume to surface ratio means a compact building that would minimise conduction losses through the fabric hence requiring less heating
- Thermal mass – Building elements with high mass and calorific capacity can absorb excess heat and delay peak conditioning times
- Improved fabrics and glazing –To exceed the requirements of Part L which would minimise heat losses
- Improve air tightness – Reduces the level of heat losses and gains and the energy required to condition the infiltration air

- Natural lighting – Careful design to incorporate daylighting and use of lighting controls would lead to a reduction in artificial lighting required and its associated energy demand
- Natural and demand-driven ventilation – Minimise the amount of energy required to condition a building

These methods are discussed in further detail in Technical Annex 16D.

16.6.2 Review of energy efficiency measures

A range of potential energy efficiency measures have been reviewed and are set out in detail in Technical Annex 16E. Table 16.7 presents a summary of the results of this review. Measures marked with a tick are to be considered in the detailed design stage while measures marked with an x are not considered feasible for the specified area.

Technology	North Quay	South Quay	East Quay	Riviere Fields	Conclusions
Wind- Large Scale	×	×	×	×	Will conflict with adjacent bird sanctuary
Wind- Small Scale	×	×	×	×	Unproven technology, low carbon savings. could be used for art, educational or way-finding
Solar Photovoltaics	✓	✓	✓	✓	High capital cost, good for 'green' image, could be used to supplement other technologies
Solar Hot Water	×	×	×	✓	High capital cost, good for 'green' image, could be used to supplement other technologies
Biomass	✓	✓	✓	✓	Would work well with district heating system or for individual properties
Biomass CHP	✓	✓	✓	×	Unproven technology with high capital cost which requires further investigation
Ground Source Heat Pumps	✓	✓	✓	✓	Energy efficient provision of both heating and cooling but require electrical energy
Ground Water & Harbour Cooling	✓	✓	✓	×	Low capital cost and energy efficient. Further investigation required

Energy from Waste	×	×	×	×	On-site waste stream is not considered sufficient but could be investigated if local plans dictate
Hydro Power from Sluicing	✓	✓	✓	×	Use of energy generated from sluicing will require further investigation

Table 16– 7 Initial review of suitability for applying energy efficiency measures across the proposed

16.6.3 Hayle Harbour redevelopment

For the purposes of Table 16-7, the units proposed for Hilltop are split between North Quay and Riviere Fields.

The energy reduction impact and level of utilisation of passive and energy-efficiency design measures cannot be assessed at the masterplanning stage. These require detailed designs for each building to establish the effect of overshadowing, air flow and floor layout. Integration of these measures will be incorporated as the project develops through detailed design.

Regardless of the design, there has always been a significant difference between calculated and actual building energy consumption. Quality of construction is considered one of the reasons for this discrepancy. It would therefore be necessary to have an inspection regime in place to ensure items such as continuity of insulation and the treatment of cold bridging to be signed off by a competent person. This could involve the use of thermal imaging at completion to provide visual evidence of faults.

16.6.4 Review of renewable energy options

A range of renewable energy technologies have been reviewed, which are set in detail in Technical Annex 16F. Table 16.8 presents a summary of the results of this review. Options marked with a tick require further investigation during the detailed design stage to establish their potential contributions to the proposed development while options marked with an x are not considered feasible for the specified area The following renewable energy technologies were reviewed:

- Large scale wind – Large scale wind turbines which typically generate large amounts of electricity
- Small scale wind – Building integrated urban scale turbines which generate electricity
- Solar photovoltaics – Solar photovoltaic panels convert direct and diffuse energy from the sun into electrical energy
- Solar hot water collectors – Utilising the sun's energy to heat water on south facing roofs
- Biomass boiler – The use of woodchip as part of modern efficient heating systems for heat supply

- Biomass Combined Heat and Power (CHP) – Biomass CHP is the simultaneous generation of useful heat and electricity from biofuels
- Ground source heat pump – A heat pump that uses the earth as a heat source when operating in heating mode, or a heat sink, when operating in cooling mode
- Ground water and harbour cooling - Heat is extracted from a building by way of a heat pump and rejected into the harbour/ ground water which acts as the heat sink.
- Energy from waste – waste treatment that creates energy in a form of electricity or heat from a waste source that would have been disposed of in a landfill
- Tidal power – A form of hydropower that exploits the rise and fall in sea levels due to the tides, or the movement of water caused by tidal flow
- Hydro power from sluicing – Power generated through the sluicing of pools

Technology	North Quay	South Quay	East Quay	Riviere Fields	Conclusions
Intelligent Control Systems	✓	✓	✓	✓	To be investigated and incorporated during the detailed design of the development
Low Energy Lighting	✓	✓	✓	✓	To be incorporated during the detailed design of the development
Lighting Control Systems	✓	✓	✓	✓	To be investigated and incorporated during the detailed design of the development
Demand Driven Ventilation	✓	✓	✓	✓	To be reviewed at the detailed design stage for areas such as enclosed car parks
Heat Recovery Systems	✓	✓	✓	✓	To be investigated further during the detailed design of the development
High Efficiency Plant and Equipment	✓	✓	✓	✓	To be incorporated during the detailed design of the development
District Heating	✓	✓	×	×	More efficient and would serve to 'future proof' development but with additional capital cost
Combined Heat & Power (CHP)	✓	✓	✓	×	Promotes local involvement and provides operational savings

Table 16– 8 Review of renewable energy options summary

16.7 Residual impacts from the mitigated scheme

16.7.1 Key features of mitigated scheme

The commitment to meeting the targets of BREEAM 'Very Good' and Code for Sustainable Homes Level 4 would allow for a site wide CO_2 emissions reduction of approximately 24% based on an average energy requirement. Table 16.9 shows the percentage improvement beyond Part L and the effective total reduction. The values do not include cooking or appliance energy consumption which is not assessed as an element of Part L.

	Building type	CO_2 reduction beyond Part L	CO_2 Savings (tonnes)	CO_2 Savings (%)
North Quay BREEAM 'Very good' CfSH Level 4	Commercial	27%	263	5%
	Residential	44%	261	5%
South Quay BREEAM 'Very good' CfSH Level 4	Commercial	27%	344	6%
	Residential	44%	137	3%
East Quay BREEAM 'Very good'	Commercial	27%	49	1%
Riviere Fields CfSH Level 4	Residential	44%	217	4%
Total			1,270	24%

Table 16– 9 Estimated CO_2 emission savings required to meet policy targets

* The percentage carbon savings are based on the estimated values for the proposed development which include both cooking and appliance loads. The percentage reduction beyond Part L is therefore higher than the estimated reduction.

The values in Table 16.9 are calculated based on indicative floor areas. Hilltop areas are included within Riviere Fields and North Quay

The reduction would be achieved through a combination of passive and energy efficiency measures (as detailed previously), and renewable energy options. From an initial feasibility study comparing technical performance, site suitability, environmental impacts and financial viability the following renewable energy technologies are considered to be the most appropriate for the proposed development:

- Biomass district heating for North Quay
- District heating using biomass boilers or gas-fired CHP for South Quay
- An individual biomass boiler or heat pump system for the building proposed for East Quay
- Individual dwellings covering Hilltop and Riviere Fields will use technologies deemed suitable by the housebuilder, this may include ground source heat pumps or biomass boilers or roof-mounted technologies such as solar hot water collectors

These technologies would be sized to achieve the CO_2 reduction levels required to meet the targets as demonstrated in Table 16.9.

16.7.2 Renewable energy framework

The renewable energy framework aims to achieve a minimum of 10% saving in CO_2 emissions using on-site renewables. This 10% target would be met as part of the BREEAM and CfSH targets previously described. These aims require careful consideration and comparison of the viability of renewable energy options for each of the building types proposed for Hayle Harbour. In addition, the ability to adapt the systems and strategies as technologies develop or energy demand changes is important for a multi phase development of this scale.

The areas of high density mixed-use development provide an opportunity for using a district heating system served by an energy centre. District heating would help to 'future proof' the development as the energy centre could be adapted as new technologies emerge without requiring retrofitting of every building connected to the system. The most effective energy options for use with district heating are biomass boilers or CHP systems (though CHP is not a renewable energy technology unless fed with renewable fuels).

The low density housing areas such as Riviere fields may not be suitable for connection to district heating due to the larger pipe distances required. These properties would be more suited to using individual renewable energy systems such as solar roofs. Individual systems would allow for flexibility in technology selection dependent on factors such as land availability, roof space or lack of accessibility. This flexibility in design is particularly convenient in multi-phase masterplan developments. The most cost-effective renewable technologies to achieve the targets for individual properties are likely to be biomass boilers and ground source heat pumps. Additional heat or power could also be provided by wind turbines, solar hot water collectors or solar photovoltaic roofs.

16.7.3 Result of mitigation measures

Table 16.10 summarises the emission reductions arising from the adoption of the renewable energy options that may be used to satisfy the needs of the renewable energy framework.

The renewable energy options and energy saving measures selected for the mitigated scheme would reduce CO_2 emissions by 24% from the unmitigated scheme, with the renewables accounting for at least 15%. The mitigation measures reduce the increase in emissions from the baseline scheme. The unmitigated scheme would emit more than twelve times the current baseline emissions, whereas the mitigated scheme would reduced emissions to nine times greater than the baseline. The mitigated scheme results in an increase of total estimated Hayle CO_2 emissions of 15% accounting for a 2% increase for Penwith District. This small increase represents a minor environmental impact.

Area	Technology	Size	Option1 CO_2 savings (tonnes)	Option1 CO_2 savings (%)	Option2 CO_2 savings (tonnes)	Option2 CO_2 savings (%)
North Quay Option 1 Option 2	100% Biomass	2.8MW	762	14%		
	50% Biomass	1MW			381	7.2%
South Quay Option1 Option2	50% Biomass	0.6MW	317	6%		
	CHP	160kWe			101	1.9%
East Quay Option1	100% GSHP	0.5 MW	33	0.6%	33	0.6%
Riviere Fields Option1 Option2	Biomass Boilers	25kW	360	7%		
	GSHP	4kW			295	6%
	Solar HW	4m2			265	5%
	Solar PV	2m2			105	2%
Total			1472	28%	1180	22%

Table 16– 10 CO_2 emission reductions from chosen renewable energy technology options

16.7.4 Barriers to the implementation of mitigation measures

Several barriers exist to the implementation of the mitigation measures discussed throughout this chapter. In particular, detailed building layouts are unknown which limits the extent to which mitigation measures can be assessed. Some of the main barriers are as follows:

Barriers to passive measures:

- Orientation, shape and position of buildings has not been fixed. Detailed design decisions would influence the use of passive lighting and ventilation strategies
- Insulation levels, material selection and construction types would vary between buildings
- Part L requirements for building fabric, glazing and air tightness may change
- Associated costs of implementation of passive measures would vary between buildings and with time

Barriers to energy efficiency measures:

- Associated costs of implementation of energy efficiency measures would vary
- Existing infrastructure and development phasing could affect the viability of a district heating scheme

Barriers to renewable energy technologies:

- Capital cost limitations and phasing
- Insufficient land available for some technologies
- Impact of existing infrastructure for deliveries of biomass fuels
- Overshadowing of surrounding buildings
- Public perception of the visual impact of technologies
- Ownership and financing of the systems
- Perceptions of risk and uncertainty of performance
- Low density areas such as Riviere Fields and areas of Hilltop
- Ecological issues surrounding the proposed development

The majority of these barriers are characteristic of proposed developments at the masterplanning stage. The mitigation measures recommended in this report have taken into account the nature of the proposed development site and the barriers to their implementation and have therefore selected those technologies viewed to be most appropriate. The mitigation approach has been developed in consideration of these barriers and on this basis we are confident that the mitigation measures proposed are feasible and practicable.

16.7.5 Further mitigation

The technical options for mitigation of energy consumption impacts are described and analysed in detail in Technical Annex F. The chosen mitigation options are a balance between meeting the CO_2 targets set, financial constraints and practical limitations. Provision of centralised heating systems on North and South Quay allows flexibility for further mitigation and other options are also available as outlined in Table 16.10. The extreme level of mitigation would be to aim for carbon neutrality; this would require reducing energy consumption to an absolute minimum and supplying all energy from local renewable sources. In the context of the proposed development, the main difficulty is the generation of power on-site. In the UK wind power is an economical and efficient means of generating electricity on a large scale. However, the risk of bird strike and the difficulties of locating a wind turbine near to residential accommodation cancelled out all of the most beneficial locations on the site. The second option for site wide electricity generation and provision would be the use of Biomass CHP. Although there are several installations underway in the UK at present these are yet

to be constructed and operated reliably for long periods, so it is still considered an untested and unreliable technology.

At present the ability for the proposed development to attain carbon neutrality is not seen as an attainable goal. This may change as new technologies establish themselves as reliable and suitable for larger developments. The mitigation measures of the proposed development facilitate the reduction of a large proportion of the CO_2 emissions far above the required or anticipated levels with opportunities for future improvements through the provision of the district energy system. In conclusion, the residual emissions, whilst inevitably greater than in the baseline scenario, are minor in the context of regional and national emissions and the overall environmental impact of those increased emissions is a minor detriment.

16.7.6 Monitoring of impact

The European Union Energy Performance of Buildings Directive (EPBD), which was implemented in January 2006 calls for energy performance targets to be set based on either calculated Carbon Dioxide emissions or on measured performance data. To enable tenants and building occupiers to monitor there energy use individual metering would be provided. The provision of visible smart meters, giving an instantaneous indication of current energy consumption would be reviewed as the scheme develops.

The proposal to include central generation of heat via biomass fired boilers gives the opportunity to monitor energy use for the proposed development as a whole. It is anticipated that smart meters would be provided as part of the district heating provision. If an energy services company were to be used, the energy consumption per property would be monitored for billing purposes.

16.7.7 Ongoing cumulative effects

The energy consumption predictions are based on measurements taken from existing buildings. This chapter considers the environmental impact from this energy use in terms of man-made CO_2 emissions which are believed to lead to global warming. The IEA (2005) estimated world CO_2 emissions from energy use as 24,983 million tonnes in 2004, of which UK emissions account for 540 million tonnes CO_2. The anticipated CO_2 emissions resulting from this energy use are too small to be considered to have a measurable cumulative effect on the global scale.

16.8 Conclusions

The recently issued Housing Green Paper (DCLG, 2007a) illustrates the Government's target of increasing the amount of housing available. Although it is encouraged that this housing be built with sustainability in mind, it is clear that due to the lack of imposed regulations beyond minimum Building Regulations, the majority of new buildings in the UK will meet only minimum requirements for the immediate future.

This study has evaluated the impact of the existing buildings at Hayle Harbour and compared the proposed development under minimum requirement conditions. A strategy for mitigation beyond minimum regulatory requirements has been developed to meet planning requirements, relate to wider strategies and reflect the commitment of the client to reducing CO_2 emissions. This mitigation strategy provides significant improvements beyond the unmitigated scheme and the requirements of relevant regulations.

16.8.1 Mitigation and contributions

The proposed development aims to reduce the impact it could have on the environment far beyond levels currently required. It aims to anticipate future legislation which may affect later phases. This would be achieved through:

- Meeting and anticipating future legislation with regards to CO_2 emission reductions
- Efficient use of energy
- Use of renewable energy
- Reduction of annual CO_2 emissions by approximately 1,270 tonnes (24%) compared to the standard unmitigated scheme
- Reducing reliance on imported fossil fuels and support local fuel supply
- Contributing to the achievement of international, national, regional and local goals for the sustainable use and generation of energy

16.8.2 Meeting policy requirements

The Draft Regional Spacial Strategy for the south west includes two relevant policies, as discussed in section 16.2.1:

Development Policy G– Sustainable Construction

"…all new and refurbished buildings achieve the requirements of BREEAM and Eco-homes, very good standard, or at least Level 3 above minimum building standards in the emerging 'Code for Sustainable Homes' in order to minimise lifetime resource use, energy consumption, water use and waste production

Requiring that all larger scale developments, in particular, urban extensions, are designed and constructed to meet the top Level 5 of the emerging 'Code for Sustainable Homes', including carbon neutrality"

RE5 Renewable Energy and New Development

"Larger scale developments will be expected to provide, as a minimum, sufficient on-site renewable energy to reduce CO2 emissions from energy use by users of buildings constructed on site by 10%. .."

Penwith District Council specifies in the Penwith Local Plan 2004 Policy GD-2 that ''the design and layout of development should: (iii) maximise passive solar gain and utilise energy efficient building types.'' (Penwith DC, 2004).

Although these requirements are not yet in the Hayle local plan, they are expected to form part of the context for the emerging Penwith Local Development Framework and Hayle area action plan. As such, the proposed development has been designed to reflect these strategies through:

- Achieving BREEAM 'very good' rating for all commercial buildings
- Achieving a minimum of CfSH level 4 for all residential properties
- Seeking to maximise passive solar gain
- Seeking to employ the use of energy efficient building types

16.8.3 Residual impacts

The proposed mitigated development would increase the number of households in Hayle by approximately 27% while increasing the CO_2 levels by only 15%. Likewise the number of households for Penwith District would be increased by 4% with an associated CO_2 emissions increase of only 2%. It is anticipated that an unmitigated scheme would increase the emissions proportionally to the increased accommodation. Mitigation lessens the impact of the scheme and is considered a highly significant aspect of the proposed scheme. The increase in the emissions of the proposed development can be considered minor when compared to the proportion of housing and non-domestic facilities provided by the development.

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