CENTRE FOR SUSTAINABLE ENERGY

Towards Low-carbon Housing Developments: a cumulative approach to reducing carbon emissions

Final Report

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With Claire Chambers

Feasibility study under the Innovations Programme 2004–2005

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A cumulative approach to carbon reduction

1 Project details

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The work described in this report was carried out with support from the Energy Saving Trust's Innovation Programme. The views and judgements expressed in this report are those of the authors and do not necessarily reflect those of the Energy Saving Trust.

2 Partner details

Partner organisations	**The partner's role within the project**
South Gloucestershire Council	**Lead Partner.** South Gloucestershire Council has lead this project. The council provided both cash and in-kind support during the feasibility phase. Anthony Keown has helped to facilitate the project, and will ensure that findings are disseminated to appropriate council staff and departments such as Planning and HECA.
Centre for Sustainable Energy (CSE)	**Project manager and project consultant**. CSE has managed the delivery of this project, facilitated the joint activities, and provided the technical input. CSE has also been responsible for reporting progress to the Key Contact and the EST.
Gallagher Estates	**Project partner**. Gallagher Estates are one of a consortium of developers that will build housing on the Emersons Green site. Gallagher Estates have provided in-kind support and the developer's perspective to this project. Gallagher Estates have been represented on this project by the Richard Hodkinson Consultancy

3 Executive summary

This report has been prepared by the Centre for Sustainable Energy. It is submitted following completion of the feasibility study '*Towards Low Carbon housing developments: a cumulative approach to reducing carbon emissions'* completed under the Energy Saving Trust's Innovation Programme.

Unless otherwise stated, the views, recommendations and conclusions expressed within this report are those of the Centre for Sustainable Energy and are not necessarily those of either South Gloucestershire Council or Gallagher Estates or their representative in this project Richard Hodkinson Consultancy.

This study has considered the options for achieving additional reductions in the net emissions of carbon dioxide (CO_2) for a mixed development proposed at Emersons Green on the northern fringe of Bristol. The development will comprise some 1500 homes, a science park, leisure facilities and school. 'Additional reductions' refers, in this context, to a lowering of emissions of carbon dioxide from those which would be produced by constructing the development to relevant current building and planning regulations.

The study has adopted the government target for achieving a 60% cut in emissions by 2050 from levels in 1997/8, as the overall target for this development.

By way of comparison the study has considered a mixed development in Kronsberg, Germany. Unlike the Emersons Green development this was designed from first principles to achieve a reduction in emissions of carbon dioxide of 80%. Though clearly different in approach it has been considered to see what lessons may be learned and applied in this and other developments in the UK.

The starting point for this study was to consider the policy context and drivers for achieving additional reductions in emissions of green house gases, at a national, regional and local level.

In order to assess progress towards the government's 60% reduction target it was necessary to consider the impact of changes and tightening in Part L of the Building Regulations which have applied since 1998. This was assessed by working back and assuming that the proposed development was constructed in 1998, to applicable building regulations. The improvements in thermal efficiency and emissions resulting from changes in Part L of the Building Regulations between 1998 to 2005 and changes in the carbon factor were then applied to this model, to assess the overall reduction in emissions. The model incorporates a number of assumptions such as the breakdown of house types, sizes and plan forms. These have been stated within the report, and where available, calculated data has been compared with published sources, and has been found to be a good fit.

The study has considered an Energy Hierarchy used in Kronsberg for the application of carbon saving measures to a large mixed use development and has considered a similar approach adopted within the London Energy Strategy. The latter may be summarised as 'Be Lean – reduce demand, Be Green – make use of renewable energy, and Be Clean – maximise efficiency when using fossil fuels'. The London Energy Strategy hierarchy has been used to order the recommendations contained within the report.

Barriers to the inclusion of additional carbon saving measures have been considered along with solutions for overcoming these and what role the local authority might take in this respect, both now and in the future.

The recommendations within this report are relatively modest and reflect the fact that, unlike the Kronsberg development, Emersons Green has not been designed from first principles to achieve very low carbon emissions. Included within these is a recommendation for a minimum EcoHomes standard for the domestic dwellings. EcoHomes provides a convenient way of 'wrapping' the individual factors which go to make up the total environmental impact of the development including energy use and transport.

The study has produced a number of findings. In addition to the government CO_2 target, there are other strong policy drivers for improving the energy efficiency of the proposed dwellings which include the forthcoming EU Directive on Buildings, and the Sustainable Buildings Code. Furthermore, the expected lifespan of the dwellings constructed today easily exceeds the timeframe for achieving the 60% reduction in emissions.

It is obvious from considering other developments as part of this study that few developers at the present time regard better environmental performance (including energy saving) as a strong selling point. This may change with the introduction of the Sellers Packs in 2006, but it also suggests the need for further and sustained work in raising awareness of the short and long term benefits of better energy and environmental performance.

With the review of the instruments of local planning policy and the publication of Planning Policy Statement 22, local authorities have an opportunity to set targets for renewable energy within new developments. A number of local authorities are now in the process of doing this. Setting a target for renewable energy has the knock on benefit of improving energy efficiency and reducing overall energy demand, as this is generally cheaper than providing the requisite level of renewable energy input.

The study has concluded that the proposed revisions to Building Regulations due to take effect in 2005 will lead to approximately a 40% reduction in emissions of CO_2 when compared to a similar dwelling built to regulations in 1998.

One of the main barriers and constraints identified in this study is that additional carbon saving measures were not factored into the calculation of Residual Land Value, and are therefore considered as additional costs which must either be passed on to purchasers or absorbed by the developer. This is a significant factor in considering what additional measures would be feasible, in this and other developments. The developer of the Emersons Green site has made it clear that any additional measures would need to be considered on their merits and with due regard to the cost and practicality.

To be effective, additional measures need to be factored in before land is purchased, and purchasers need to be aware of the benefits they will bring. The use of targets within Local Development Framework provides one route for doing this. Initiatives by the developer, local authority and third party agencies to sell the immediate and long term benefits of better energy and environmental performance are also required. In this development there is scope for making further reductions in emissions of CO_2 over and above those which will result from the 2005 revision to Part L of the Building

Regulations, by implementing some or all of the recommendations within this report, where agreement can be reached between all parties.

4 Description of the feasibility study

4.1 Scope of the study

This study has considered the feasibility of achieving additional reductions in emissions of carbon dioxide, at a new development proposed for Emersons Green in South Gloucestershire. These additional reductions are over and above those which would be reached by constructing to appropriate building and planning regulations.

Emersons Green is situated on the northern fringe of Bristol. The development will comprise 1500 new houses, a science park, school and leisure facilities. Construction is due to commence in 2006/2007 and to take place in 2 phases over a period of 6 or more years.

The study has examined a methodology developed in Germany by Hannover City Council for a new development at Kronsberg as part of a European Expo, to see if it might be applicable for a UK development of this sort.

One of the key differences between the development at Emersons Green and that at Kronsberg was that the latter was designed from first principles to be a low carbon development, reducing overall emissions of carbon dioxide by 80% (when compared to a conventional development).

This study has considered what modifications can be made to a 'conventional' development which will be built according to applicable Building Regulations (2005).

The report includes recommendations for relatively minor modifications for achieving further reductions in emissions of carbon dioxide.

Unless otherwise stated the views and recommendations expressed within this report are those of the Centre for Sustainable Energy. From discussions with the Richard Hodkinson Consultancy, representing Gallagher Estates, it is apparent that there are areas where there will be a difference of opinion or emphasis between CSE and the developers. Where this is the case we have endeavoured to clearly state these as they are both valid and important in a study of this sort, particularly in considering how the conclusions may be applied to other developments, and by other Local Authorities. Gallagher Estates has made it clear that any initiatives that are taken to reduce emissions of CO_2 will be considered on their merits which due regard to cost effectiveness and practicality.

4.2 Background to the study

The local context

South Gloucestershire Council (SGC) is faced with a significant demand for new housing. Between 2005 and 2011 approximately 3700 new homes will be constructed on two mixed use sites at Emersons Green and Filton North Field.

In its forthcoming Local Plan the Council has said it will seek to *'meet the dwelling needs …in a manner which is consistent with the concept of sustainable development'*.

SGC is a signatory to the Future Energy West strategy, and is also striving to reduce CO_2 emissions by 60% by 2050 in line with the commitment in the Energy White Paper (2003).

Large scale housing developments provide an opportunity to make progress towards this long term target, by exceeding current standards. One of the difficulties faced by local authorities is persuading developers to go beyond the energy efficiency and design requirements of building and planning regulations, when the development is on private land.

South Gloucestershire Council is in the process of developing a draft development brief for public consultation which comprises the following headings:

- Local character assessment
- Site analysis
- Development objectives
- Indicative Master Plan
- Urban Development concept
- Transport concept
- Landscape concept
- Open space concept
- Social concept
- Supporting strategies
- Design principles
- Character areas
- Implementation
- Monitoring and review

The master developer in this case is Gallagher Estates which is one of the largest developers promoting and developing residential and mixed use schemes through the planning system in Britain.

The company is not a house builder but acts as a 'master developer'. As such the company retains responsibility for the delivery of planning obligations and all aspects of the public realm including affordable housing and landscaping.

Developers purchasing land from Gallagher's are obliged to build in accordance with the design codes agreed between Gallagher Estates and South Gloucestershire Council.

International experience

This study has drawn on a methodology developed by Hannover City Council for use on a development in Kronsberg. In order to apply a structured and coherent approach to a low carbon development Hannover City Council implemented a cumulative approach to carbon reduction.

The features of this approach are that:

i) it provides a rational and transparent framework for achieving reductions in emissions

ii) it employs both existing and new technology and techniques

iii) it is holistic taking into account total carbon emissions

iv) it restricts the use of 'sweeteners', (measures which appear attractive but have a low carbon saving potential)

v) it ranks measures according to their carbon saving potential enabling dissimilar measures to be compared and

vi) by considering issues such as build quality it is highly relevant to the current agenda within the construction industry.

A similar hierarchical approach has been developed as part of the London Energy Strategy and this has also been considered in detail in this study.

National considerations

In February 2003, the Government published the Energy White Paper in which it made a commitment to reduce emissions of carbon dioxide by 60% by 2050 from levels in 1997/8. This study has taken the 60% reduction as the target for this development. As stated above, South Gloucestershire Council has signed up to the Future West Strategy and is committed to the government targets for reducing emissions of CO_2.

In January 2006, the EU directive Energy Performance of Buildings will come into force in 25 countries across the EU including the UK. The directive states that when a building is constructed, sold or rented an energy performance certificate should be made available to the owner or by the owner to the prospective buyer or tenant.

One of the expected impacts of this legislation is that the energy performance of the building will take on a greater significance during the purchase or rental of a property. We have considered the implications of this forthcoming legislation in the study and made recommendations accordingly.

The government has implemented a revision to planning policy with the Planning and Compulsory Purchase Act in 2004. Planning Policy Guidance have been replaced by Planning Policy Statements. In August 2004 the government published Planning Policy Statement 22 (PPS22) which provided guidance on how local authorities should include requirements for renewable energy into local plans. PPS22 sets the framework for the inclusion of renewable energy in new developments and is discussed further below.

4.3 Aims and objectives

The overall aim of this study was to achieve significant reductions in the total emissions of carbon dioxide from the proposed Emersons Green development.

The study also sought to test the applicability of a cumulative and hierarchical approach to carbon reduction with a large conventional development of this sort.

The four specific objectives of the feasibility study were:

- to develop a hierarchy of carbon reduction measures for implementation on Emersons Green East and other new developments across South Gloucestershire where appropriate
- to work with the developer to establish how many of the recommended measures could be adopted
- to identify the barriers to the implementation of the recommended measures

- to establish what additional support and steps can be taken by South Gloucestershire Council and the other partners, and third parties to overcome these barriers and in so doing enable the development to achieve further reductions in emissions of CO_2.

South Gloucestershire identified their specific objectives as being to:

- review the measures that could be deployed to reduce emissions for the development
- identify the barriers to the deployment of these measures
- draw together the drivers that have a bearing on the efficiency of dwellings including financial, legislative and advisory, and relevant government policies.

4.4 Role of the project partners

The role of the project partners is described above in Section 2.

4.5 Programme of work/methodology adopted

The study has been divided into the following tasks:

i. Review of past projects and policy drivers.
ii. Assessment of baseline emissions of CO_2 from the proposed development.
iii. Development of an energy hierarchy.
iv. Recommendations of measures for inclusion in the proposed development and discussion with the developer on the feasibility of these recommendations.
v. Discussion of further activities and measures which can be adopted to overcome the barriers to implementation with further recommendations.

Task i) Review of past projects and policy drivers

The first phase comprised a review of the following:

- The broad policy context for this study and the local and national policy drivers.
- Best Practice Guidance – guides relevant to this development and study
- UK and European case studies relevant to this development and study.

The bulk of this research was desk based. However, a visit was made to a new development that will comprise of 1500 dwellings at Portishead, a joint venture between Crest Nicholson Residential and Persimmon Homes.

Summarised results are given below. The full findings of the review are given in Appendix 1.

Task ii) Assessment of baseline emissions of CO_2 from the proposed development.

The two objectives within this task were:

(i) to assess the baseline energy consumption and emissions of carbon dioxide from the development as proposed

(ii) to estimate the percentage reduction in emissions and energy consumption when compared to the same development built to the building regulations which applied in 1997/8.

The data was compiled on a spreadsheet which may be found in Appendix 3. The baseline energy consumption and emission figures for the proposed development were produced from an iterative process described below.

Energy consumption figures for the domestic dwellings within the development were modelled by assuming that they were constructed in 1998 to the applicable building regulations. Once this starting point had been established further reductions in energy consumption and emissions of carbon dioxide were calculated by applying the appropriate reductions in both factors arising from the more stringent building regulations implemented in 2002 and 2005.

At each stage in the process the calculated figures were cross checked against data for houses of a similar size from published sources such as the Building Research Establishment (BRE).

Comparison with stock average in 2004:

By way of creating a reference point with which to compare the calculated consumption figures, energy consumption and CO_2 emission figures were obtained for the UK stock average dwellings in June 2004. The data was provided by Practical Help via the EST, and modelled using BREDEM-12. The data assumes stock average dwelling characteristics, standard heating patterns and occupancy.

These figures were not used in further calculations but serve to illustrate how much more efficient new build dwellings are in comparison to the stock average in the UK.

Energy consumption and CO_2 emission figures for dwellings constructed in 1998:

These figures form the basis for the additional calculations as set out above.

Information was requested from the developers at the start of the study regarding the house types planned for the site in order to model the proposed dwellings using NHER Builder and Evaluator. However, this information was not available. The resultant model is based on standard house types and sizes.

For the purposes of these calculations seven basic house types have been considered as used in the stock average model described above. ‘Standard’ floor areas have been assumed and these have been derived from the EEC (Energy Efficiency Commitment) matrix for each house type.

The standard house types are:

- Semi-detached bungalow
- Detached bungalow
- End terrace house
- Mid terrace house
- Semi-detached house
- Detached House
- Flat

Corresponding exposed wall measurements were not available so it was assumed that dwellings had a rectangular plan form, with the long wall forming the party wall with neighbouring properties in the case of the semi-detached and terraced houses. The number of rooms per house is based on an average derived from the number of bedrooms and dwelling type.

The predicted annual delivered energy requirements for these dwellings assuming construction in 1998, and assuming construction to 1990 building regulations, were arrived at by inputting the appropriate measurements, and building data, into NHER Surveyor (Build 5.4).

Standard assumptions were made regarding heating systems and flue types. The software itself includes standard assumptions on the quantity of insulation and heating requirements at a given location.

The software model calculates a total annual energy requirement for each dwelling type and the associated carbon dioxide emissions using the relevant carbon factors (emissions of CO_2 in kg per kWh consumption for each fuel type).

Assessment of the reduction in consumption and emissions arising from the 2002 Building Regulations

Regulatory Impact Assessment (October 2001) states the effect of the 2002 building regulations on the performance of new dwellings as a 25% reduction in heating and domestic hot water cost and a 25% reduction in carbon emissions.

This equates to approximately a 10% reduction in electricity consumption as the change in carbon factor (from 0.51kg CO_2 per kWh to 0.43 – reflecting the change from coal to gas generated electricity) accounts for the remainder of the difference.

Therefore the gas consumption has been reduced by 25% from the 1998 levels and electricity by 10% and the related CO_2 emissions have reduced accordingly.

In order to verify the accuracy of these figures they have been compared to figures provided by Richard Hodkinson Consultancy (arrived at using NHER and BREDEM 12 software), the BRE and the 'One Planet Living in the Thames Gateway' report from the WWF.

Assessment of the reduction in consumption and emissions arising from the 2005 Building Regulations

The Building Regulations 2005 consultation document states that the new regulations will lead to an improvement in energy efficiency of new housing by 25%.

Therefore the 2002 figures for gas and electricity have both been reduced by 25% and the carbon emissions recalculated. The carbon factors have remained unchanged (DEFRA assume 0.43 kg/kWh for electricity from 1999 to 2010 to ensure a consistent base on which to measure savings).

Assessing the impact of renewable energy on the development as a whole

The impact of integrating some forms of renewable energy for each dwelling has been modelled to show what impact this might have on emissions of CO_2.

Solar Hot Water Heating (SHW)

It has been considered that Solar Hot Water will reduce the gas requirement to each household by 1000kWh p.a. and 800kWh p.a. per flat. At this stage in the model it was assumed that all dwellings would have solar water heating. In reality this would not be the case due to the layout of the development and issues such as shading. However the assumption was made in order to model the maximum benefit SWH might provide.

The figures for energy displaced by SHW are based on estimates for the size of panels, which are in turn based on the theoretical mix of housing in the development. The estimated figure of 1000kWh per annum is slightly lower than some of the published data, such as Best Practice guidance which uses a working figure of 1200kWh per household per annum for a 'typical' household and solar collector in the UK. We have adopted the lower figure to show the minimum which might be achieved per household where the measure is installed.

Photo-voltaic panels (PV)

An assessment has been made of the impact of using between 6m^2 and 10m^2 of polycrystalline PV on all dwellings excluding flats. The size of the PV array has been adjusted according to the dwelling type, i.e. the larger the roof area of the dwelling, the larger the panel to be installed (none on flats).

It has been assumed that the arrays would generate between 480kWh and 800kWh per annum for the two sizes, assuming optimum tilt angle and orientation due south. Again the assumption has been made that all dwellings would be fitted with PV. As with SWH this is a theoretical calculation to show the maximum potential benefit that this measure could achieve.

Wind turbine

A scoping assessment was made of the potential for generating electricity from a wind turbine on site. As with PV and SHW this is provided as a theoretical calculation to illustrate the potential of this technology.

Using mapped wind speed data (www.bwea.com), it was calculated that a 15kW turbine at 25m height would be subject to an average windspeed of 5.5m/s and would therefore provide in the region of 35,000 kWh of electricity per year which equates to approximately 20 kWh per dwelling.

Further research would need to be done into the feasibility of wind turbines and whether planning permission would be attainable but it is possible that more than one could be erected onsite thereby increasing the energy supplied on a per dwelling basis.

Task iii) Development of an energy hierarchy

The objective in this phase of the study was to develop a rational approach to the addition of carbon reduction measures in a large scale development.

A detailed assessment of similar approaches included one developed in Kronsberg in Germany and the hierarchy included in the Mayor of London's Energy Strategy.

As a first stage a comprehensive list was compiled of all measures that have been applied to new build housing in the different projects considered as part of the literature review.

The contents of this list were then categorised under relevant headings that grouped together measures along the same vein.

A number of different hierarchies were examined in detail including the Kronsberg hierarchy, (P15 Model of a Sustainable new Urban community) and a hierarchy proposed by the University of Ulster – 'Principles of Green Building'.

The hierarchy used in the Mayor's Energy Strategy was also examined and considered to be the most appropriate in this context.

This takes a more condensed form from that used in Kronsberg, and is therefore easier to apply in a given situation.

It is based on the following objectives:

Use less energy "Be Lean"	Reduce energy consumption through behaviour change Improve insulation Incorporate passive heating and cooling Install Energy Efficient lighting and appliances
Use renewable energy "Be Green"	Install renewables on site Import renewable energy
Supply energy efficiently "Be Clean"	CHP and community heating Cut transmission losses though local generation

This provided a sensible structure under which to organise the categorised proposed measures and enabled the list to be consolidated into a clear structure of energy saving measures to be considered as well as biodiversity, site layout and water management measures (See Appendix 2).

Detailed consideration was also given as to how to 'wrap' the different elements within the hierarchy, and the potential for using EcoHomes to this end.

EcoHomes is the BRE's methodology for assessing the environmental impact and credentials of both new build and refurbishment developments.

Task iv) Recommendations of measures for inclusion in the proposed development and discussion with the developer on the feasibility of these recommendations.

CSE have produced a number of recommendations of measures for inclusion in this development.

These were presented to the project partners on the 6th February and discussed with them along with suggestions for overcoming barriers to implementation. The recommendations and conclusions are presented below.

Task v) Discussion of further activities and measures which can be adopted to overcome the barriers to implementation with further recommendations.

As described above these have been discussed with the project partners.

4.6 Results

4.6.1 Results: Literature review and review of policy drivers and past projects

This section summarises the findings of the literature review. An expanded version may be found in Appendix 1.

Policy drivers

Overarching policy drivers

There are a number of overarching policy drivers which are pushing the requirement to improve the standards in new housing. The strongest of these drivers is climate change.

In the 'central England temperature record' which goes back to the 17th century, four of the five hottest summers have occurred since 1990. In 2001 the third Intergovernmental Panel on Climate Change (IPCC) stated in its Third Assessment Report (TAR) that 'most of the [climate] warming observed over the last 50 years is attributable to human activities'.

In the Energy White Paper published in February 2003, the government accepted the evidence for climate change and adopted the target put forward by the Royal Commission on Environmental Pollution for a reduction in CO_2 emissions of 60% by 2050, from 1998 levels.

Within the White Paper the Government has made it clear that it expects to work with regional and local bodies to deliver the target. It also expects to establish regional targets for renewable energy based on an assessment of the energy resource potential.

The government has also made a commitment to eradicate fuel poverty by 2016 (Warm Homes and Energy Conservation Act 2000). Underpinning these targets is a commitment to a 'free' and deregulated energy market and a commitment to ensure security of supply.

Set alongside the policy commitment to cut carbon emissions is the demand for new housing. The ODPM has estimated a requirement for 120,000 new homes to be built annually on top of current levels to meet demand and reduce house price inflation.

A key factor with regard to the design and specification of new housing is to do with the lifespan of new dwellings. Properties constructed today to current building and

planning regulations will be expected to have a lifespan of 80-100 years, thus exceeding the timeframe for achieving significant cuts in emissions.

Once constructed, it is both difficult and expensive to make significant further improvements in areas such as the thermal efficiency and ventilation losses from a dwelling.

National policy drivers

Building regulations: Recognising the point above, the government has stated that there will be an incremental ramping up of Part L of the building regulations. New regulations which were to have come into force in 2008 have been brought forward to April 2005.

Section 4.6.2 below describes the overall effect of applying the 2002 and proposed 2005 building regulations to theoretical dwellings constructed in 1998.

Sustainable Buildings Code: Defra, the ODPM and DTI have jointly committed to the publication of a Sustainable Buildings Code in early 2005. The details of the code are yet to be confirmed, however, early press releases suggest that it will cover energy efficiency, materials and waste. The code is to be voluntary rather than mandatory.

Preparation of the code follows a recommendation by the Sustainable Buildings Task Group in the report 'Making today's buildings fit for tomorrow'.

EU Directive on Buildings: The EU Directive on Buildings became law on the 5th January 2003. The principle objectives of the Directive are to:

- promote the improvement of the energy performance of buildings within the EU through cost effective measures
- promote the convergence of building standards towards those of Member States which already have ambitious levels.

The measures include:

- Methodology for calculating the energy performance of buildings
- Application of performance standards on new and existing buildings
- Certification schemes for all buildings
- Regular inspection and assessment of boilers/heating and cooling installations.

The Directive must be implemented by 4th January 2006. However, there is an additional three year period to allow Member States to apply the provisions relating to Energy Performance Certificates, Inspection of Boilers, and Inspection of Air Conditioning Systems.

The most significant factor for this study is that all new buildings will be required to have an Energy Performance Certificate which will be part of the Home Information Pack (part of the Housing Bill 2003) that will become a requirement for all houses that are sold or rented after January 2006.

The energy performance certificate for buildings will include reference values such as current legal standards and benchmarks in order to make it possible for consumers to compare and assess the energy performance of the building. The certificate will be accompanied by recommendations for the cost-effective improvement of the energy performance.

Local Policy drivers

Planning Policy Statement 22 (PPS22): Renewable Energy

This is a national planning policy relating to the incorporation and encouragement of renewable energy in new developments, the impact of which will be measured locally.

Following the Planning and Compulsory Purchase Act of May 2004, Planning Policy Guidance has been replaced by Planning Policy Statements. In August 2004, Planning Policy Guidance (PPG22) was replaced by the Planning Policy Statement 22 (PPS22)

PPS22 is significant because it shifts the emphasis for how planning authorities should view renewable energy.

PPS22 states that:

'LAs and planners should consider opportunity for incorporating renewable energy into all new developments.'

'Local planning authorities should specifically encourage [small scale renewable energy] schemes through positively expressed policies in local development documents.'

A further change resulting from the Planning and Compulsory Purchase Act was the introduction of Local Development Frameworks (LDFs). A number of local authorities, mainly London Boroughs to date, have used these as a mechanism for setting targets for renewable energy for new dwellings.

The London Borough of Merton has adopted a policy by which '*All new non-residential development above a threshold of 1000 sqm will be expected to incorporate renewable energy production equipment to provide at least 10% of predicted energy requirement'.*

Other local authorities are considering similar policies for commercial and non-commercial dwellings.

Ratings systems

Energy and environmental rating systems are not drivers in themselves. However, they are becoming increasingly common place when defining specifications for new buildings.

SAP (Standard Assessment Procedure) has been used as a means of assessing the theoretical energy performance of domestic dwellings for over a decade, and is based on the BREDEM (Building Research Establishment Domestic Energy Model). Systems such as NHER (National Home Energy Rating) incorporate SAP with the

addition of emissions and running costs which include lights and appliances and the location and orientation of the dwelling.

EcoHomes is an environmental rating system also developed by the Building Research Establishment. It provides a comprehensive assessment of the environmental impact of a development (at any scale), and can be applied to both new and refurbishment projects. Developments assessed under EcoHomes receive ratings of Pass, Good, Very Good, and Excellent, denoted by one to four sunflowers.

Promotion of energy and environmental credentials in existing developments

There are many developments already in existence where additional energy saving and carbon reduction measures have been included to varying degrees.

On reviewing these and looking into the different measures installed, it was noted that developers rarely seem to be actively promoting the action they have taken towards making their sites more environmentally sound. It was often found that measures were not mentioned in the formal literature and it would only be through conversations with developers or research on websites such as 'Sustainable Homes' (www.sustainablehomes.org) that these aspects of the developments would come to light.

This suggests that developers don't regard these features as offering a significant competitive advantage to their customers, or may indeed be nervous of putting them off in some way.

Best Practice Guidance

There is a large volume of work providing advice to developers on how to improve energy efficiency in new build dwellings. The focus of these ranges from the planning and layout of the developments themselves to the incorporation of renewable energy measures such as passive solar design and ways of improving the thermal performance of the buildings.

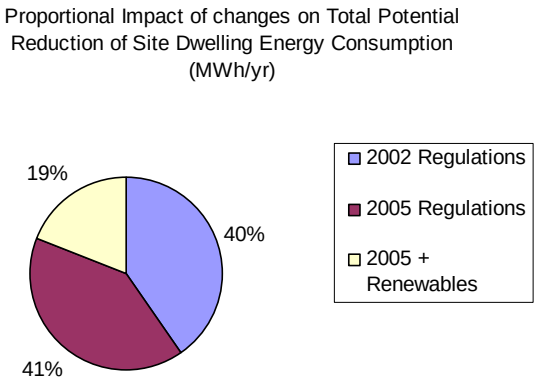
A number of these illustrate the improvement in environmental performance of such dwellings and also seek to demonstrate that these improvements in standards do not have to come with extra costs attached.

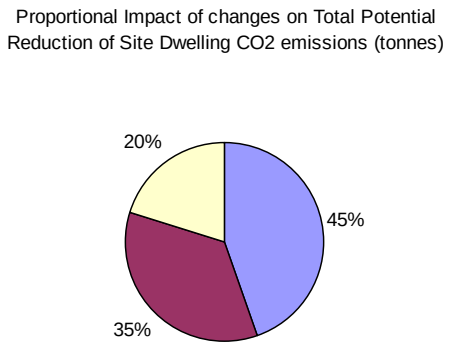
4.6.2 Results: Assessment of baseline emissions

	Site Dwelling Energy Consumption (MWh/yr)			CO2 emissions (tonnes)			
	gas	electricity	Total	dwellings	transport	food	Total
stock average	30,716	4,785	35,501	7,894	4,422	9,409	21,724
1998	16,875	2,963	19,838	4,763	4,203	9,409	18,374
2002	12,656	2,666	15,685	3,606	4,422	9,409	17,436
2005	9,492	2,000	11,492	2,704	4,422	9,409	16,535
2005+Renewables	8,097	1,406	9,503	2,178	4,422	8,937	15,536

The above table shows the potential development wide energy consumption and emissions at Emersons Green under the different scenarios. It is based on the 1500

proposed dwellings being built to the ratios suggested by the Richard Hodkinson Consultancy: 20% detached (taken as 4 bedroom houses), 45% terraced (3 bedroom) and 35% flats (2 bedrooms).





The above pie charts illustrate the overall reduction in site wide consumption and emissions that are attributable to each change in implemented measures. They depend on qualitative analysis of the building regulations standards

A complete breakdown of energy consumption and emissions per house type under the different scenarios according to changes in building regulations is given in Appendix 3.

Appendix 4 then illustrates the impact on development wide emissions based on varying ratios of dwelling type. What the results show is that moving from Part L of the Building Regulations which applied in 1998 to those which will apply in 2005 results in a 44% reduction emissions of carbon dioxide.

In considering emissions resulting from Transport there is a small increase in assumed emissions when moving from 1998 to 2002 (Appendix 3). However, there is insufficient data to relate transport emissions specifically to this development as opposed to those that would take place anyway. Reductions in local movements by car have been considered as part of the recommendation for an EcoHomes standard for the whole development described below.

With respect to net emissions resulting from the processing and consumption of food, we have assumed a small decrease when moving from the 2005 scenario to the 2005 + Renewables scenario.

Published data suggests that the emissions per person per annum falls for an individual who is assumed to be environmentally aware from 2.692 tonnes per person per annum to 2.557 tonnes per person per annum. There is a small further decrease for vegetarians to 1.953 tonnes per person per annum.

Research by organisations such as the BRE suggests that food is highly significant in terms of the overall carbon footprint for an individual household, and some studies have suggested that this may contribute up to 50% of the total emissions. Food miles will clearly be a significant component of this.

However, there is very little data available on the effect on emissions of increasing the proportion of local food within a weekly shopping basket. More research is required in this area.

4.6.3 Results: Energy Hierarchy

As described in Section 4.5 above, having looked at hierarchical approaches to the implementation of measures it was concluded that the approach developed in the London Energy Strategy was the most appropriate to this study.

This may be summarised as follows:

- Reduce demand – use less
- Offset fossil fuels – use renewables
- Supply efficiently – where fossil fuels have to be used this should be done efficiently.

4.7 Key issues and lessons learnt

The key issues concern the barriers to implementation of additional measures and the role of the Local Authority in overcoming these.

The main barrier to implementation of additional measures is cost. In deciding whether to purchase an area of land developers need to consider the residual land value – what they are prepared to pay for the land.

Residual land value equals the completed value of the development, minus standard building type, minus abnormals (which would include the additional measures described here, and requirements included within 106 agreements), minus costs of design codes, minus additional costs and profit.

The additional carbon saving measures recommended here were not considered before the land was bought. Therefore unless they can be passed on to buyers they detract from the residual land value.

If a developer knows before bidding for land that additional measures such as renewable energy are going to be a requirement they can factor these into the price they are willing to pay for the land.

If a local authority owns the land they are likely to receive a lower price by putting extra demands on the developer. In this case the land was not owned by the local authority so this was not an option.

Where there is a level playing field and all developers bidding for the land are in the same situation additional measures may be factored in before the land is sold.

In overcoming these barriers in the future there is clearly a role for the local authority in setting the planning policy framework such that carbon saving targets apply to all land. As discussed in section 4.9 a number of local authorities are actively considering this, through targets for renewable energy.

There is also a role for South Gloucestershire Council, working with other agencies such as CSE in raising awareness of the benefits of lower emissions to consumers. These include the immediate and sustained benefit of reduced running costs as well

as the longer term benefit of contributing to a reduction in the emission of 'green house' gases such as CO_2.

4.8 Recommendations

Recommendations have been made in line with the hierarchical approach described above.

The recommendations are made to South Gloucestershire Council by the Centre for Sustainable Energy as the author of this report. They relate the proposed development at Emersons Green, although some are generic in nature.

The recommendations do not necessarily reflect the views of South Gloucestershire Council or Gallagher Estates.

It is important to note that the original objective was to reduce overall emissions of carbon dioxide by 60% in line with the government's national target stated in the 2003 White Paper for achieving a cut in emissions of CO_2 by this amount by 2050 from levels in 1997/8.

In putting forward recommendations of measures for inclusion a pragmatic approach has been adopted. That is to say that measures which are being proposed are those which could be integrated into a 'conventional' development to be constructed under 2005 Building and Planning Regulations.

In this respect this development is significantly different to the Kronsberg energy village where different building and planning regulations are in force and more importantly the entire development was designed from first principles to reduce energy demand and achieve an 80% reduction in CO_2 emissions when compared to a conventional development of the same size.

Whilst this would be the preferred method of planning a new development in response to climate change, it is not an option in the case of the Emersons Green development.

4.8.1 Application for Implementation funding under the EST Innovation Programme

South Gloucestershire Council have considered the options for making an application for additional funds under the Innovations Programme. Whilst it is possible that further funding may be sought at a later date, an application is not being made at this time.

South Gloucestershire Council would like more time to evaluate the options for implementation before proceeding further.

4.8.2 Recommendations for achieving additional demand reduction

Recommendation: **Implement a Quality Assurance and Testing programme for all construction phases of the development.**

Discussion:

The predicted energy consumption figures and emissions of carbon dioxide described above are based on the assumption that the paper requirements set out in the Building Regulations are implemented in practice on the ground. For the development at Kronsberg it was estimated that implementing a quality assurance programme to monitor the standard of construction resulted in a 7% improvement (reduction) in emissions for the development as a whole.

The implementation of the 2005 building regulations (as proposed) will result in a significant reduction of emissions over the previous 2002 regulations. However, the full benefit of these will only be realised if they are enforced and monitored during construction phases. For this reason the recommendation for a QA programme is made. Particular emphasis should be given to air leakage as the relative importance of this will increase under the 2005 regulations.

Recommendation: **Minimum standard of EcoHomes 'Very Good' across the development.**

- It is proposed that all domestic dwellings in the planned development should achieve the standard of EcoHomes Very Good.
- Consideration should also be given to achieving EcoHomes Excellent in the third of the stock allocated to social housing.

Discussion:

EcoHomes provides a convenient and well understood methodology for assessing the environmental impact of a development.

The recommendation of a single minimum standard of Very Good follows discussions with the Local Authority and Richard Hodkinson Consultancy on behalf of the developer.

Most developments constructed in 2005 would achieve or come close to achieving EcoHomes Good. Very Good represents a step up from this and is in line with the proposal made by the Chief Executive of the Housing Corporation that all housing developed with Housing Corporation funding from October 2005 should achieve the equivalent of EcoHomes Very Good].

One of the key advantages of EcoHomes is that it may be applied to a development of any scale, and that it encompasses a broad range of environmental impacts including those from transport and materials.

EcoHomes assessments are based on a range of factors, which are weighted according to their relative importance. Energy, in terms of emissions of CO_2 and the thermal efficiency of the building fabric carries the greatest single weighting.

One of the disadvantages of the EcoHomes assessment system is that because energy is only one of a number of factors which go to make up the final rating, setting an EcoHomes standard does not guarantee meeting a given target for energy consumption or emissions.

However, in practical terms one of the most cost effective ways of achieving the higher standards within EcoHomes is to improve the fabric efficiency within the development – something which was reiterated in discussions with Crest Nicholson about the Portishead development in the early stage of this study.

However, we think there is merit in considering a higher standard for the social housing. This would give the tenants the advantage of lower running costs, would provide an exemplar of what could be achieved, would contribute to a reduction in the overall level of emissions and would provide an opportunity to include additional renewable energy measures which may not be so applicable in the rest of the development.

We therefore recommend that South Gloucestershire Council work with the developer and Homes West (the consortium of preferred RSLs) to consider how a higher standard might be achieved and funded.

Richard Hodkinson Consultancy acting on behalf of the developer has said that their preference would be for a single viable EcoHomes standard across the development where the costs are fully understood in relation to the overall commercial considerations. However, at this stage in the process they would be unable to agree to a minimum standard of Very Good, and would have to consider the cost implications and practicability of achieving this in detail. Their view is that to achieve a standard of Excellent in the one third of the stock which will be allocated to social housing stock is not practical and will require further consideration.

Recommendation: **Maximise efficiency of white goods by supplying A rated fridges, freezers, and washing machines to all new dwellings, and removing need for tumble dryers.**

Discussion:

This measure is included within an EcoHomes assessment. With each increment in building regulations the relative importance of space heating in terms of emissions of CO_2, decreases and the relative proportion of that associated with so-called 'White Goods' (fridges, freezers, washing machines and tumble dryers) goes up.

It is therefore recommended that developers should provide A rated fridges, freezers (as a single unit where appropriate) and washing machines with each property. These should be supplied with guidance and advice on how best to use these.

By supplying these it reduces the possibility of households using lower efficiency appliances.

Tumble dryers are by far the biggest consumers of electricity within the home [1500 houses without tumble driers at 3kW per load (kWh rating comes from Electricity Association Service Ltd 'Electricity and You' leaflet.) with average 100 loads per household p.a. would equate to 450,000 kWh over the development annually, causing 2,000 tonnes of CO_2]. Whilst A-rated tumble dryers are available their energy consumption is still high. We therefore recommend that developers should remove the need for a tumble dryer by installing purpose made drying facilities in the form of a drying cupboard with appropriate heating and ventilation, and external facilities to dry clothes for example a clothes dryer or washing line.

4.8.3 Recommendations for offsetting fossil fuels through the use of renewable energy

Recommendation: **Maximise use of passive solar gain through appropriate orientation, glazing and use of thermal mass.**

Discussion:

Constructing buildings to maximise the use of passive solar gain can be one of the most cost effective ways of reducing the demand for space heating.

Generally this requires southern orientation and an extended east-west axis, and the appropriate use of glazing and thermal mass.

A standard reference building, in a northern temperate climate, would typically have a window-to-floor ratio of approximately 22%, and a 50:50% window area both on the north and south facades. To improve this format to a more passive solar configuration glazing would be redistributed so that 75% is on the south façade. This would reduce the energy consumption by 6% (figures provided by Dr S. Lo University of Ulster (2005) 'Passive Solar Heating Design for Heating', Building Orientation.)

If this heavily glazed facade is oriented away from the south then the energy consumption increases accordingly. The overall decrease in energy consumption from the standard reference dwelling facing due east/west, to a more passive solar configuration facing south, can be as much as 20%.

Gallagher Estates have expressed concern that designing the glazing to maximise passive solar gain could possibly reduce the credits available under Section HEA1 Daylighting of the EcoHomes rating. Within this one credit is available where kitchens meet the daylighting criteria set out in British Standard BS 8206: Part 2. One credit is available where living rooms, dining rooms, and studies meet the daylighting criteria set out in British Standard BS 8206: Part 2.

As living rooms and dining rooms are most likely to be orientated on the south side of the building this primarily impacts on the kitchens and studies. In end terrace, semi-detached and detached houses these may be orientated to the west or east sides of the property. Other options include the use of internal glazing to spill light from the living room to the kitchen and open plan arrangements, both of which may be considered under EcoHomes.

All credits are optional within EcoHomes and some developers choose to focus on the other factors such as CO_2 emissions for which there are 10 credits available, rather than day lighting.

Thermal mass is the third component needed to make best use of passive solar gain and to avoid summer overheating. The developer has raised concerns that the additional embodied energy associated with the use of thermal mass may wipe out the benefits through energy not required to provide either space heating or cooling. This obviously needs to be taken into consideration. Embodied energy is a product of the energy required at every stage in the production transport and installation of a given material. For this reason the embodied energy and resulting CO_2 emissions of, say, a concrete floor slab is dependent on a range of factors such as where the material was quarried, processed, how far it travelled, the efficiency of the processes, as well as behavioural factors such as driving patterns. For this reason, and because specifications of design and materials are not available, it is not possible to calculate the embodied energy for this development in order to quantify the impact of

additional thermal mass in the lifetime energy cost of the development. Published studies on this suggest that embodied energy is generally a fraction of the lifetime energy cost. In this case we recommend the installation of a solid concrete ground floor slab within the insulated envelope as a means of increasing the overall mass of the dwellings.

The developer has highlighted concerns regarding practical layout considerations particularly with regard to the interconnectivity of internal and external spaces which will constrain window arrangements. This will apply particularly to courtyard areas where windows will face every direction but will need to be of a consistent size configuration.

Clearly to maximise the benefits of passive solar design does require consideration of these issues and appropriate modifications to the design.

Recommendation: **Install solar water heating as a standard measure in all dwellings with unshaded roof space oriented between south west and south east.**

Discussion:

It is recommended that solar water heating should be fitted as a standard measure in all dwellings with roof space oriented between south west and south east and provided the normal restrictions regarding issues such as over-shading can be met.

It is also recommended that the controls and temperature readouts should be located in a prominent position within the living area.

As previously discussed SHW makes a contribution to offsetting emissions of CO_2 from the use of gas for heating hot water. In addition to the savings which are achieved directly from this measure it is also being recommended as a behavioural measure leading to further indirect savings. There is evidence (see B Boardman, Energy Policy 32 (2004) 1921-1933, and Fraunhofer, 2000 European Commission) that where householders have a renewable energy measure in their home and have been provided with appropriate information and advice on how to use it, their overall awareness of the energy increases and they modify their behaviour to reduce their overall consumption.

The developer has expressed concern that SHW makes properties more difficult to sell and detracts from their value; householders are unclear of the benefits and concerned about the maintenance and servicing. This is one area where the local authority in partnership with an energy advice agency could have a real role to play in providing the appropriate advice, information and publicity to overcome these concerns.

Furthermore, the introduction of the Sellers Pack in 2006 is likely to raise awareness of energy consumption within the home and the relative value of renewable energy such as solar water heating, and for this reason it is an appropriate time to implement this measure.

Recommendation: **Where secondary heating is required install biomass secondary heating in place of gas secondary heating.**

Discussion:

When fuelled from a sustainable source and burnt in an efficient (80-90%) appliance, biomass in the form of logs or pellets provides a source of heat with very low emissions of carbon dioxide.

To achieve a very low level of emissions the wood needs to come from a local source to avoid emissions associated with transport, and be replenished when harvested. Wood also needs to be untreated. The local supply of wood is an area where the local authority of Energy Efficiency Advice Centre can provide appropriate information.

In order to maximise the benefits from wood as a source of secondary heating, dwellings would need to be fitted with appropriate heating controls to minimise unwanted demand from the primary boiler, such that the secondary heating was used as an alternative to all or part of the primary source rather than in addition to this.

Appliances would need to comply with the appropriate emissions standards for the area.

It should be noted that in smaller dwellings a secondary source of heating may not be required.

The developer feels that wood heating may be viable as a secondary source in larger homes but has expressed concern regarding the viability and practicality of this recommendation in respect of smaller and medium sized dwellings.

Recommendation: **Consider use of ground source heat pumps in social housing.**

Discussion:

As the description implies Ground Source Heat Pumps use a heat pump to extract solar energy from the ground.

Ground source heat is classed as a form of renewable energy because when extracted using a heat pump 3 to 4 units of heat are extracted for every unit of energy which is required to drive the heat pump. This ratio is known as the Coefficient of Performance (COP).

The emissions of carbon dioxide for a ground source heat pump with a COP of 3 are approximately a third less than those of a gas condensing boiler. If the electricity to power the pump is derived from a renewable source then the emissions may be regarded as zero.

Running costs are comparable to or better than those of a gas condensing boiler depending on the efficiency of the boiler and COP of the heat pump.

Heat pumps provide low temperature heat and are therefore suited to low temperature distribution systems such as under-floor heating and low temperature radiators. They are also best suited to thermally efficiency properties. For this reason we recommend that they be considered in the social housing.

The experience of the developer is that ground source heat pumps are expensive to install and costly to maintain and run in terms of electrical consumption.

Recommendation: **Consider options for the use of wind energy on site.**

Discussion:

We have considered the option of a small wind turbine on site for the generation of electricity. Initial estimates of wind speed using published rather than monitored data suggest that it may be viable. However detailed on site monitoring would be needed to ascertain if it would be commercially viable, as this is very sensitive to annual average windspeed.

A wind turbine would provide not only a strong visual cue as to the generation of renewable energy, but also significant potential as an educational resource. It would also provide an opportunity to engage the local community directly through the issuing of community shares or alternative mechanism. We recommend that, if wind energy is considered as an option, mechanisms for involving the local community should be considered at the same time.

To date, a relatively large number of wind turbine planning applications have been refused due to objections from the Ministry of Defence. The main concern is that aircraft communications or radar may be disrupted by electromagnetic interference from the wind farm. As a result, details of all planned wind farms must be submitted to the MOD, the Civil Aviation Authority (CAA) and the National Air Traffic Service (NATS). Assessment is made against air safety and defence interests through evaluation of the possible effects on air traffic systems, defence systems and low flying needs.

Exactly what scale a project has to be before it warrants such an application is not clearly defined. Given the proximity and scale of the development the potential for disturbance due to noise would need to be considered at the scoping stage.

Constraints maps exist for wind power and one of these for the area in question could be consulted.

4.8.4 Recommendations for the clean supply of energy

Recommendation: **Consider potential for the use of combined heat and power, and biomass district heating.**

Discussion:

The proposed development offers the potential for the use of combined heat and power (CHP), or district heating. CHP is a very efficient technology for generating electricity and heat together. District heating is the centralised production of heat which is distributed to the dwellings via an insulated ‘heat main’.

A CHP plant is an installation where there is simultaneous generation of usable heat and power (usually electricity) in a single process. The basic elements of a CHP plant comprise one or more ‘prime movers’ usually driving electrical generators, where the heat generated in the process is utilised via suitable heat recovery equipment for a

variety of purposes including: industrial processes, community heating and space heating.

In this case it is envisaged that the heat could be used to provide space and water heating for the dwellings, school and commercial units within the science park.

Due to the utilisation of heat from electricity generation and the avoidance of transmission losses because electricity is generated on site, CHP typically achieves a 35% reduction in primary energy usage compared with power stations and heat only boilers. This can allow the host organisation to make economic savings where there is a suitable balance between the heat and power loads. The current mix of CHP installations achieves a reduction of over 30% in CO_2 emissions in comparison with generation from coal-fired power stations, and over 10% in comparison with gas fired combined cycle gas turbines. The newest installations achieve a reduction of over 50% compared with generation from coal-fired power stations.

The vast majority of CHP systems in the UK are gas powered. However, a gas CHP system installed at the present time could in theory be modified or upgraded to use biomass to produce combined heat and power or heat only.

There are a number of models for the implementation of CHP. These range from a local authority undertaking the process directly or setting up a separate company to do this, to companies that supply heat and electricity on a contract basis.

District heating may also be considered on a contract or heat only basis. In order to achieve significant reductions in CO_2 emissions biomass district heating should be considered, as an alternative to heating using a gas boiler in each dwelling.

We recommend that the potential for both CHP and biomass district heating is considered in more detail, by a consultant specialising in this field. The feasibility will depend on a combination of the demand for heat, power and the resale value of surplus electricity generated on site and sold to an energy supplier.

CSE recommend that CHP and biomass district heating should only be considered in addition to the other recommendations and not as a substitute for one or more of suggested measures.

4.8.5 Recommendations for reducing emissions associated with food

Discussion:

As discussed above, some research suggests that food may account for up to 50% of the overall household emissions of CO_2. As much of this will be associated with ‘food miles’ we recommend measures to stimulate the production and purchase of local food.

The three recommendations are to provide gardens with an appropriate top soil (both type and depth) for growing vegetables and a community space or forum within the development which would be suitable for a regular farmer’s market.

There may be other measures which the local authority can take which tie in with existing campaigns to support local food production and consumption which can be extended to this area. We recommend that these are considered from an early stage.

4.9 Conclusions

i. The analysis undertaken in this study suggests that the proposed revisions to Part L of the Building Regulations to be implemented in 2005 could lead to a reduction in emissions of CO_2 from the domestic component of the proposed development at Emersons Green of up to 40% when compared to the same development constructed in 1998.

ii. Because of limited data on the specifications of the dwellings proposed at Emersons Green the analysis has been based on a number of assumptions which are listed in the report. These include:

- The number of dwellings
- Mix of different house types
- Foot print of the different house types and ratio of exposed wall area to floor area.
- Improvement in thermal efficiency and resulting reduction in emissions resulting from proposed revisions to Part L of the building regulations.

iii. Where assumptions have been made, calculated figures have been compared with published data and data supplied by the developer. Though limited in range the calculated energy consumption and emissions figures compare well with published data.

iv. The development differs significantly from that Kronsberg Energy Village in Hannover. The Kronsberg development was designed from first principles to reduce emissions by 80% from those of a conventional development of the same scale. The development at Emersons Green is being developed speculatively in accordance with the relevant Building and Planning Regulations. For this reason the recommendations have been confined to those which could be incorporated into the development without major redesign work.

v. With each increment in Part L of the Building Regulations the relative fraction of carbon dioxide emissions arising from space heating falls and the relative importance of emissions from hot water, and the use of lights and appliances increases. For this reason, the proposed recommendations for the dwellings have focused on the use of lights and appliances, and hot water as well as those associated with fabric losses.

vi. The energy hierarchy included within the London Energy Strategy has been applied to the recommendations made within this study. Of the three approaches considered this was felt to be the most workable for a development of this sort.

vii. This report includes a recommendation for a minimum EcoHomes standard to be applied to this development. We have concluded that EcoHomes is the best means of setting a standard for the environmental credentials of a development as whole, including the issue of transport.

viii. The Emersons Green Development is proposed to be ‘car neutral’. That is there will be no net increase in the number of cars on the road as a result of the development. In designing the spatial layout of the development there is an opportunity to reduce the need to use cars for very short local journeys. For example this may be achieved by providing safe pedestrian and cycle access to

local amenities and cycle storage facilities. These factors are included within the EcoHomes rating.

ix. There are strong policy drivers to cut emissions of green house gases in new housing developments. The relative importance of new housing within the national stock is increased because the rate at which the poorest (in terms of emissions) housing stock is demolished is very low.

x. The expected lifespan of housing constructed today, easily exceeds the timeframe for the government's commitment to cut emissions of CO_2 (60% by 2050).

xi. Whilst there are stated policies to reduce emissions from new housing it is up to the developer to 'sell' the features which bring these cuts about to their customers. This is the main barrier to the implementation of additional measures. The scope for the inclusion of additional measures is determined by the gain the developer can achieve from a given site. Additional costs detract from this gain. There are a number of smaller developments where additional measures have been successfully implemented. However, in the majority of cases these, like the Kronsberg development, have been designed from first principles to be low or zero emission developments. The developer in this case has argued that measures such as solar water heating will make properties less attractive to buyers. If this is the case then it suggests that more work needs to be done to raise the awareness of the general public (and not just those with an existing interest in these issues) of the benefits, such as lower running costs and a cut in CO_2 emissions, of energy efficiency measures and renewable energy. The most important issue here is the perception of the buying public. The introduction of the Sellers Pack in 2006 may serve to stimulate raised awareness in the short and long term benefits of better environmental performance.

xii. There is a role for the local authority in partnership with other agencies to continue work to raise awareness about the immediate and long term benefits of reducing emissions. Particular focus needs to be given to new housing developments to support developers which work to include additional measures.

xiii. South Gloucestershire Council has been proactive in preparing technical briefings to serve as guidance for developments of this sort. The best option for pushing up standards within new housing above those imposed by building regulations and the existing planning controls may be to specify more stringent requirements within Local Development Frameworks (LDFs). A number of local authorities are proactively considering the use of Local Development Frameworks to specify a minimum percentage target for renewable energy for both commercial and domestic developments.

Appendix 1: Literature Review

Developments taking environmental impact into consideration

Name of development	Best Practice	address	key features / conclusions	Description
Amersham Road	www.sustainablehomes.co.uk	Reading, Berkshire	Active Solar Heating, Condensing Boiler, Low Energy Lighting, Stack Ventilation, Cellulose Insulation, CFC and HCFC Free, Construction Waste Recycling, Education of Occupants on Control Use, Feedback on User Comfort, Handbook For How to Use the House, 6 Litre or Less WCs, Water Butts	50 Houses built to a very high environmental performance in a larger development of 190 houses. 2, 3 and 4 bed houses for social housing with some bungalows for the disabled. Part of a European project to promote solar design in housing called SUNH, which is part of Thermie. Detailed 12 month monitoring exercise shows: Energy reduction - 31% due to solar initiative. Average solar contribution is 57% (range 35%-82%). Average saving per household - £5.76 per week. Detailed tenant survey shows a 92% tenant satisfaction rate.
BedZed - Beddington Zero Energy Development, Sutton	General Information Report 89	www.est.org.uk/bestpractice/publications/detail.jsp?pk=1118	Passive solar design, super insulation, reduced embodied energy and renewable energy. CHP fuelled by waste timber from local tree surgery, EE design and appliances, PV.	Joint initiative of the Peabody Trust and BioRegional Development Group, Bedzed shows how housing can be built without degrading the environment.
Bristol Harbourside	Crest Nicholson	Bristol Harbourside	Built on brownfield site. Actually costing less in terms of efficient site management and recycling of materials.	SUDS, reed beds, rainwater use in landscaping, ecohomes, waste separation. no mention of this in preliminary advertising material
Christopher Taylor Court	www.sustainablehomes.co.uk	Bournville Solar Village, Nr Birmingham	Orientation Optimised for Solar Gains, Passive Solar Orientation, Trombe Wall, Thermal Mass: Almost every flat has a large single glazed mass wall and windows and glazed door on the south facade to exploit passive solar gains and natural ventilation. Dual purpose internal sliding shutters reduce heat transfer from the mass wall to the room in summer and insulate the glazing and expose the mass wall in winter. Highly insulated structure with double glazed and draught stripped windows.	The development comprises of 42 flats mostly located in east/west terraces with the dwellings facing south and insulated corridors to the north. All corridors are lit by daylight. An energy management system controls the central heating to ensure maximum use of solar gains.
Cotford St Luke	www.edie.net/library/view_article.asp?id=639andchannel=0	nr Taunton, Somerset	Bristol based Oxford Architects 20 x ecohomes excellent	Each house includes a "live work" space to enable the occupant to set up a home office. At least 25% of light fittings only accept low energy bulbs (all fittings are supplied with low energy bulbs). greywater recycling, passive ventilation.

Name of development	Best Practice	address	key features / conclusions	Description
East Portishead Action Area / Portishead Quays Consortium (joint venture, Crest Nicholson and Persimmom homes)	Portishead Case Study - using a collaborative approach to develop a master plan and encourage sustainability	www.sustainablehomes.co.uk /pdf/JanNewsletter.pdf and www.housingcorplibrary.org.uk/HousingCorp.nsf/ AllDocuments/143AD6A1ED9B201D80256EC200579F05/$FILE/14150c.pdf -	3499 new homes, 1500 homes being developed to Ecohomes 'good' rating, 30 will be 'excellent'	emphasis on affordable housing in a landscaped environment. Ecohomes included to lift the standard of the housing
Ecolonia (Alphen Aan Den Rijn, Netherlands)	A guide to Sustainable Housing	www.students.ncl.ac.uk/n.m.simpson/ecolonia.htm www.sustainablehomes.co.uk	Micro Climatic Design, Active Solar Heating, Energy Efficient Appliances, Orientation Optimised for Solar Gains, Recycled Materials, Super Insulated Structure, Timber Frame, Rainwater Recycling, Water Butts	101 sustainable housing units built 1991-93. 61 apartments are equipped with air conditioning system and heat recovery. 80 apartments are equipped with solar collectors for hot water production
Europahaus Project	www.sustainablehomes.co.uk	Langenhagen, near Hannover, Germany	Ecological materials, high levels of insulation, rainwater collection and a co-generation heating system are used to minimise environmental impact. High ecological standards have been achieved. A small co-generation plant is included to provide a central supply of energy and heating/hot water for the dwellings. All construction materials are ecologically sound and provision is made for rainwater collection in barrels.	64 occupied dwellings (rented) The project was built as a result of an international competition to design a cost saving housing project to high social, ecological and architectural standards. It consists of 64 rented dwelling units at a cost of construction 25% less than normal due to the innovative design and integrated planning and implementation methods. Now being replicated elsewhere in Germany.
Gallions Ecopark	www.sustainablehomes.co.uk	Gallions Reach Urban Village Thamesmead	Water Conservation Devices, Active Solar Heating, Biodegradable Materials, BREEAM Assessment, Brownfield site, Cellulose Insulation, Condensing Boiler, Daylight designed, Flexibility of Design, Fresh Air Design Maximised, Greywater Recycling, HCFC free, High Performance Facades/Windows, Low Energy Lighting, Night Cooling, Passive Solar Orientation, Rainwater Recycling, Recyclable Materials, Roof u value<0.25, Solar Preheating of Ventilation Air, Solar Preheating of Water, Stack Ventilation, Sustainable Managed Sourcing of Materials, Timber Frame, Timber from managed sustainable sources, Waste Heat Recovery, Windows U- Value<2.0,	39 dwellings occupied since Jan 2002. Gallions Ecopark is an ecologically sustainable social housing project, which demonstrates the benefits to users, social landlords and private developers, of planning and building to standards which incorporate sustainable materials, construction methods and renewable energy efficient measures. The houses adjoin a Visitors Centre and unique 'Naked House' exhibition home designed to showcase the features incorporated throughout the development and disseminate associated information. The project focuses on features which can be replicated in future development, to exclude any feature which cannot be seen to be cost effective within the next decade but, where possible, to make provision for its future inclusion or adaptation.

Name of development	Best Practice	address	key features / conclusions	Description
Garden Homes for the Future	www.sustainablehomes.co.uk	Mason Moor, Millbrook, Southampton	33 homes under construction. Yet to be fully evaluated, but perceived as follows: Lower running costs for residents, priority to children's play and pedestrian movement over vehicular traffic. Innovative house types and use of sun room will provide extra space for residents. EcoHomes, sunspaces and homezones likely to be used on future schemes.	Aiming to achieve EcoHomes Very Good rating. Passive solar design and the use of sunspaces in 18 homes. Timber panel construction. Homezone incorporated into the design of public realm.
Gloucestershire Docks	Crest Nicholson	Gloucester	They are being built on a created habitat so no land being used. The focus has been environmental rather than EE.	76 apartments being built to ecohomes excellent standard
Great Bow Yard,	South West Eco-Homes Ltd (part of Somerset Trust for Sustainable Development)	Langport, Somerset	CO2 emissions 75% reduction from current norms. Recycled materials 50% by volume and materials from sustainable sources. 50% reduction in water use.	12 Dwellings in a waterfront development.
Greenhaven Close (Fazakerley, Liverpool)	Case Study in Green Housing for the Future (see reports)	www.sustainablehomes.co.uk / pdf/Green%20Alliance%20Report.pd	timber frame, high insulation, grey water and waste recycling, recycled paper insulation	12 bungalows to replace a tower block and provide new sustainable homes for the tenants. NHER and Sap ratings of 100
Harlow Foyer	www.sustainablehomes.co.uk	Occasio House, Playhouse Square, Harlow, Essex	Public Transport Enhanced, BREEAM Assessment, Brownfield site, Car Free Housing, Daylight designed, Education of Occupants, Education of Occupants on Control Use, Feedback on User Comfort, Environmental Purchasing Policy - Construction, Energy Efficient Appliances, Embodied Energy Calculated, Embodied Energy Reduced, Green Roof, Maintenance Reduced Materials	116 dwellings occupied since June 2001. The scheme used a new Egan Compliant engineering and construction contract, and is a Housing Demonstration Project. The foyer exploits volumetric design with advanced/specialist materials and a partnering contract. The scheme achieved reduced cost, integrated design, enhanced predictability and quality and time savings. It also reused a brownfield site, and was built to high energy efficiency standards.
Harlow Park (Toxteth Liverpool)	Case Study in Green Housing for the Future (see reports)	www.sustainablehomes.co.uk / pdf/Green%20Alliance%20Report.pd	Resource conservation and EE measures, natural paints and daylight maximised.	33 houses and bungalows to rehouse tenants from damp inadequate housing. Tenants consulted throughout process.
The Hockerton Housing Project	EE Best Practice in Housing	www.est.org.uk/bestpractice/publications/detail.jsp?pk=94	no space heating, self sufficient water, < 25% of the energy of a conventional house	Self-build cooperative
Kronsberg District (HannoverProgramm 2001, Germany)	World Exposition an Kronsberg District	www.sibart.org/pdf/**kronsberg**.pdf	District Heating, EE appliances, water and waste management. Streets favour cyclists and pedestrians.	In its final form, Kronsberg will provide 6000 dwellings for a population of 15,000

Name of development	Best Practice	address	key features / conclusions	Description
Passive housing, Lindas, Gothenburg, Sweden		www.teknik.uu.se/ftf/staff/mari-louise/dokument/windowsizes.doc	houses do not require a heating system due to building design	
Millenium Green (Gusto Homes, Notts)	A guide to Sustainable Housing	www.students.ncl.ac.uk/n.m.simpson/milleniumGreen.htm www.gustohomes.com	Triple insulation, solar gain and heat recovery, SHW, condensing boilers, EE appliances. 70% reduction in CO2 at 10% increase in building cost	Privately built development of 24 two to six bed houses, SAP rating > 100
Millennium Homes	www.sustainablehomes.co.uk	Millennium Close, Walton	Active Solar Heating, Lights with Presence Detectors, Occupant Controlled Environment, Pre-Fabricated/Modular Construction, PVC Minimised, Solar Preheating of Ventilation Air, Solar Preheating of Water, Stack Ventilation, Timber Frame.	15 occupied houses. Timber frame, solar panel, passive solar collectors, (sun spaces) Passivent Ventilation system warmcell insulation, SAP100. High individual modern building, highly insulated with low running costs for tenants
Millenium Mews (Liverpool)	Case Study in Green Housing for the Future	www.sustainablehomes.co.uk / pdf/ Green%20Alliance%20Report.pd	PV, SHW super insulation, water and waste recycling, recycled / sustainable building materials. 20% increase in building costs	Demonstration project of 14 dwellings
Nelson Street	www.sustainablehomes.co.uk	Perth, Scotland	Passive Solar Orientation, Orientation Optimised for Solar Gains, Education of Occupants, High Performance Facades/Windows, Thermal Mass, Windows U- Value<2.0. Passive solar scheme designed to achieve high levels of energy efficiency within a traditional solid masonry structure. A relatively high density scheme (117 dwelling per hectare) built on a brownfield site. The scheme is located in the city centre, and is well served by public transport. There is a very low level of parking provision - 6 spaces for 27 dwellings.	27 dwellings occupied since Aug 97. High energy efficiency is achieved throughout south facing sunspaces that supply warm air to the rest of the dwelling, sunshades to prevent overheating in the sunspaces, increased insulation (walls 80mm styrofoam, roof 200mm mineral fibre, floor 35mm styrofoam), and double glazed, low emissivity coated, argon filled windows. The sun spaces are integral to the building and ventilate into living rooms and bedrooms. The aim was to reduce fuel costs to residents and reduce maintenance costs to the housing association.
Oak Meadow (originally Livarot Walk), South Molton, N.Devon	Somerset Trust for Sustainable Development Case Study	www.northdevon.gov.uk/environment/livupdate.pdf.	Sustainable and non-toxic building materials, timber frame as lowest embodied energy rainwater recycling, SHW, EE, transport options	35 Eco-homes built in partnership between council, HA and construction companies.
Park View, Southampton (Barratt Homes)	Good Practice Case Study 400	www.est.org.uk/bestpractice/publications/detail.jsp?pk=140	Capital cost saving of £300 per unit, Carbon Emissions reduced by 32 tonnes p.a.	Community heating scheme serving luxury newbuild private apartments
Plymstock Quarry (Westbury Homes)	Feasibility Study by Enact	Enact, Enact House, Tolvaddon Energy Park, Tolvaddon, TR14 0HX	Enact tried to work with Westbury homes but were given very little access to plans and technical specifications to understand or advise on potential EE improvements	Enact ended up working with Space 4, one of the only mass producers of timber framed homes in the UK to improve the U values of the buildings

Name of development	Best Practice	address	key features / conclusions	Description
Sherwood Energy Village (Ollerton, Nottinghamshire)	Success stories, Sherwood Energy Village. 'Contribution to sustainable development and people's quality of life.'	www.emra.gov.uk/s_d_success/sherwood_energy_village.asp and www.sherwoodenergyvillage.co.uk/	Strong emphasis on EE. Best practice methods in design and construction. Renewable energy sources will also feature. Has UK's largest system of sustainable urban drainage – conserving surface waters, and improving biodiversity.	The Energy Village is the transformation of a former colliery site into a mixed use development of housing; industry and commerce; leisure, recreation and education.
Slateford Green	www.sustainablehomes.co.uk	Gorgie Park Close, Edinburgh	District Heating and Cooling, Energy Efficient Appliances, Exposed floor u value<0.25, External wall U value <0.35, Fresh Air Design Maximised, Occupant Controlled Environment, Passive Solar Orientation, Pre-Fabricated/Modular Construction, Roof u value<0.25, Safe Stack Ventilation, Timber Frame.	120 occupied dwellings. Living in a community with minimal fuel bills and reducing car usage and congestion. Construction system and the use of district heating would be used on similar future projects
Solarsiedlung Auf Dem Kruge	www.sustainablehomes.co.uk	Bremen, Gropelingen, Germany	Energy Efficient Appliances, Green Electricity, Low Energy Lighting, Orientation Optimised for Solar Gains, Photovoltaics - Grid Connection, Photovoltaics - Street Lighting, Super Insulated Structure, Education of Occupants on Control Use, Education of Occupants	80 Terraced Houses and 72 Flats. One the biggest projects in Europe whereby PV modules were integrated into roofs of new built housing. 960 modules were installed 200kW output per year = 150,000kWh Reduction of 130 tonnes of carbon dioxide per year
Solar City, Linz, Austria	Detailed web site on whole of planned development	www.linz.at/solarcity/SolarCity.asp	"waste-water free estate", 106 homes to be fitted with urine separation toilets. The urine is enriched with nutrients and supplied as agricultural fertiliser. The solids are composted. Grey water, cleaned locally in a sand bed filter, rainwater soaks into ground locally. SHW. Development to be connected to rapid rail system.	Over 1000 properties to be developed along with school and other community facilities. 12 development companies involved along with the City of Linz
Stamford Brooks, Cheshire (Redrow and Bryant Homes + National Trust)	Background and sales info, press releases	www.stamfordbrook.co.uk	Priority to walking/cycling/public transport. Passive Solar, Water efficiency and EE, high levels insulation, recycling facilities.	650 properties to be built in total. Big interest in purchasing the properties.

Name of development	Best Practice	address	key features / conclusions	Description
Warkworth Close	www.sustainablehomes.co.uk	Balmoral Drive, Felling, Gateshead	Allergen and Asthma Reduction Measures, Dust Mites Minimised, Urea Formaldehyde Foam Excluded, Tropical Timber Excluded, Timber from Managed Sustainable Sources, Active Solar Heating, Energy Efficient Appliances, Low Energy Lighting, Solar Preheating of Ventilation Air, Trombe Wall, Windows - Low Emissivity Coating, Occupant Controlled Environment, Water Conservation Devices	A development of 44 highly insulated dwellings with care taken to provide air tight details with a heat recovery system to the exhaust air. The design also includes a solar wall, K glass, insulated doors, aerated water to reduce water flows, showers rather than baths and low energy lighting. Low energy bills have been achieved for tenants with knowledge and experience gained for the Housing Association. Solar domestic hot water heating was found to be of marginal benefit. Heat recovery ventilation was found to be successful but depends on tenant co-operation.
Wilton Road	www.sustainablehomes.co.uk	The Old Sorting Hall, Wrights Walk, Mortlake, London, SW14 8EN	Steel frame construction, pre-fabricated, low energy environmentally friendly homes	25 occupied homes, completed Sept 2001
The Wintles	Living Villages Limited www.livingvillage.com	Bishops Castle, Shropshire	Super insulated, solar gain, natural materials, encouraged to work from home, air extraction and heat exchangers, timber frame, internal thermal heat mass store, triple glazing, SHW, condensing boilers, underfloor heating, grey water recycling, low energy appliances and lighting.	phase 2 = 9 individual houses amongst 15 acres of gardens, orchards and woodlands.

Current Policies influencing energy efficiency in housing

Title	Policy	web address	Description	key features / conclusions
Government	Energy White Paper (Feb 2003)	www.dti.gov.uk/energy/whitepaper/index.shtml	Defines a long-term strategic vision for energy policy combining environmental, security of supply, competitiveness and social goals.	Adoption of target set out by Royal Commission of Environmental Pollution for a reduction in CO2 emissions by 60% by 2050, from 1990 levels.
Building Regulations	Part L - the conservation of fuel and power.	www.odpm.gov.uk/stellent/groups/odpm_control/documents/contentservertemplate/odpm_index.hcst?n=4204andl=4	Requires reasonable provision to be made for conservation of fuel and power by limiting heat loss through building fabric and addressing efficiency of heating, lighting and ventilation. Refers to Draught proofing, min. boiler efficiencies, insulation, U Values, SAP ratings and Carbon Indexing of properties.	The revisions to Part L constitute the Building Regulations' contribution to achieving the government's target for CO2 emmissions reductions. New regulations that were to have come into force in 2008 have been brought forward to April 2005.
European Commission's Action Plan on Energy Efficiency	EU Directive on Buildings	http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_001/l_00120030104en00650071.pdf.	Promotes improvement of energy performance of buildings within the EU through cost effective measures; Promotes convergence of building standards towards those of Member States which already have ambitious levels. **Must be translated into national law by January 2006**	Methodology for calculating the energy performance of buildings; Application of performance standards on new and existing buildings; Certification schemes for all buildings; Regular inspection and assessment of boilers/heating and cooling installations.
BRE Ecohomes	ECOHOMES:The environmental rating for homes. Revised October 2003 (£25)	http://products.bre.co.uk/breeam/ecohomes.html	BREEAM (BRE Environmental Assessment Method) is the world's most widely used means of reviewing and improving the environmental performance of buildings. EcoHomes is the homes version of BREEAM providing an authoritative rating for new, converted or renovated homes.	Energy: operational energy and CO2 emissions. **Transport:** location issues. **Pollution:** air and water pollution. **Materials:** environmental implications of materials selection, recyclable materials. **Water:** consumption issues. **Ecology and land use. Health and well-being.**
BRE	Green Guide to Housing Specification (£35)	www.brebookshop.com	Contains over 150 specifications. Covers wall roof and floor constructions, landscaping, waste disposal etc	Provides guidance to designers and specifiers on the environmental impacts of common specifications used in housing
BREDEM	Building Research Establishment Domestic Energy Model	www.nher.co.uk	Can be used for estimating energy requirements in different dwelling types, savings arising from EE measures etc.	Simple energy calculation procedures for dwellings. Takes into account the physical characteristics of the dwelling and the lifestyle of the occupants.
Sustainable Buildings Task Force (Defra, ODPM and DTI)	Code for Sustainable Buildings	www.defra.gov.uk/news/2004/040727a.htm	Code should be complete by the end of 2005 for a national rollout by early 2006	Recommendations on energy and water efficiency, waste and the use of sustainable timber
PPS22	Renewable Energy (August 2004)	www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_030334.hcsp	National planning policy relating to the incorporation and encouragement of Renewable Energy in new developments.	Regional spatial strategies & local developments should contain policies to promote & encourage development of RE resources. Consideration should be given to opportunities for incorporating renewables in all new developments.
PPS 3	Access, Movement and Parking (Public Consultation Draft Dec 2002)	www.planningni.gov.uk/AreaPlans_Policy/PPS/PPS.htm	Details how developers must have a transport assessment to offer a realistic choice of access by public transport, walking and cycling and should contribute to the cost of infrastructure improvements.	Doesn't appear to be any legal minimum for the number of parking spaces per dwelling in a residential development, only in commercial developments
Warm Homes and Energy Conservation Act 2000	UK Fuel Poverty Strategy (November 2001)	www.defra.gov.uk/environment/energy/fuelpov/index.htm.	Commitment to eradicate fuel poverty by 2016, the first target is to reach those most vulnerable to cold related ill health by 2010.	Issues relating to the definition of fuel poverty.
FTSE4Good Index Series	aims to set a global standard for Socially Responsible Investment (SRI)	www.ftse.com/ftse4good/index.jsp	The FTSE4Good Index Series has been designed to measure the performance of companies that meet globally recognised corporate responsibility standards, and to facilitate investment in those companies.	Transparent management and criteria alongside the FTSE brand make FTSE4Good the index of choice for the creation of Socially Responsible Investment products.
Private members bill on stamp duty rebates for energy efficient homes	Introduced 12 January, second reading scheduled for 8 April 2005.	www.practicalhelp.org.uk/localauthorities/news/index.cfm?ty=1andnewsid=416	Proposes to reduce stamp duty for house buyers who install energy efficiency measures in their home. Stamp Duty rebates offer a 'Whole House' approach, by encouraging householders to look at their entire home and install energy saving measures.	The Government is unlikely to achieve the 20% improvement in domestic energy efficiency by 2010 so there needs to be further tax incentives to encourage consumers to take up energy efficiency measures.
Home Condition Report (HCR)	Mandatory. Likely to be launched in 2006	www.odpm.gov.uk/	Still being developed. Condition rating of property from 1 (no work required) to 3 (Defects of a serious nature)	Will include information on the energy performance of a dwelling similar to mile per gallon rating of a car.

Current Reports and organizations promoting best practice in energy efficient housing

Name of organisation	Report	web address	key features / conclusions	Description
Energy Efficiency in New Housing: Summary of Specifications	EE Best Practice in Housing	www.est.org.uk/bestpractice/publications/detail.jsp?pk=318	Recommendations and Requirements to improve EE in New Build	Guide for those involved in design and construction of dwellings
Energy Efficiency in New Housing: A guide to achieving best practice	Good Practice Guide 79 (March 2002)	www.est.org.uk/bestpractice	Sections on passive solar design, insulation standards, ventilation, heating and DHW, EE appliances	Guide aims to help housebuilders design and build new EE homes that can achieve standards higher than current building regs for little or no extra cost.
Energy Efficiency Standards - for new and existing dwellings	General Information Leaflet 72 (Sept 2002)	www.housingenergy.org.uk	Three standards for new housing better than minimum required by the building regs: Good Practice, Best Practice, Advanced. Measurements based on Carbon Index achieved and U-values	Provides specifiers, installers and purchasers with a set of EE standards that can be used in the design , construction and refurbishment of dwellings in the UK.
Building a Sustainable Future - houses for an autonomous community	General Information Report 53 (1998)	www.est.org.uk/bestpractice	focuses on planning and layout of developments and homes plus a case study on Sherwood energy village.	Reviews some of the issues involved in sustainable development
Sustainable Homes	Promotes awareness of sustainable development issues for housing associations.	www.sustainablehomes.co.uk	Includes an ecodatabase of ecofriendly housing developments and refurbishments from estates to individual dwellings.	Encourages adoption of sustainable and environmental policies and practices. Funded by Innovation and Good Practice Grant from Housing Corporation
Association for the Conservation of Energy	Consultancy and educational resources about Energy Efficiency	www.ukace.org	ACE is separated into two core operations. A parliamentary campaigns unit, with an interest in developing and promoting sound UK energy policy and a research department investigating many aspects of energy efficiency both in the UK and Europe.	Aims to encourage a positive national awareness of the need for, and benefits of, energy conservation. To help establish sensible and consistent national policies and programmes, and to increase investment in all appropriate energy saving measures.
Green Street	advice on improving the environmental performance of government housing stock	www.greenstreet.org.uk	Aims to help reduce the impact of existing buildings, specifically the 4 million homes maintained by Housing Associations and LAs	Uses eight different standard flat and house types to demonstrate ways of reducing environmental impact and improving performance of these types
Stockholm Environment Institute and WWF	One Planet Living in the Thames Gateway	www.wwf.org.uk/filelibrary/pdf/thamesgateway.pdf	If built to Ecohomes 'very good' standard, 32% reduction in CO2 emissions from energy use in the home. Found significant environmental savings can be made through developing sustainable homes and enabling residents to live sustainable lifestyles.	Study investigates the implications of building 200,000 homes in the Thames Gateway to higher than 2002 building regulations environmental standards
WWF	Building Towards Sustainability	www.wwf.org.uk/sustainablehomes	Analyses the sustainability performance of the UK's 13 largest house building firms.	part of WWF's One Million Sustainable Homes campaign

Name of organisation	Report	web address	key features / conclusions	Description
Merseyside green Housing Alliance	Green Housing for the Future	www.sustainablehomes.co.uk/pdf/Green%20Alliance%20Report.pd	explores ways in which the green agenda inhousing can be pushed forward by looking at building design, landscape, funding and partnership issues	Group of RSLs LA representatives, Liverpool Housing Action Trust and consultants.
London Energy Partnership (Sept 2004)	London Renewables Toolkit: integrating renewable energy into new developments. Toolkit for planners, developers, consultants.	www.london.gov.uk/mayor/environment/energy/london_renew.jsp	Section 4 gives relative cost effectiveness of different RE technologies for medium density housing plus carbon savings	The aim of the toolkit is to improve understanding about renewable energy technology, in order to increase its use. The Toolkit provides information on cost, installation and suitability to urban areas such as London. It offers case study examples and information on funding schemes.
Review of Housing Supply	Delivering Stability: securing our future housing needs. (March 2004)	www.hm-treasury.gov.uk/consultations_and_legislation/barker/consult_barker_index.cfm	Concludes a lower trend in house prices is desirable: To bring the real price trend in line with the EU average of 1.1 per cent an extra 120,000 houses each year might be required.	Presents choices for Government depending on its objectives for housing
ACE, EST and Housing Corporation	User behaviour in energy efficient homes	www.ukace.org	23% use heating systems correctly and efficiently, 23% inefficient. But gives no indication of how this compares to prior to EE measures or to homes without EE measures!	118 interviews with residents of estates of participating housing associations having had EE improvements in the past 15 months
Green Moves	A website dedicated to advertising homes for sale that are more energy efficient than conventional homes. (eco homes or green homes)	www.greenmoves.co.uk	To be launched as soon as 50 properties listed.	An ethical business initiative that has the support of two environmental charities: the Somerset Trust for Sustainable Development and the WWF. GreenMoves reinvests some of its income in tree planting to help offset the carbon emissions from housing.
Carbon Community Reduction Project (CRed) Norwich	Innovation Programme	www.practicalhelp.org.uk/briefings/sub.cfm?main_id=2andsub_id=13 www.cred.org.uk	Identifying: Relationships between developers, community etc. Barriers to low carbon private housing developments, solutions to these barriers	Identified institutional reluctance in building industry to experiment with new design or to build to higher standard than minimum required. UEA survey found some evidence of consumer demand for low carbon housing

Appendix 2: Hierarchy of 'greening' measures given consideration

Use Less Energy

"Be Lean"

Behavioural Measures

Build Quality

Sustainable Building Materials

Timber home construction from FSC (no tropical timber)

10% of UK CO2 emissions arise from the production of building materials

If recycled, 95% of the embodied energy may be recovered

compared to timber the embodied energy of:

brick = 4x

cement = 5x

aluminium = 126x

Local Materials - Transport Minimised

Construction Waste Recycling

Natural Materials

Recycled paper insulation / thermafleece etc

Paints & Solvents - natural, non-toxic

Householder Awareness

Education of Occupants - Handbook For How to Use the House

Install Highly visible electricity & water meters in kitchen to encourage reduced consumption

food energy

Shop of local produce, walking distance from all houses

Recycling

Household Waste Recycling Scheme / Collection with multi divisional bin provided

Composting System

Transport / communications

Discouraging Car use

Ensure footpaths so cars not needed to cross development - discourage car use

Encouraging Bicycle use

Cycle Priority routes and pathways

Connection of development to local cycle network routes

roads with smooth paving only for cyclists and pedestrians

Cycle Storage Facillities at each home

Encouraging Public Transport use

Public Transport Enhanced

Discouraging unneccesary travel

Home Working

local Kindergarten / Health Facilities

Improve insulation

Super Insulated Structure

Thermal Mass

Extra loft insulation (350mm)

Draught Lobby - Porch to act as Sun trap / wind shelter

Windows - Triple Glazed / Low Emissivity Coating

U Values

Window U value < 2.0

Exposed floor u value<0.25
External wall U value <0.35
Roof u value<0.25

Air

Air Tight Envelope
Fresh Air Design Maximised
Allergen & Asthma Reduction Measures

incorporate passive heating and cooling

Passive Solar Gain
Maximise natural daylight

Site Layout

Plan streets to run from East to West to allow house to be south facing
Site dwellings with one elevation to face within 25^{O} of south
terraces reduce heating requirements
Multi storey dwellings reduce heat load
Provide adequate spacing to minimise overshadowing - stagger dwellings
Wind Shading/Deflection with Vegetation
South facing slopes will allow greater densities

Dwelling Design

Avoid Building forms which cause overshadowing
Maximise south facing windows and minimise north facing
Arrange house plans so that highly heated spaces are south facing
living and bed rooms south, kitchens and bathrooms north facing
Use exposed masonry to provide thermal storage in rooms with solar gain
Avoid westerly orientations particularly for kitchens
Provide Blinds for windows facing between South and West

install EE lighting and appliances

Boiler

Condensing Boiler
Appropriate and well maintained Control Systems

Lighting

pre-fitted Energy efficient
lamps

Appliances

passively cooled larder to reduce size of fridge needed
Houses come with A-rated white goods installed (can reduce relating electricity demand by over 50%)
footings for rotary drying line in all rear gardens
tidy driers over baths in flats

Water

Grey water recycling (only 5% of water consumed daily is used for drinking)
Rainwater butts - Rainwater Recycling
Demand
Reduction
Short Flush / dual flush / 2 Litre or Less Toilets
saving estimated 55,000 litres water per household p.a.
Low Water White Goods
aerated shower and taps
Highly visible water meters to encourage water efficiency

Use Renewable Energy

"Be Green"

Install renewables on site

Individual Household Renewables

Solar Hot Water

Development Wide Renewables

Photovoltaics - Street Lighting

Import renewable energy

Green Electricity

Supply Energy Efficiently

"Be Clean"

Install CHP on site

Non-Energy related development issues

Bio Diversity

Construction on Brownfield sites - land deemed of low ecological value - reclaimed land

Fauna

Wildlife Conservation

Natural Landscapes Preserved

Flora

Trees Retained on Site and planted

Street Design / Social Structure

Open Space Quality - avenues of trees, hedges rather than walls

Avoid Grouping of house types and prices

Quality of Life

Communal Gardens - Allotments

Water

Sustainable Urban Drainage System (SUDS)

Minimise roads and hard surfaces in accordance with HomeZones

Porous Paving and Landscaping

Appendix 3: Dwelling Energy Consumption & Emissions by age and relevant building regulations

Stock Average

					Energy Usage				Carbon Emissions			
Carbon emissions factor used for this fuel									0.19	0.43		
Property Type	**Bed-rooms**	**assumed # of rooms**	**ground floor area m2**	**exposed perimeter wall (m)**	**Gas (kWh/yr)**	**Electric (kWh/yr)**	**Total (kWh/yr)**	**kWh/m2/yr**	**Gas kg CO2 / yr**	**Electricity kg CO2 / yr**	**total kg CO2 / yr**	**CO2/m2/yr**
Flat	1	4	42	10.5	9,878	2,008	11,886	283	1,877	864	2,740	65
Flat	2	6	61	15.25	14,155	2,487	16,642	273	2,689	1,069	3,759	62
Flat	3	7	89	16	20,453	3,432	23,885	268	3,886	1,476	5,362	60
Mid Terraced House	2	6	31.5	9	14,092	2,530	16,622	264	2,678	1,088	3,765	60
Mid Terraced House	3	7	39.5	10.5	17,562	3,044	20,606	261	3,337	1,309	4,646	59
End Terraced House	2	6	31.5	16	18,142	2,540	20,682	328	3,447	1,092	4,539	72
End Terraced House	3	7	39.5	18	22,640	3,056	25,697	325	4,302	1,314	5,616	71
Semi Detached Bunglalow	2	7	63.5	23	19,240	2,570	21,810	343	3,656	1,105	4,761	75
Semi Detached Bunglalow	3	8	74	25.25	22,350	2,903	25,253	341	4,247	1,248	5,495	74
Detached Bungalow	2	7	67	32.75	21,987	2,678	24,666	368	4,178	1,152	5,329	80
Detached Bungalow	3	8	78	35.5	25,526	3,042	28,569	366	4,850	1,308	6,158	79
Detached Bungalow	4	10	90	38	29,386	3,486	32,873	365	5,583	1,499	7,083	79
Semi-Detached House	2	8	38.5	18	22,080	2,981	25,061	325	4,195	1,282	5,477	71
Semi-Detached House	3	9	44.5	18.9	25,453	3,417	28,870	324	4,836	1,469	6,305	71
Semi-Detached House	4	10	51	20.5	29,106	3,941	33,048	324	5,530	1,695	7,225	71
Detached House	2	8	45	27	28,689	3,453	32,141	357	5,451	1,485	6,936	77
Detached House	3	9	52	29	33,082	4,024	37,106	357	6,286	1,730	8,016	77
Detached House	4	10	60	31	38,101	4,749	42,850	357	7,239	2,042	9,281	77
Transport										2,948		

Figures for stock average in June 2004 provided by Practical Help - Energy use modelled using BREDEM-12.

Carbon Emission Factors taken from Defra's Environmental Reporting Guidelines for Company Reporting on Greenhouse Gas Emissions. For electricity, the real emissions vary with the different mix of fuels used in the power stations however, it has been held constant at 0.43kg CO2/kWh since 2000 to ensure a consistent base on which to measure savings and will be used for environmental reporting until 2010

Transport: average miles travelled per car = 9000, cars per household 2002 = 1.06, average car CO2 emissions = 192g/km

1998

					Energy Usage				Carbon Emissions			
Carbon emissions factor used for this fuel					0.19	0.51						
Property Type	**Bed-rooms**	**assumed # of rooms**	**ground floor area m2**	**exposed perimeter wall (m)**	**Gas (kWh/yr)**	**Electric (kWh/yr)**	**Total (kWh/yr)**	**kWh/m2/yr**	**Gas kg CO2 / yr**	**Electricity kg CO2 / yr**	**total kg CO2 / yr**	**CO2/m2/yr**
Flat	1	4	42	10.5	5,278	1,194	6,472	154	1,000	600	1,600	38
Flat	2	6	61	15.25	7,806	1,667	9,472	155	1,500	850	2,350	39
Flat	3	7	89	16	9,000	2,361	11,361	128	1,800	1,200	3,000	34
Mid Terraced House	2	6	31.5	9	9,722	1,472	11,194	178	1,850	750	2,600	41
Mid Terraced House	3	7	39.5	10.5	10,917	1,833	12,750	161	2,150	900	3,050	39
End Terraced House	2	6	31.5	16	11,139	1,472	12,611	200	2,150	750	2,900	46
End Terraced House	3	7	39.5	18	12,472	1,833	14,306	181	2,400	900	3,300	42
Semi Detached Bunglalow	2	7	63.5	23	11,444	1,528	12,972	204	2,200	800	3,000	47
Semi Detached Bunglalow	3	8	74	25.25	12,361	1,778	14,139	191	2,400	900	3,300	45
Detached Bungalow	2	7	67	32.75	12,861	1,639	14,500	216	2,500	800	3,300	49
Detached Bungalow	3	8	78	35.5	13,917	1,889	15,806	203	2,700	1,000	3,700	47
Detached Bungalow	4	10	90	38	15,194	2,194	17,389	193	2,900	1,100	4,000	44
Semi-Detached House	2	8	38.5	18	12,389	1,806	14,194	184	2,400	900	3,300	43
Semi-Detached House	3	9	44.5	18.9	13,250	2,056	15,306	172	2,600	1,000	3,600	40
Semi-Detached House	4	10	51	20.5	14,583	2,389	16,972	166	2,900	1,200	4,100	40
Detached House	2	8	45	27	15,111	2,111	17,222	191	2,900	1,100	4,000	44
Detached House	3	9	52	29	16,417	2,417	18,833	181	3,300	1,200	4,500	43
Detached House	4	10	60	31	18,028	2,833	20,861	174	3,500	1,400	4,900	41
Transport										2,802		
Food												

figures calculated in NHER for standard assumptions
transport: National Travel Survey July 2004: 1998 avg miles per car = 9360, cars per household = 1.00. avg car CO2 emissions = 186g/km

2002

		Energy Usage						Carbon Emissions					
Carbon emissions factor used for this fuel								0.19	0.43				
Property Type	**Bed-rooms**	**Gas (kWh/yr)**	**Electric (kWh/yr)**	**Total (kWh/yr)**	**Predicted Total kWh/yr**	**kWh/m2/yr**	**PredictedTotal kWh/m2/yr from varying sources**	**Gas kg CO2 / yr**	**Electricity kg CO2 / yr**	**total kg CO2 / yr**	**predicted total kg CO2 / yr from varying sources**	**kg CO2/m2/yr**	**predicted kg CO2 / yr /m2**
Flat	1	3,958	1,075	5,178		123		769	462	1,231		29	
Flat	2	5,854	1,500	7,578	7,625	124	125	1,138	645	1,783	2,196	29	36
Flat	3	6,750	2,125	9,089		102		1,312	914	2,225		25	
Mid Terraced House	2	7,292	1,325	8,956		142		1,417	570	1,987		32	
Mid Terraced House	3	8,188	1,650	10,200	11,060	129	140	1,591	710	2,301	3,002	29	38
End Terraced House	2	8,354	1,325	10,089		160		1,623	570	2,193		35	
End Terraced House	3	9,354	1,650	11,004		139		1,818	710	2,527		32	
Semi Detached Bunglalow	2	8,583	1,375	9,958		157		1,668	591	2,259		36	
Semi Detached Bunglalow	3	9,271	1,600	10,871		147		1,802	688	2,490		34	
Detached Bungalow	2	9,646	1,475	11,121		166		1,874	634	2,509		37	
Detached Bungalow	3	10,438	1,700	12,138		156		2,028	731	2,759		35	
Detached Bungalow	4	11,396	1,975	13,371		149		2,215	849	3,064		34	
Semi-Detached House	2	9,292	1,625	10,917		142		1,806	699	2,504	3,057	33	
Semi-Detached House	3	9,938	1,850	11,788		132		1,931	796	2,727	3,043	31	
Semi-Detached House	4	10,938	2,150	13,088		128		2,125	925	3,050		30	
Detached House	2	11,333	1,900	13,233		147		2,202	817	3,019		34	
Detached House	3	12,313	2,175	14,488	16,640	139	160	2,393	935	3,328	4,264	32	41
Detached House	4	13,521	2,550	16,071		134		2,628	1,097	3,724		31	
Transport										2,948			
Food										6,272			

figures for 2002 are gas figures from NHER 98 reduced by 25%, electricity reduced by 10% and carbon factor adjusted.
Sources for verifying figures: Richard Hodkinson Consultancy, WWF report "One planet living in the Thames Gateway", BRE.
Transport: National Travel Survey July 2004: 2002, avg miles travelled per car = 9000, cars per household = 1.06, avg car CO2 emissions = 192g/km
Food: typical UK resident in typical new UK home to 02 regs based on avg UK consumption = 2.692 tonnes/person/annum, 2.33 persons per household.
sources: P45 One planet living in the Thames Gateway and DEFRA.

2005

		Energy Usage				Carbon Emissions					
Carbon emissions factor used for this fuel						0.19	0.43				
Property Type	**Bed-rooms**	**Gas (kWh/yr)**	**Electric (kWh/yr)**	**Total (kWh/yr)**	**kWh/m2/yr**	**Gas kg CO2 / yr**	**Electricity kg CO2 / yr**	**total kg CO2 / yr**	**predicted total kg CO2 / yr from varying sources**	**kg CO2/m2/yr**	**predicted kg CO2 / yr /m2 from varying sources**
Flat	1	2,969	806	3,775	90	577	347	924	917	22	22
Flat	2	4,391	1,125	5,516	90	853	484	1,337	1,332	22	22
Flat	3	5,063	1,594	6,656	75	984	685	1,669	1,944	19	22
Mid Terraced House	2	5,469	994	6,463	103	1,063	427	1,490	1,423	24	23
Mid Terraced House	3	6,141	1,238	7,378	93	1,193	532	1,725	1,784	22	23
End Terraced House	2	6,266	994	7,259	115	1,218	427	1,645		26	
End Terraced House	3	7,016	1,238	8,253	104	1,363	532	1,895		24	
Semi Detached Bunglalow	2	6,438	1,031	7,469	118	1,251	443	1,694		27	
Semi Detached Bunglalow	3	6,953	1,200	8,153	110	1,351	516	1,867		25	
Detached Bungalow	2	7,234	1,106	8,341	124	1,406	476	1,882		28	
Detached Bungalow	3	7,828	1,275	9,103	117	1,521	548	2,069		27	
Detached Bungalow	4	8,547	1,481	10,028	111	1,661	637	2,298		26	
Semi-Detached House	2	6,969	1,219	8,188	106	1,354	524	1,878	1,667	24	22
Semi-Detached House	3	7,453	1,388	8,841	99	1,448	597	2,045	2,064	23	23
Semi-Detached House	4	8,203	1,613	9,816	96	1,594	693	2,287	2,750	22	27
Detached House	2	8,500	1,425	9,925	110	1,652	613	2,265	1,957	25	22
Detached House	3	9,234	1,631	10,866	104	1,795	701	2,496	2,261	24	22
Detached House	4	10,141	1,913	12,053	100	1,971	822	2,793	2,609	23	22
Transport								2,948			
Food								6,272			

Dwelling Carbon Emission Rate (DCER) and the Target Carbon Emission Rate (TCER) will be required in order to show compliance with the Building Regulations 2005
figures for 2005 are 2002 figures reduced by 25%, plus carbon factor reduced
Sources for verifying figures: WWF report "One planet living in the Thames Gateway", BRE, target DCERs
Dwelling Carbon Emission Rate (DCER) and Target Carbon Emission Rate (TCER) will be required in order to show compliance with the Building Regulations 05
Transport: no updated figures available for 2005 but not decreased despite better fuel efficiency in newer cars as people have shown a tendancy to buy larger cars.
Source: Energy efficiency in the UK 1990-2000
Food: typical UK resident in typical new UK home to Ecohomes very good based on avg UK consumption = 2.692 tonnes/person/annum, 2.33 persons per household.
Sources: P45 One planet living in the Thames Gateway and DEFRA.

2005 + Renewables

		Energy Usage				Carbon Emissions			
Carbon emissions factor used for this fuel						0.19	0.43		
Property Type	**Bed-rooms**	**Gas (kWh/yr)**	**Electric (kWh/yr)**	**Total (kWh/yr)**	**kWh/m2/yr**	**Gas kg CO2 / yr**	**Electricity kg CO2 / yr**	**total kg CO2 / yr**	**CO2/m2/yr**
Flat	1	2,169	786	2,955	70	421	338	760	18
Flat	2	3,591	1,105	4,696	77	698	475	1,173	19
Flat	3	4,263	1,574	5,836	66	828	677	1,505	17
Mid Terraced House	2	4,469	494	4,963	79	868	212	1,081	17
Mid Terraced House	3	5,141	738	5,878	74	999	317	1,316	17
End Terraced House	2	5,266	494	5,759	91	1,023	212	1,236	20
End Terraced House	3	6,016	738	6,753	85	1,169	317	1,486	19
Semi Detached Bunglalow	2	5,438	211	5,649	89	1,057	91	1,148	18
Semi Detached Bunglalow	3	5,953	380	6,333	86	1,157	163	1,320	18
Detached Bungalow	2	6,234	286	6,521	97	1,212	123	1,335	20
Detached Bungalow	3	6,828	455	7,283	93	1,327	196	1,523	20
Detached Bungalow	4	7,547	661	8,208	91	1,467	284	1,751	19
Semi-Detached House	2	5,969	399	6,368	83	1,160	171	1,331	17
Semi-Detached House	3	6,453	568	7,021	79	1,254	244	1,498	17
Semi-Detached House	4	7,203	793	7,996	78	1,400	341	1,741	17
Detached House	2	7,500	605	8,105	90	1,457	260	1,718	19
Detached House	3	8,234	811	9,046	87	1,600	349	1,949	19
Detached House	4	9,141	1,093	10,233	85	1,776	470	2,246	19
Transport								2,948	
Food								5,958	

Solar Hot Water: assumed to reduce the gas requirement to each household by 1000kWh p.a. and 800kWh per flat
PV: between 6m2 and 10m2 of polycrystalline PV on all dwellings excluding flats
15kW turbine at 25m providing approximately 35,000 kWh of electricity p.a. equating to 20 kWh per dwelling.
Transport: no updated figures available for 2005 but not decreased despite better fuel efficiency in newer cars as people have shown a tendancy to buy larger cars.
Source: Energy efficiency in the UK 1990-2000
Food: figure per person decreases to 2.557tonnes/person/annum for an environmentally aware resident (increased consumption of local or organic food)
(to 1.953 for vegetarian / minimal meat lifestyle, less packaging, promotion of local/organic food.)

Appendix 4: Development wide emissions according to building regulation scenario, based on varying ratios of dwelling type

based on 2005 regs

Total dwellings	1500	suggested combination to be used		using 4 bed detached				Poundbury		Stanway Colchester		Ingress Park			
Dwelling type	proportions	CO2 emissions	proportions	CO2 emissions	proportions	CO2 emissions	proportions	CO2 emissions	proportions	CO2 emissions	proportions	CO2 emissions	proportions	CO2 emissions	proportions
Detached	20%	748,786	20%	837,901	10%	374,393	31%	1,160,618	36%	1,347,815	32%	1,198,058	15%	561,590	10%
semi	0%	-	0%	-	10%	306,749	0%	-	0%	-	0%	-	35%	1,073,620	30%
terrace	45%	1,164,667	45%	1,164,667	45%	1,164,667	43%	1,112,904	28%	724,682	45%	1,164,667	40%	1,035,260	50%
flat	35%	876,282	35%	701,915	35%	876,282	22%	550,806	36%	901,318	23%	575,842	10%	250,366	10%
	100%	2,789,735	100%	2,704,482	100%	2,722,090	96%	2,824,328	100%	2,973,815	100%	2,938,567	100%	2,920,836	100%
Carbon emissions reductions from change in dwelling types				3.06%		2.42%		-1.24%		-6.60%		-5.33%		-4.70%	

based on 1998 regs

				using 4 bed detached											
Dwelling type	proportions	CO2 emissions	proportions	CO2 emissions	proportions	CO2 emissions	proportions	CO2 emissions	proportions	CO2 emissions	proportions	CO2 emissions	proportions	CO2 emissions	proportions
Detached	20%	1,350,000	20%	1,470,000	10%	675,000	30%	2,025,000	25%	1,687,500	20%	1,350,000	15%	1,012,500	10%
semi	0%	-	0%	-	10%	540,000	35%	1,890,000	35%	1,890,000	35%	1,890,000	35%	1,890,000	30%
terrace	45%	2,058,750	45%	2,058,750	45%	2,058,750	25%	1,143,750	30%	1,372,500	35%	1,601,250	40%	1,830,000	50%
flat	35%	1,575,000	35%	1,233,750	35%	1,575,000	10%	450,000	10%	450,000	10%	450,000	10%	450,000	10%
	100%	4,983,750	100%	4,762,500	100%	4,848,750	100%	5,508,750	100%	5,400,000	100%	5,291,250	100%	5,182,500	100%
Carbon emissions reductions from 98 to 2005 regs		44%		43%		44%		49%		45%		44%		44%	

based on 2005 regs plus renewables

Total dwellings	1500			using 4 bed detached and 2 bed flat											
Dwelling type	proportions	CO2 emissions	proportions	CO2 emissions	proportions	CO2 emissions	proportions	CO2 emissions	proportions	CO2 emissions	proportions	CO2 emissions	proportions	CO2 emissions	proportions
Detached	20%	584,707	20%	673,822	10%	292,354	30%	877,061	25%	730,884	20%	584,707	15%	438,530	10%
semi	0%	-	0%	-	10%	224,709	35%	786,482	35%	786,482	35%	786,482	35%	786,482	30%
terrace	45%	888,369	45%	888,369	45%	888,369	25%	493,538	30%	592,246	35%	690,954	40%	789,662	50%
flat	35%	790,148	35%	615,781	35%	790,148	10%	225,757	10%	225,757	10%	225,757	10%	225,757	10%
	100%	2,263,225	100%	2,177,972	100%	2,195,580	100%	2,382,838	100%	2,335,369	100%	2,287,900	100%	2,240,430	100%
Carbon emissions reductions from adding renewables to 2005 regs		18.87%		19.47%		19.34%		15.63%		21.47%		22.14%		23.29%	
overall reductions from 1998		**55%**		54%		55%		57%		57%		57%		57%	