Developing low energy and sustainable homes

Climate change and energy security are the greatest challenges facing the world today. Climate change is causing global warming, which is the increase in the average temperature on the earth’s surface, air and oceans. The release of greenhouse gas emissions into our atmosphere, from human activities, such as burning fossil fuels and deforestation have been a major factor in their increase over the last 100 years.

Energy security is vital for any developed economy. The OPEC member countries control about 75% of the world’s oil reserves (R). Many of these countries are politically unstable and they can control the price of oil. In the early years of this decade, the UK was a net exporter of gas and it is estimated that by 2020, they will only be able to meet about 40% of their oil and gas needs themselves(R). The UK needs to reduce its green house gas emissions and meet their energy demands without having to rely on other nations.

The Kyoto protocol was established to limit and reduce the amount of green house gases released into the atmosphere. Industrialised countries, and those is transition to a market economy, which were called the Annex I countries have agreed to ratify the agreement and reduce their emissions to a 1990’s baseline (R).

The UK’s commitment under the protocol is to reduce their green house gas emissions by 12. 5% of 1990 levels, by 2008-2012. This involves an 8% reduction in their C02 emissions, the main cause of global warming, over this time frame. Further aspirational targets are set out in the DTI Energy White

Paper published in 2003, such as to reduce CO2 emissions by 80% by 2050 (R).

In 2002, the residential sector caused 27% of the UK's CO2 emissions, of which 82% of the energy was for space and water heating (R). The proposals, as laid out by Gordon Brown in 2006 stated that " within ten years, every new home will be a zero-carbon home". The Code for Sustainable Homes was introduced in 2007, the code rates the sustainability of homes over six levels based on certain criteria. In theory, constructing zero-carbon homes (homes which can generate their own electrical and heating needs either onsite or locally) is a fantastic idea which will eventually lower energy demands and then lower the CO2 emissions countrywide. But they are ambitious plans and there are several issues that need to be resolved such as:

1. Zero-Carbon Home: Definition
2. New Construction Techniques & Building Regulations
3. The Code for Sustainable Homes
4. Planning Laws
5. Grants and incentives
6. What's happening now?
7. Certifying Agencies
8. Zero Carbon Homes:

There is still some confusion as to the detailed description of a zero-carbon home. The Housing Minister, John Healy published on the Communities and Local Government (CLG) website the zero carbon homes definition:

“ A zero carbon home is one whose net carbon dioxide emissions, taking account of emissions associated with all energy use in the home, is equal to zero or negative across the year. The definition of ‘ energy use’ will cover both energy uses currently regulated by the Building Regulations and other energy used in the home”. (R)

Detailed information is still needed about energy imported and used in the zero carbon homes. The energy standards state that there has to be onsite renewable energy and a locally connected heat supply to achieve a 70% reduction in the carbon emissions from current levels. Currently there is no allowance made for renewable energy generated off site, for example, wind and wave power. If I design a proposed zero carbon home and connect it to an energy company that is generating electricity in the north of Scotland, I might not achieve the rating I want which is unfair, even though he electricity is generated from a renewable source.

The life cycle of a building is not taken into account in the definition of a zero carbon homes either. The construction, renovation and disposal can cause significant amounts of CO2 emission to be released. A life cycle analyses of a zero carbon home should include the embodied energy within the materials and waste disposal. Of course, not all of the material could be sourced locally as this would be impossible, but each council/local government should be able to compile a list of materials that are located locally. Ideally, a certain percentage of the local materials should have to be used. This would not only decrease the embodied energy within some of the construction materials but also help support local businesses. The government should

invest more in the research of this idea, with many businesses suffering in the current economic climate, we should be buying locally, not importing.

New Construction Techniques & Building Regulations:

Our European neighbours have been developing low energy houses and energy saving construction techniques for over 30 years. While some of the techniques might be new to the UK, they have been tried and tested on the continent. Currently the averaged U-Value for Walls, Roofs and Floors (wm2K) in Part L of the Building Regulations for the UK is 0. 24, whereas in Germany and Switzerland the Passivehaus' and Minergie-P regulations are achieving an average of 0. 10(R). In 2013 the averaged UK Part L will lower to 0. 18 and then in 2016 to 0. 14. (R)

The German designed Passivhaus has been a hugely successful energy saving concept that has only reached the UK in recent years. The basic principle include very good levels of insulation with minimal thermal bridging, utilising solar and internal gains by house orientation, window design and location, excellent levels of air tightness and good indoor air quality provided by whole house mechanical ventilation system with highly efficient heat recovery.(R)

Sweden, also has produced energy efficient house designs since the 1970's, with different mandatory standards for the north and south due to the difference in climate. There performance standards are among the highest energy efficiency requirements in the world, already in line with Passivhaus standards. Over 7000 home have been constructed across Europe to the

Passivhaus standard, the techniques used can easily be adapted here within the UK.

The highly insulated and airtight passivhaus' have a heating requirment of 15kwh/m2/year, which is nearly 90% less energy used to heat a standard UK home (R). These homes often need little or no heating for 9 months of the year. This will not automatically mean that the houses will achieve the highest level on the Code for Sustainable Homes. If we are to achieve the standards of the Passivhaus, the design and construction techniques should be introduced into the university courses now, for such degrees as I studied (Architectural Technology). These techniques are the future for zero carbon residential, commercial and industrial building. Starting with the basic house construction, if we are thought the techniques on how to construct dwellings that minimise their heat and hot water demand, less energy is needed, and expensive renewable options such as PV cells, geothermal pumps and domestic wind turbines can be reduced. We can then adapt these techniques for other building types.

Code for Sustainable Homes & Sullivan Report:

The Code for Sustainable Homes (CSH) was introduced in England on a voluntary basis in May 2007 and a code rating for all new buildings became mandatory from 1st May 2008. The Code Level 3 rating for newly constructed homes promoted or supported by the Welsh Assembly Government became mandatory from 1st May 2008 also and from 2nd June 2008, Code Level 3 is required for all new self-contained social housing in Northern Ireland (R).

The Code does not apply in Scotland. A panel was appointed by the Minister for Transport,

Infrastructure and Climate Changet, chaired by Lynne Sullivan, they made recommendations to develop a strategy to achieve zero net carbon emissions. Experts for the UK as well as from Norway, Denmark and Austria participated. They agreed on eventual and staged recommendations to be achieved by new build and existing homes in Scotland.

The following was recommended for all new build homes in Scotland:

- Net zero carbon buildings (i. e. space and water heating, lighting and ventilation) by 2016/2017, if practical.
- Two intermediate stages on the way to net zero carbon buildings, one change in energy standards in 2010 (low carbon buildings) and another in 2013 (very low carbon buildings).
- The 2010 change in energy standards for non-domestic buildings should deliver carbon dioxide savings of 50% more than 2007 standards.
- The 2010 change in energy standards for domestic buildings should deliver carbon dioxide savings of 30% more than 2007 standards.
- The 2013 change in energy standards for non-domestic buildings should deliver carbon dioxide savings of 75% more than 2007 standards.
- The 2013 change in energy standards for domestic buildings should deliver carbon dioxide savings of 60% more than 2007 standards.

- Backstop levels of U-values and airtightness for building fabric should be improved in 2010 to match those of Nordic countries, but consideration must be given to the social and financial impact of measures that would necessitate mechanical ventilation with heat recovery in domestic buildings.
- The ambition of total-life zero carbon buildings by 2030.

The Code for Sustainable Homes was introduced to replace Ecohomes which was the energy assessment rating for all homes in B. R. E. E. A. M. (R). The CSH was intended to be a single national standard for design and construction of sustainable homes. The code complements the system of Energy Performance Certificates (EPC) which was introduced in June 2007 under the Energy Performance of Buildings Directive (EPBD) (R). All new homes (and eventually all homes, when they are sold or leased) will have an EPC which provides key information about the energy efficiency/carbon performance of a home. The CSH and EPC and energy assessments used the same terminology.

The CSH was developed by using the existing Building Research Establishment’s (BRE) EcoHomes System. The Code has a scoring system of six levels. The different levels are made up by achieving both the appropriate mandatory minimum standards together with a proportion of flexible standards. Level 6, being the highest level achieves a Zero-Carbon Home standard. The Code has been designed so it is closely linked to the Building Regulations, which are the minimum standards by law. The minimum standards for the Code compliance have been set above the

requirements of the Building Regulations. The Code has been set out as a baseline in relation to carbon emissions from energy use in a home.

The introduction of the Code for Sustainable Homes will encourage developers to build to higher standards. Homes that will be constructed to the higher standards set out in the Code will produce lower levels of CO2 and generate lower energy bills for the occupants. Including the 6 level scoring systems is a good opportunity for developers and buildings to try various construction techniques and see what level they can achieve. The levels are a good stepping stone to achieve a level 6 score and obtaining a zero-carbon home status.

The Code for Sustainable Homes was designed to show how sustainable a home could be. Sustainable homes should include the three pillars of sustainability: Environmental, Social & Economic. In the Code, only one of these pillars is addressed, Environmental. For the Code to be truly sustainable the social and economic issues need to be included in the design, construction and operation of all new homes. The location of new homes, either in a rural or built-up area could be added to the weighting system for points scoring. Constructing a home within a certain distance of a public transfer route could also gain points on the scoring system, this would reduce the home owner’s daily car use and CO2 emissions.

The government or local authorities could have specially designated areas, preferably Brownfield sites that could be classed as “ sustainable sites”. A points system could be incorporated into the CSH for constructing a new home in this area. As transport makes up over 23% of UK’s GHG emissions

(R), encouraging alternative-fuel vehicles and electric cars would be beneficial. An alternative-fuel top up station could be constructed within these proposed “ sustainable sites” area. This would meet some of the economic issues by creating employment within the green industry. Until the social and economic issues have been addressed, we should consider contacting the Department for Communities and Local Government and asking them to rename the Code for Sustainable Homes to the Code for Environmental Homes.

Planning Laws:

As stated in Section 1. 0, Zero-Carbon Homes will have to incorporate either on-site renewable technologies or locally sourced combined heat and power (CHP) for their energy needs. The National Planning Policy Statement 22: Renewable Energy gives national guidance in England, on the installation of renewable technologies. Statement 22 was last updated in 2004, but has been supplemented by the updated Planning Policy Statement 1: Planning & Climate Change published in 2007. Currently there is a consultation draft to be updated and published before the end of this year (2009). The equivalent planning statement in Scotland is the National Planning Policy Guideline 6: Renewable Energy Developments. It provides the Scottish Executives policy on national land use and planning matters regarding renewable technologies.

New permitted development rights introduced on 6th April 2008 in England and the 12th March 2009 in Scotland have made it easier to install renewable energy technologies such as solar panels and biomass boilers(R).

These permitted development rights have lifted requirements for planning permission for most domestic micro-generation technologies.

In England, The General Permitted Development Order (GPDO) gives rights to certain forms of development on the home without the need to apply for planning permission. In Scotland, these rights are under the Town and Country Planning (General Permitted Developed) (Domestic Micro-generation) TCP (GPD) Scotland Amendment Order 2009. Currently the Welsh Assembly Government and Northern Ireland Government are considering changing their legislation to permit certain renewable technology development without having to apply for planning permission. Both governments hope to introduce legislation in 2010. The GPDO in England and the TCP (GPD) in Scotland include the following technologies:

- Solar PV & Solar Thermal (Roof Mounted)
- Solar PV & Solar Thermal (Stand Alone)
- Wood burning boilers and stoves
- Ground source heat pumps
- Water source heat pumps
- Air source heat pumps
- Micro and small wind (due to legal technicalities not included yet but further legislation expected later this year)

The DPDO and TCP (GPD) are for guidance only. Each local authority has their own regulations that are set exclusively for their area. For example, a dwelling constructed within a conservation area would have to comply with

stiffer standards with regard to installation of renewable technologies towards a dwelling not located in a conservation area.

The Mid-Lothian Local Plan was published in 2007 and within ‘ NRG2 Individual Wins Turbines and Micro-Generations’ it states,

“ The Council will support development that proposes the use of individual and community scale wind turbines and other micro-generation technologies for localised power requirements, provided they are located to minimise any potential adverse impact on the local community…. The cumulative visual impact of such proposals will be taken into consideration when assessing individual planning applications”

There certainly is a good system in place in allowing the installation of certain renewable technologies without the need for applying for planning permission. The National Planning Policy Statements (England) and National Planning Policy Guidelines (Scotland) provide national frameworks which help local planning systems to evolve and deliver sustainable development. The current planning system is definitely driving us towards a sustainable future and the possibility of making ZCH’s a reality by 2016. It is great to see that certain micro-generation technologies do not need to apply for planning permission, even if certain restrictions apply. But the main concern for home developers and owners is the cost of these technologies.

Grants & Incentives

To construct a home that achieves a Level 6 in the CSH and a ZCH status requires new construction techniques and materials. There might be a higher initial cost to incorporate these techniques and materials than constructing a

current standard home, but energy savings can be achieved over the whole life cost and operation of the home. The cost of constructing a ZCH is greater than a standard home because of the requirement to install renewable technologies. The cost of renewable energy generation depends on which type of technology is going to be installed within a home.

In the UK, the government, energy suppliers and local authorities all provide grants towards installing renewable technologies into your home. The Department of Energy & Climate Change (DECC) low carbon building programme provides grants for householders. The grants are available for micro-generation technologies including Solar PV, wind turbines, small scale hydro, solar water heating, heat pumps and bio-energy. The programme also funds renewable CHP, micro CHP and fuel cells.

In Scotland, the Energy Saving Scotland home renewable grant scheme provides grants for homes. It is funded by the Scottish Government and the Energy Saving Trust. Funding is set at 30% of the installed cost up to a maximum of £4, 000. The grant covers Solar water heating, solar PV, solar thermal space heating, small scale wind and hydro systems, ground source and air source heat pumps and biomass boilers and stoves. In Scotland, you have the choice to apply for an Energy Saving Scotland home renewable grant or a low carbon buildings programme grant, but you cannot apply for a grant from both programmes for one technology.

The grants available help towards the cost of the installation of renewables, but are they enough? With the current economic climate, people are being very careful with their money. Renewable technologies can save money over

the whole life costing of a home, but it’s the initial cost that is important to people now. The grants available should be increased to really entice people to purchase these technologies.

There are also feed-in tariffs available, if a home is generating more electrical energy than it needs, it can sell it back to the main energy suppliers. There are currently two main types of feed-in tariffs available, the Export Tariff, where you are only paid for the electricity you export to the electricity network and the Generation tariffs, where you are paid for all the electricity that your system generates even if you use it in your own home. There are also some Set Price Tariffs available where a fixed amount is paid by the energy supplier based on the type of system installed. The tariff feedback system is a chance for all consumers to become producers. All homes could become energy-plus which could make the UK a net exporter of renewable energy in the future.

In Germany, they have been using a feed-in tariff system for over 10 years. It has been a huge success. Under the German system anyone generating electricity from solar PV, wind or hydro is guaranteed a payment of four times the market rate for 20 years. This reduces the payback time for cost of the renewable technologies to less than 10 years and after the payback time is complete, the home owner has a regular income from the electrical company for the power they generate. The cost is spread by generating companies among all users and has added about one cent/kwh to the average bill, or an extra €1. 50 (£1) a month (R).

The growth in home electric generation and renewable technology use in Germany has created jobs and reduced the initial cost. With more companies competing for a share of the market, they have lowered their prices, a typical 3kw PV system costs about £17, 000 in Britain but less than £10, 000 in Germany (R).

It has been proven that the feed in tariff system in Germany is lowering the initial cost of renewable technologies, creating employment and generating income for the home owner after the payback period is over. This system should be introduced worldwide, and promoted as a sustainable method as it incorporates the three pillars of sustainability: environmental, social and economic.

Certifying Agencies

BREEAM (BRE Environmental AssessmentMethod) is the leading and most widely used environmental assessment method for buildings. It sets the standard for best practice in sustainable design and has become the de facto measure used to describe a building’s environmental performance (R).

An Energy Performance Certificate (EPC) is required for all homes whenever built, rented or sold. If you are buying or selling a home it is now law to have a certificate. They are also required on construction of new homes and are needed for rented homes the first time the property is let after 1 October 2008. The certificate records how energy efficient a property is as a building and provides A-G ratings. These are similar to the labels now provided with domestic appliances such as refrigerators and washing machines.

The UK’s government’s Standard Assessment Procedure (SAP), assess the energy performance of dwellings and produces the EPC. Energy performance is based on consumption per unit floor area, energy cost rating (SAP rating), an Environmental Impact rating based on CO2 emissions (EI rating) and a Dwelling CO2 Emission Rate (DER). The SAP rating is based on energy costs associated with space heating, water heating, ventilation and lightings, less cost savings from energy generation technologies. The SAP rating is expressed on a scale of 1 to 100, the higher the number the lower the running costs.

An EPC is always accompanied by a recommendation report that lists cost effective and other measures (such as low and zero carbon generating systems) to improve the energy rating. A rating is also given showing what could be achieved if all the recommendations were implemented. EPCS are produced by accredited energy assessors.

What’s happening now?

Some local authorities in the UK have been making exemplar progress in delivering a low carbon economy, such as Fife in Scotland and in the near future, Merseyside Council are to become the biggest UK low carbon economy (R).

The Zero Carbon Hub is a web-site set up by the Government to help you understand the challenges, issues and opportunities involved in developing, building and marketing low and zero carbon homes. The Zero Carbon Hub shares practical experience and uses this information to accelerate main stream adoption of low and zero carbon methods and technologies. The web-

site identifies successful examples of low and zero carbon housing solutions. This will help identify successful design, method, technologies and approaches.

Currently major house developers within the UK are constructing prototype zero carbon homes. They are using the developments as exemplar projects on techniques and technologies needed to be included within a home to achieve Zero Carbon status. The following developers and companies have all developed a zero carbon home.

- Stewart Milne Group – Sigma Project
- Kingspan Off-Site – The Lighthouse
- Creo ProKoncept – The Creo House
- Barratt Developments Plc – The Barrett Green House
- Miller Homes Ltd. – Miller Zero Housing Project
- Tarmac Ltd – Level 6 Home University of Nottingham

It is encouraging that the major house developers are constructing their own example of zero carbon homes that can be mass produced. They are experimenting with new techniques and materials and then sharing their results and information so everyone benefits. The Stewart Milne Group claim, for their Sigma project to achieve a Level 6 on the CSH, the initial cost for renewable technologies is currently from £60, 000-£70, 000. They suggest we should be concentrating on super-insulating our homes instead of trying to generate energy. They make a valid point here, if we super insulate our homes we will need less energy to heat it, requiring less renewable technologies to generate electricity.

It is highly likely that by 2013 many of the sustainability stumbling blocks for the UK will have been swept away by neccesity. Retrofit solutions to existing properties must be part of the future. If only our banks were to protect their assets by financing a UK wide improvement programme.

As practitioners of sustainability we have the following summary for you all

What is a zero carbon home?

A zero carbon home would qualify for zero stamp duty if its design emission rating (DER) were a negative number and its Heat Loss Parameter HLP sufficiently low. At present;

- the embedded energy of the materials used
- the energy from appliances and fittings and fixtures
- the energy associated with transport and servicing are not included.

The term low carbon home is rather vague and ambiguous for the consumer

Regards

The impact of achieving the 25 per cent and 44 per cent improvements above the current Part L standard in 2010 and 2013 is estimated to have a net impact on the economy up to 2016 of around £1. 9bn. These costs are based on assuming that developers choose technologies on the basis of minimising the capital costs of construction. However, if the impact of on going costs and benefits is taken into account in technology choices, then the overall cost to the economy is reduced to £0. 85bn, which is nearly half of the £1. 9bn cost. Under this scenario there is a slightly higher capital outlay (the percentage increase in Part L above 2006 in 2013 is 6. 2 per cent

compared with 5. 4 per cent when the capital costs are minimised), but the difference in size of the ongoing benefits is clear.