

The need for sustainable construction



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Problem Specification

If everyone on the planet were to consume natural resources and generate carbon dioxide at the rate we do in the UK, we would need three planets to support us. Sustainability is becoming a central concern for all of us. It is a concern that has grown out of wider recognition that rising populations and economic development are threatening a progressive degradation of the earth's resources.

The construction, maintenance and use of housing impacts substantially on our environment and is currently contributing significantly to irreversible changes in the world's climate, atmosphere and ecosystem. Housing is by far the greatest producers of harmful gases such as CO₂ and this eco-footprint can only increase with the large population growth predicted to occur by 2050. What sustainability means is adapting the ways we all live and work towards meeting needs, while minimising the impacts of consumption, providing for people of today and not endangering the generations of tomorrow.

A Government report on the economic impact of climate change has criticized the training and organisation of the construction industry. The Stern Report, by Sir Nicholas Stern, the World Bank's former chief economist, says the lack of co-ordination between elements of the industry creates poor quality, energy-inefficient housing.

It says architects and other consultants require more training on the principles of sustainable design and efficient technologies, and that policies need to be put in place to inform decisions made at the design stage of a

building. As a result of the report, the government has set legally binding targets of a 26 – 32 per cent reduction in CO2 emissions by the year 2020 and an independent body will be introduced to advise on and monitor the Government's policies on the subject.

The drive for more sustainable development is one of the defining issues of the early 21st Century. It is often said that the costs of today's lifestyles are such that future generations will pay a high price through reduced environmental quality and living standards. However, it is also perceived that the short term costs of more sustainable practices are too high to justify their application in a competitive property market.

Government plans for sustainable housing applies to both new builds and existing dwellings. The construction industry as a whole is responsible for finding new materials and building methods, and the Government is tasked with educating the general public on the sustainable features they can add to their homes to ensure sustainability.

Despite substantial advances in best practice, there is a lag in the application of more sustainable solutions that improve building performance beyond that required by Building Regulations. There are many reasons for this, not least a lack of client/customer demand; however, one of the most cited is that more sustainable alternatives are prohibitively expensive. Typically, cost consultants can add a significant margin of as much as 10% to capital costs to allow for more sustainable solutions. (Cyril Sweett)

Often the most powerful and direct driver for addressing sustainability is that the client, funder or planning authority has made it a key project

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requirement. In order to meet this requirement, everyone involved in a construction project must re-think their operations in areas such as energy, materials, waste and pollution. For the purposes of this essay, choosing, using, re-using and recycling materials during design, manufacture, construction and maintenance to reduce resource requirements and essentially lower the costs of a project.

The design of a sustainable home and the materials used during construction are key factors in reducing CO₂ emissions from transport and operational energy, reducing mains water consumption, reducing the impact of materials used, reducing pollutants harmful to the atmosphere and improving the indoor environment.

It is claimed all of these can be done with an increase in capital costs of just 3% (John Shore). The aim of the essay, therefore, is to examine the need for sustainable construction and to identify the real costs of sustainable solutions and thereby tackling a key barrier to the industry in advancing the sustainability agenda.

Literature review

There are many articles, journals and reports that look into sustainable housing in the UK, many of which begin by explaining the extent of the problems global warming will bring and how the construction industry has contributed to this. It has been well documented in the national news on a regular basis. The Climate Change Bill, which was included in the 2006 Queens speech was the beginning to the Government acting upon the

information they were being given which indicated a strong need for change sooner than later.

This led to reports including ‘ Low Cost Homes: economical eco-options on the rise’ (Hall 2007) and articles such as ‘ Green construction costs dramatically lower than believed’ (World Business Council for Sustainable Development 2007). This article was produced on the back of findings from a survey conducted by the WBCSD that green construction costs were being overestimated by 300%. Respondents to a 1400 person estimated the additional cost of building green at 17% above conventional construction; more than triple the true cost difference of about 5 %.

At the same time, survey respondents put greenhouse gas emissions by building at 19% of world total, while the actual number of 40% is double this. As a reaction to the article on the report on the Euractiv website, the RICS has emphasized its ‘ Green Value’ study, which shows that while there are signs of an increasing market value of green housing, industry stakeholders still seem to be failing to get the message across that the main beneficiaries are the housing occupants.

Hall’s report identified the issue of the Government insisting that all new homes in Britain must be carbon-neutral by 2016, putting pressure on developers to come up with good design that doesn’t cost the earth – financially or environmentally. Hall went on to say, at the moment, going green costs money and most private sector developers are reluctant to see beyond their profits. But eco-friendly innovation is coming from elsewhere – namely social housing.

Costing Green: A Comprehensive Database (Matthiessen & Morris) used extensive data on building costs to compare the cost of green housing with housing comparable programs, which do not have sustainable goals. The report concluded that many projects achieve sustainable design within their initial budget, or with very small supplemental funding, which suggests that home owners are finding ways to incorporate project goals and values, regardless of budget, by making choices.

The Stern Report, published by Sir Nicholas Stern Head of head of the Government economic service and advisor to the Government on the economics of climate change and development is a report that suggests that global warming could shrink the global economy by 20%. The review coincides with the release of new data by the United Nations showing an upward trend in emission of greenhouse gases – a development for which Sir Nicholas said that rich countries must shoulder most of the responsibility.

The study is the first major contribution to the global warming debate by an economist, rather than an environmental scientist. Prime Minister Gordon Brown, who commissioned the report, has also recruited former US Vice-President Al Gore as an environment advisor.

However, the report has sparked furious debate among economists. An example of why the report has sparked such debates is; if the economy grows at current levels, the cost of mitigation will be less than Stern estimates – therefore we would be paying more to act now. It is said that we could save money by addressing the issues as and when they erupt. By forecasting how global warming is to affect the environment, Stern has set

himself up for criticism such as this from the many people who fail to share his views and concerns.

Gathering relevant information on the true costs of sustainable housing is not a problem with so many government and independent studies/articles/journals being produced. This data can be compared against the price of housing without the sustainable goals which are found in construction pricing books such as Spons Architect and Builders Price Book (Davis Langdon). In comparing the prices the essay will either prove or falsify the hypothesis: sustainable construction can be attained with very little additional costs to that of construction without sustainable characteristics. For the purpose of this hypothesis, 'very little additional costs' is defined as ranging from 0% – 10% additional costs.

Methodology

Chapter 2 of this essay will be a review of the literature on sustainable construction in regards to the principles of sustainable construction, sustainable construction policies and practices in the UK and the economic benefits of sustainable construction. The results of this research show that the business benefits have been made and can be illustrated by many pioneer projects in the UK. However, the misperception of higher capital cost and the lack of awareness of market value are still significant barriers to the implement and demand for sustainable construction. It is critical, therefore, to establish the economic performance of sustainable construction in order to motivate stakeholders to consider methods of sustainable construction.

This subject has been the attention of mass media in recent years meaning that existing literature such as numerous Government and independent reports as well as the Climate change Bill introduced to help prevent the situation we find ourselves in environmentally from becoming worse, will be excellent sources of information to explain thoroughly why there is a need for change and what sustainable construction entails from a economic perspective.

Chapter 3 will be researching the various sustainable construction materials and methods that are available to the industry. Each one of these will be looked at in detail to explain how they work, what exactly is involved with them and how they are deemed sustainable.

Although they are still not widely used, there are plenty of companies offering sustainable building materials and construction services. A lot of these companies are available through online websites promoting sustainable construction and offering their services. These companies will be good ways of gathering the information needed in order to give a comprehensive review of the sustainable materials and methods that are available.

Using the information gathered in chapter 3, this essay will then be finding out the costs incurred when using these sustainable construction materials and building methods and comparing them against the non-eco-friendly methods that most contractors currently choose to incorporate. This information will make up chapter 4 and will ultimately go on to either verify or falsify the hypothesis: ‘ sustainable construction can be attained with very

little additional costs to that of construction without sustainable characteristics.'

This structure has been carefully chosen to gain as much relevant information as possible and comparing two methods of construction against one another. In chapter 2, a review of existing literature will be used. Reasons for this are that the subject of sustainable construction and its financial factors have already been investigated and numerous authors have wrote their findings and ideas on the subject. These findings will be reviewed in order to pull out the relevant parts for this essay.

Chapter 3 will consist of an in depth look into the types of sustainable materials and building methods that are available to the construction industry. This will take the form of a mix between a review of existing literature and a survey of the service provider's views, feelings and attitudes towards sustainability.

Chapter 4 will be a comparative analysis of sustainable building and material costs and the costs of materials and building methods without sustainable characteristics. The information found in chapter 3 will be the argument for sustainability. The argument for construction without sustainable characteristics will come from pricing books used throughout the industry. Once both sides' costs have been discovered, they will be weighed up against each other which will verify or falsify the hypothesis. If sustainable construction can be provided with an extra cost of 5% or less, then the hypothesis will be verified.

Introduction of Sustainable Construction

In 1987, the Brundtland Report, also known as Our Common Future, alerted the world to the urgency of making progress toward economic development that could be sustained without depleting natural resources or harming the environment. It was headed by the Norwegian Prime Minister at the time, Gro Harlem Brundtland.

The report was primarily concerned with securing a global equity, redistributing resources towards poorer nations whilst encouraging their economic growth. The report also suggested that equity, growth and environmental maintenance are simultaneously possible and that each country is capable of achieving its full economic potential whilst at the same time enhancing its resource base. The report also recognised that achieving this equity and sustainable growth would require technological and social change.

The report went on to highlight three primary areas where sustainable development should come from, these were, protection of the environment, economic growth and social equity. It is imperative that our environment is protected and our resource base enhanced, by gradually making the necessary changes in which we develop technologies and put them to use.

Developing nations must be allowed to meet their basic needs of employment, food, energy, water and sanitation. If this is to be done in a sustainable manner, then there is a definite need for a sustainable level of population. Economic growth should be revived and developing nations should be allowed a growth of equal quality to the developing nations.

The Brundtland Report has often been subject to criticism, on the grounds that many of its forecasts have not come true. However, such criticisms are perhaps missing the significance of the report and the fact that despite inaccuracies in forecasting, the Brundtland Report's premise of the need for global environmental action has not been invalidated.

Back in 1994, the first sustainable construction conference was held in Tampa, USA. This conference is seen as the starting point for the whole eco-friendly building to become a global issue. The UK construction industry has so far used sustainable construction as a way to respond to the criticism that fell upon the industry, as it were seen to be one of the main contributors to greenhouse gases.

There are numerous examples of housing in the UK that have been constructed with sustainable characteristics to help provide a healthier way of living for the occupier and constructing for the developer. However, these examples tend to be bespoke designs for clients who choose themselves to build and live in a sustainable home. The idea of sustainable developments is still yet to catch on in the UK. Perceived higher risks and extra costs are the main factors in this lack of incorporation into the industry. It is becoming clear that the whole concept of sustainable construction is going to face some barriers in regards to economic justification.

Incurring higher risks and costs is not the only issue. The market value of sustainable construction is also not being considered by clients and developers. Zhou and Lowe (2003) said:

The current economic measuring tool (life cycle costing), is very effective at illustrating the long term value of sustainable construction, but at the same time is limited when showing the initial cost reduction.

If those involved in the UK construction industry continue to be encouraged by short term financial gain as opposed to the consequences of their actions in the long run then the future does not look too bright for the sustainable construction idea.

Hydes and Creech (2000) said, “ Sustainability is a holistic concept that holds economic social and environmental factors in balance, moreover it is a complex concept, which is hard to define in simple terms.” This statement recognises that clients and developers should not only take their financial rewards into consideration, but also they should consider the consequences the environment and our society is reportedly beginning to see.

Pearce et al (1989) concluded that: “ There have been over 200 different definitions of sustainability, making it extremely difficult to determine practical ways to support sustainability.” This statement could also outline the problem that the industry has still not come to an agreement on the actual definition of sustainability, therefore, making its inception into recognised practice unlikely, as people simply don’t know or don’t want to know what their role could be in reducing the problems of global warming.

In July 2005, the then Chancellor of the Exchequer, Gordon Brown announced that he had asked Sir Nicholas Stern to lead a major review of the economics of climate change, to understand more comprehensively the nature of the economic challenges and how they can be met, in the UK and globally.

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The main conclusion from the report were that 1% of global gross domestic product per annum was required to be invested in order to avoid the worst effects of climate change, and that failure to do so could risk global GDP being up to 20% lower than it otherwise might be. Stern's report suggested that climate change threatens to be the greatest and widest ranging market failure ever seen, and it provided prescriptions including environmental taxes to minimise the economic and social disruptions. Stern stated,

Our actions over the coming few decades could create risks of major disruption to economic and social activity, later in this century and in the next, on a scale similar to those associated with the great wars and the economic depression of the first half of the 20th century.

It was the findings in this report that prompted the UK Government to introduce the Climate Change Bill. It was introduced to: Combat climate change by setting annual targets for the reduction of carbon dioxide emission until 2050; to place duties on the Prime Minister regarding the reporting on and achievement of those targets; to specify procedures to be followed if the targets are not met; to specify certain functions of and provide certain powers to Members of Parliament with regard to ensuring carbon dioxide emission are reduced; to set sectoral reduction targets and targets for energy efficiency, the generation of energy from renewable sources, combined heat and power and micro-generation; and for connected purposes.

This Bill was outlined in the Queens speech, and would also see the setting up of a ' Carbon Committee' to ensure the targets are met. Announcing the

Government's planned legislation for the forthcoming parliamentary session, the Queen told MPs and peers: " My Government will publish a Bill on climate change as part of its policy to protect the environment, consistent with the need to secure long term energy supplies".

The construction industry uses vast quantities of natural resources such as energy, water, materials and land, and produces large amounts of waste in the region of 70 million tonnes per annum to landfill. The Brundtland definition of sustainable development; " Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" informs us that this cannot continue. There is a big difference between the environment impacts of a poorly performing building compared to what is achievable using current practice. If we are to deliver the legally binding targets set by the Government we must ensure that today's housing meet best practice (BREEAM).

BREEAM is the world's longest standing and most widely used environment assessment method for housing. It sets the standard for best practice in sustainable development and demonstrates a level of achievement. It has become the vocabulary used to describe a building's environmental performance.

The BRE Sustainable community's team is involved with aiding local authorities, land owners and developers to identify the relevant sustainable development opportunities available to help deliver sustainable communities. They work with them to provide assessment framework to

guide the sustainable developments, and to allow developers to demonstrate the sustainability features of their proposals to the local planning authority.

The benefits are said to be enormous, and cost effective. Developers can assess the sustainability of proposed designs iteratively, and understand its strengths and weaknesses. Expensive reworking is avoided by considering issues in the right stage of the design issues. The value in this approach for developers and land owners is that sustainability credentials are presented to both the local planning authority, and importantly to potential purchasers.

Our homes account to some 27% of the UK's CO₂ emissions and for this reason, in order to meet its targets for cutting carbon emissions by some 60% by 2050, the Government has announced that, as part of the new Home Information Pack which all homes sold after June 1st 2007 must make available, every home should have an energy rating. The so called Energy Performance Certificate will give home buyers A to G ratings for their home's energy efficiency and carbon emissions. They will tell them current and average costs for heating, hot water and lighting in the home. This helps the Government meet the EU target for all homes having energy ratings by 2009.

Changes to a currently constructed dwelling or additional features on a new build are always going to give an immediate impression of 'extra costs.' And getting people to dig a little bit deeper into their pockets is always going to be a difficult task whatever the reason being, and the fact that the public are generally over pricing the cost of these new construction methods and

features, increases the difficulty the Government have of achieving their targets.

This chapter has looked into how and why sustainability has become such a big issue in recent years. The Brundtland report which is said to have started it all off was published over 20 years ago, outlined the potential problems that have begun to arise. And although a lot of what was said in the report did not happen, it can't be said that the potential environmental problems it predicted have not materialised. Chapter 3 will now go on to look at the sustainable construction methods and materials that are available to be implemented into the industries everyday life.

Sustainable Construction Materials and Methods

There is an urgent need to address the great challenges of our times: climate change, resource depletion, pollution, and peak oil. These issues are all accelerating rapidly, and all have strong links with the UK construction industry (SustainableBuild).

There is a growing consensus from scientists and the oil industry that we are going to reach peak oil within the next twenty years, and that we might have reached this point already. Global demand is soaring, whilst global production is declining, and oil is set to become increasingly expensive and scarce.

The building industry is hugely dependent on cheap oil, from the manufacture and transportation of its materials, to the machinery and tools used in demolition and construction. In the UK, it uses vast quantities of fossil fuels, accounting for over half of total carbon emissions that lead to

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climate change. The built environment is also responsible for significant amounts of air, soil and water pollution, and millions of tonnes of landfill waste. This is a situation that clearly needs to change (SustainableBuild).

Sustainable construction is not only a wise choice for our future; it is also a necessary choice. The construction industry must adopt eco-friendly practices and materials that reduce its impacts, before we reach a point of irreversible damage to our life supporting systems.

The UK Government is beginning to recognise this urgency, and is committed to integrating green specifications into building regulations and codes, but the process of developing policy is slow. The industry needs to take its own initiative and find alternative ways to build, using green, renewable energy resources, and adopt non-polluting practices and materials that reduce, recycle and reuse, before it is too late (SustainableBuild).

In the previous chapter, this essay examined current literature on sustainable construction in terms of the principles of sustainable construction, sustainable construction policies and practices in the UK and the economic benefits of sustainable construction. In this chapter it will now investigate the various sustainable construction materials and methods available to the industry ranging from very large complex items to small simple items. These are:

- Biomass roofing
- Solar Water and Electric
- Wind power

- Cob building
- Insulation materials
- Non-toxic paints
- Heat pump
- Green roofs
- Reclaimed materials
- Lime
- Using locally sourced materials

Biomass roofing

The use of plant materials to build the roof on a building is known as biomass roofing. Vegetation that was found locally and in abundance has been used to build roofs all over world for many years. This cultural and environmental diversity has led to a range of roofing materials and styles, from simple and short lived to the more durable and complex. Although hundreds of different plants have been used to roof houses, these can be classified into two main types: thatch and wood tiles.

Thatch is one of the oldest forms of roofing, dating back thousands of years. It is found in almost every country, from savannah grasses in Africa to coconut palm fronds in the Caribbean to banana leaves in the Amazon. It was the predominant roofing material in Britain up until the 19th Century and thatched cottages remain a hallmark of the English Countryside.

All sorts of plants have been used for thatching in Britain: oats, reeds, broom, heather, bracken and various grasses. But today only three main thatching materials are used: water reed, wheat reed and long straw.

Water Reed is the most popular thatching material. Both water reed and wheat reed (actually a straw but cut with a binder and combed to give the appearance of reed) give a compact and even texture when applied to a roof. This is in contrast with long straw (wheat straw that has been threshed so that the ears and butts are mixed up together), which gives a shaggy, rounded appearance. The lifespan of thatch is around 30 to 50 years, although this varies widely depending on the skill of the thatcher, the pitch of the roof, the local climate conditions and the quality of the materials.

The technique for thatching is basically the same for all materials. First the thatch is fastened together in bundles about 25 inches in diameter. Each bundle is then laid down with the butt end facing outwards, secured together to the roof beams, and pegged in place with wooden rods. Successive layers are added on top of each other, working from the bottom of the roof up towards the top, with a final layer used to reinforce the ridgeline.

Thatch roofs can withstand high winds and heavy rains, provide good thermal insulation and are easy to repair. Thatch is light and needs only a simple support structure, and is flexible so it can be used for any roof shape. On the downside, thatching is labour intensive and a certain level of skill is required. The materials can be expensive as reeds are increasingly imported from Europe to keep up with demand. Like all biomass materials, thatch is

flammable which means that building restrictions may apply and home insurance can be high.

Wood tiles have been used since medieval times in Britain. They are traditionally made by hand-splitting logs into small wedge shaped pieces, but today most are manufactured by machine. There are two basic types: shingles, which are sawn, and shakes, which are split.

Shakes are thicker and have a more rustic, rough look, whilst shingles are thinner and smoother. Both come in a variety of lengths and are made from the heartwood of unseasoned wood. Hardwood is best, with cedar being the most popular, although any straight-grained wood can be used. Split bamboo can also be used to create Spanish-style tiles, and are popular in some countries, but bamboo has the disadvantage of decaying fast in wet conditions unless chemically treated.

Wood tiles are laid from the bottom of the roof to the top, with each row overlapping the previous one. A cap is placed at the roof ridge. Typically tiles are nailed onto wood strips spaced a few inches apart between the roof beams, to allow air to circulate and prevent decay.

Wood tiles last between 25 – 50 years. Like thatch, they give good insulation and are flexible so can cover any roof shape. They are highly resistant to wind, heavy snow and hail, but must be regularly cleaned of vegetative debris. They are also flammable, and building regulations may prohibit their use in urban areas.

The recognised need to use renewable resources has led to a revival of traditional, natural building methods, along with a growing market for biomass roofing. Thatch and wood tiles are not only aesthetically appealing, but are durable and biodegradable. But their sustainability value is diminished if the materials have been imported or produced and treated with chemicals. Biomass roofing is only a true sustainable solution if the materials are obtained from a local, renewable source, and are grown, harvested and manufactured in an environmentally sensitive way (SustainableBuild).

Using the sun to provide energy is split into two areas, solar panels which are used for heating water, and PV cells, which are used for creating electricity. A heating system tends to cost around £2, 000 installed and can usually provide enough hot water all year round, the problem from a value point of view is that it only costs around £100 a year to provide this anyway. PV cells create a more significant amount of electricity which may allow you to sell some of the energy you have created back to the grid.

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