# COMELY GREEN
# FINAL REPORT

WREN
&
BELL

## CONTENTS

# 1 SUSTAINABLE CONSTRUCTION

Sustainable Construction and Environmental Construction are all terms that have been introduced in the last 15yrs and in this time many housing developments up and down the length of Britain have been built with these concepts in mind. Across the rest of Europe and the rest of the world similar projects have also appeared. Why then has the world suddenly changed the way buildings are constructed? Or has a new label simply been attached to something that has existed all along? Perhaps this "greening" of the construction sector is a reaction to other industries which have improved their environmental performance and as a result created consumers that are increasingly aware of environmental issues?

Research commissioned during 1999 by a Government Focus Group found some evidence, particularly in the commercial property sector, of cultural barriers (sometimes described as a 'circle of blame') within the chain of investors, developers, contractors and occupiers, to more sustainable development of built assets. The barriers have been created largely by a perception that more environmentally efficient buildings incurred higher capital costs and lower financial returns. This view was most strongly held by investors, with developers second. Contractors were the least likely to believe it. The researchers found that change would be driven primarily by the prospect of lower running costs and more socially and environmentally responsible corporate attitudes. The actors most likely to promote change were occupiers, with contractors being least likely. The researchers concluded that greater awareness and education would be the principal drivers of change.

The construction sector differs from other manufacturing industries as the 'manufacturing process' (construction) various depending on the design requirements and geographical location. This fundamental difference means that each project is unique and that a standard infrastructure cannot be put in place around a site. Each site has unique characteristics that create issues that have to be overcome. Most developments have unique building structures which reduces the possibility for mass production. The standard infrastructure that exists within a factory allows for mass production, isolation from the outside and standardised disposal routes.

## 1.1 Standard Construction

The majority of developers in the UK are producing buildings that provide space, lighting, insulation and design that surpasses the majority of buildings previously constructed. Legislation has forced many of these changes, while the expectation from the consumer has forced others. City centre sites that had become run down are being restored while industrial sites are being remediated and built on.

Although the standard of housing in the UK is at an all time high, there remains the potential for the quality to be even greater. SAP ratings of over 60 are expected of new housing, however the potential for over 90 is not unrealistic. The volume of building materials, and also demolition waste, continues to put a strain on limited resources.

Building design has changed to reduce the build time, to reduce costs and reduce man handling. Instead perhaps the focus should be moved towards improving the heat insulation or the selection of materials involved.

## 1.2 Environmental Construction

Of these projects built under the environmental construction label, many have received funding from government or Europe. These projects have produced numerous one off projects that are environmentally sound from a variety of different aspects. These buildings are ground breaking in their design, they utilise materials that are environmentally sound and have minimal environmental impact. Most however are not restricted by economics and would be therefore impossible to apply to the mass housing market.

The Centre for Alternative Technologies (CAT) produces a whole house building guide which provides a wide variety of projects from around the world. All these buildings provide possible answers to the inefficient use of energy by buildings and also the unsustainable use of materials during construction. Against the background of mass produced housing these buildings are radically different in both design and materials. The CAT guide does not prescribe a set building method, it does provide however a comprehensive review of technologies and materials available to those interested in environmental construction.

The transfer of these technologies to the mass housing market would be the ideal, but a number of issues stand in the way of this. These designs and materials, are generally more expensive than those in conventional housing. Many of these technologies, especially those for water, require space that is not available to most urban developers. Developers are a conservative group who are slow to change and are happiest working with materials and designs that they are familiar with. By examining materials and technologies from environmental design and placing an economic factor into the equation a construction technique of sustainable housing is created.

## 1.3 Sustainable Housing

Meeting the needs of today without compromising the needs of future generations is not an easy task. We do not yet know what the needs of future generations are and also, even on a UK scale, we are not yet meeting all the needs of today. Sustainable issues are gradually seen as a more balanced view of environmental concerns. They encompass not just environmental impacts but also the social and economic impacts.

**The result is low cost or no cost sustainable housing and it is achievable now and it is capable of being used on the massive scale required.**

For housing this has been the coming together of the standard building practices with the environmental building purposes to create housing that is both affordable and also has a minimal environmental impact. To a limited extent it can be seen as a compromised version of environmental housing as issues that are not economically viable are not actioned. The result is low cost or no cost sustainable housing and it is achievable now and it is capable of being used on the massive scale required.

# 2 THE SUSTAINABLE HOUSING ISSUES

## 2.1 Sustainable Building Materials

The construction industry uses about 6 tonnes of material per person per year in the UK. About 20% of this is for infrastructure and over 50% is for repair and maintenance of the existing building stock (if DIY and other unrecorded works are included). The quarrying of 250-300 million tonnes of material in the UK each year for aggregates, cement and bricks imposes significant environmental costs.

If a sustainable construction project aims to minimise the environmental impact of the proposed development over its design life, then considerable care must be taken to select the most appropriate materials, in terms of the impacts of their manufacture, use and final disposal or recycling.

It is not sufficient to state that materials are "recyclable". Practically all materials fit this description but only a tiny fraction of them actually are recycled. It is important that materials should, as far as is practical, be kept separate and be clearly labelled to facilitate recycling at the end of their useful life. Even this will, of course, not guarantee that they will be recycled but it is the responsibility of everyone involved at every stage of a sustainable construction project to ensure that they have acted to the best of their ability to minimise the current and future impact of the development.

The selection of appropriate materials depends on the financial, environmental and operational performance of competing products, as well as on the criteria set out for the development. For example, there is no point in reducing the materials intensity of the wall design at the expense of its insulating effect, as to do so would lead to a greater environmental impact over the design life of the building. Similarly, it would be unwise to invest the limited resources of a project in untried technologies when the overall impact of the development could be more effectively reduced by investing the money elsewhere.

**About 10% of national energy consumption is used in the production and transport of construction products and materials**

About 10% of national energy consumption is used in the production and transport of construction products and materials. To reduce this, materials should be sourced as locally as possible and great care should be taken before "thermal mass" is cited as an environmental benefit. A recent large development claimed that the extensive use of concrete throughout the building made it sustainable by providing a large thermal mass, deliberately overlooking the huge embodied energy of the material and associated environmental impacts.

Selection of materials depends on the nature of the development and the aims of the project but with a reasonable amount of care and a pragmatic approach, it is possible to make significant environmental improvements at little or no extra cost.

## 2.2 Sustainable Building Design

The main area where the sustainability of construction can be improved is in thinking carefully about the integrated design of the whole project. From the ground up and from cradle to grave (or cradle to cradle), every element of a construction project has an effect on

every other. This complexity means that it is very difficult to set out a definitive approach to sustainable construction, as the variation within and between different projects would make this approach almost irrelevant in some cases, while being ideally suited to others.

The sustainable design of a project must consider all the relevant elements that go into the location, orientation, structure, systems, construction, use and eventual demolition of the project and also how each decision at each stage will affect all of the others. Clearly, this process is not going to be an exact science and the trade-offs that are made in each case will reflect the information, values and resources available to the design team.

For the discipline of sustainable construction to develop even further, it is essential that these trade-offs and decisions are clearly described. The information and values on which they are based are in a state of constant change, on top of which it is perfectly possible for even the most experienced professional to make an honest mistake. Only through a process of peer review from one project to the next can real progress be made to improve the sustainability of construction and the built environment.

There is no single correct approach, although there are some general principles which can be applied to all projects. One overall guiding principle is to minimise the environmental impact of the development over its design life.

## 2.3 Sustainable Construction

The construction process itself generates significant quantities of waste: about a fifth of all waste arisings are attributable to the construction sector. This waste is generated at every stage in a normal construction project, from initial winning of resources such as aggregate, through processing, packaging, transport, use on site, repair and disposal.

A significant portion of these arisings can be designed out of a project with careful selection of materials. For example, a steel frame building generates waste from ore mining, processing, transport and smelting before the foundations are laid but a timber frame building carries no such environmental burden. However, it is important to give careful consideration to such decisions and to avoid sweeping assumptions. If the steel is manufactured from scrap, as a large proportion is, then there is a net reduction in waste (although there is still a considerable energy burden) and timber sourced from unsustainable forestry practices can have a dramatic detrimental effect on biodiversity. For any particular material, there is often a wide variation in the environmental impact of production by different manufacturers. It may therefore be necessary to assess the environmental performance of a number of potential suppliers.

Waste and environmental pollution from transport of materials to the construction site can be minimised by specifying local producers wherever possible. This also makes it simpler to check up on the environmental performance of suppliers and provides a useful incentive for prospective suppliers to demonstrate their environmental credentials, as their products may then be specified for subsequent sustainable construction projects in the area.

## 2.4 Auditing

The reduction of environmental impacts from the construction process itself requires an additional level of control over all aspects of construction. One useful way of addressing

these issues is to consider the construction project in exactly the same way as any other manufacturing or production process and to apply the principles of waste minimisation on this basis. A typical waste minimisation project of this sort would consider the inputs, processes and outputs of the production process, as well as any utility inputs such as energy, water etc. One difficulty with applying these principles to construction is that each project is unique, which can lead to problems when assessing the effectiveness of a waste minimisation approach. However, if the right measures and benchmarks are chosen, these difficulties can be overcome.

The efficiency of a construction project is usually measured only in terms of cost per square metre. This measure is something of an over-simplification but it does provide a useable foundation for other measures which can be compared across projects. Floor area provides a somewhat crude but nonetheless useable denominator with which a single house can be compared with a housing estate, or an office block. However, it does not allow comparison of a house with a bypass, for example. Such comparisons require an agreed standard of environmental performance across the various divisions of the construction sector. BRE's EcoHomes produces a good broad spectrum environmental standard for building but still no one standard can produce a good, all encompassing sustainable standard.

Gathering and analysing information that would normally be overlooked reveals trends that show the potential for cost savings and for reductions in the environmental impact of construction activities. An example is the proportion of waste generated on site that has not been used. Waste arisings from construction include off-cuts, packaging and other legitimate wastes but also include material which has simply been spilled, dropped or run over before ever being used. Indeed, some of this material never even makes it into the skips: sand, for example, is often seen in large, spreading mounds with tyre tracks through it. Once a waste of this kind has been identified, steps can be taken to address the issue. Specification of pre-mixed mortar removes the requirement for sand and simultaneously leads to an improvement in quality. Similar examples of cost and environmental savings are found in the project examples and more will be added to the web site as they arise.

## 3 COMELY GREEN/ LOWER LONDON ROAD

The Comely Green Sustainable Housing Project is the first major sustainable housing project in Scotland to use these techniques to find a better way of building the kind of houses that people want to live in.

Too often, shiny new projects are launched which proclaim their adoption of sustainable principles, then wind up with a cosmetic "green" finish in an attempt to cover a lack of any real substance. This may be a result of the way in which environmental projects are usually financed; in effect, whoever can provide the greenest project for the least money wins the prize. This approach inevitably leads to the promotion of trivial issues at the expense of those which may be more prosaic but which are also more effective.

**Comely Green is not a high-flying architectural extravaganza but a normal housing development being built in a better way**

This programme is a collaborative effort undertaken by Link Homes, Hart Builders, Norman Gray & Partners Architects and Wren & Bell Civil, Structural and Environmental Consultants. The aim of the programme is to build a block of traditional timber-frame tenement flats, much the same as those being built all over the country on a daily basis. The difference is that Comely Green will be built to have the lowest practicable environmental impact throughout the lifetime of the development. This will require the life cycle environmental aspects of every major component and activity to be considered during design, construction and use.

The lessons learned from this programme will be of enormous value to future developments, since Comely Green is not a high-flying architectural extravaganza but a normal housing development being built in a better way.

The Comely Green project has been one of the most publicised sustainable development in the UK over the last 2 years. Articles have appeared in most of the broad-sheet papers and also in numerous different construction journals including AJ and the Faculty of Building Journal. Throughout all this the building has been seen as a beacon for others to look to and emulate. The funding provided through the DETR Partners in Innovation Programme has allowed Wren and Bell to closely plan the project, and then examine the consequences. The close examination has shown that the project is realising the majority of the original goals however where it is not, this is being used to help others not make the same mistakes.

### 3.1 Material and Design Specification

The original material and design specifications were published in April and August 1998 respectively. These were a detailed report that gave a full list of the issues that were discussed by the forum. These meetings were often quite lengthy as some issues could not be resolved as easily as had been expected but after some compromises a final material specification was created. As with all building projects the material specification was not "set in stone" and a number of items were changed as the construction went up. These changes were due to either materials not being available for the project when construction started or that the specification stated by manufacturers were not accurate.

The design specifications mention in the guide also comment on ideas that were not brought to fruition. By doing this it is hoped that the numerous ideas that were originally on the table

that were not used in this particular project may be examined by others and prove appropriate to their circumstances.

An important point mentioned within this report is that specifications are out of date as soon as they are published. This work was carried out in 1998 and so three years later a lot has changed. The volume of "sustainable" building materials has increased dramatically as general awareness has increased. The information available, even for the less sustainable materials, has increased dramatically which in theory should make research simpler.

*- appendix one -- appendix two -*

### 3.2 Follow up Audits

The auditing of the activities carried out on this site was an important aspect for two reasons. Firstly we wished to ensure that the actions that had initially been proposed were implemented in the way that had been agreed. Secondly, we wanted to examine the performance of the ideas that had been proposed for waste minimisation and design improvements. Both the Wren and Bell team and the Harts Builders team carried out the audits on a regular basis during the lifetime of the project.

The results were interesting. Apart from the usual housekeeping issues the results identified further aspects relating largely to communication and awareness. One example includes the proposal by a supplier to supply material with a recycled content in excess of 80% however in actual fact it was later discovered to have a recycled content of only 50%. Furthermore the wood skip was removed half way through the project due to lack of space. This increased the volume of general waste dramatically and consequently the cost of waste disposal rose sharply.

*- appendix three -*

### 3.3 Flat Log Books

With any new product it is important that an "instruction manual" is supplied with it. This is true also for houses. Comely Green though similar to most other housing developments contains a number of unique features which have to be explained to the new resident. The users guide will be a reference book for when these problems occur which will both reduce the number of complaints and also mean that the facilities in the house are used correctly.

The log book is also an ideal opportunity to provide information about the surrounding area to increase the speed with which locals can integrate into the local community. Details of local amenities, shops, schools and similar will ease the stress of moving into the new area. It is also possible to encourage the recycling of waste by explaining where and when it is possible.

*- appendix four -*

### 3.4 Dissemination

The success of this project has enabled Wren and Bell to spread the word that it is possible to build a sustainable project for low or no additional cost. A number of presentations have been given to industries, universities and also to the general public on the subject. These lectures have proved excellent forums for discussions on the subject with the groups taking two very different view points. Both the Universities and the general public were very

positive and questioned more about why it had not been practised on such a wide scale before while the construction industry, who had seen it as a subject they need not concern themselves with, saw the subject in a whole new light.

The web site has proved an enormous success with it taking on average around 100 visitors (450hits) per day. The web site has been used by a large variety of individuals to post information about their own projects. It is through the web that most of the questions have been delivered to us.

# 4 THE FUTURE OF SUSTAINABLE CONSTRUCTION

The conservative attitude of the construction industry means that sustainability is slow to be adopted, but this is not to say that it is not being adopted. Change is happening and it is being driven from both within and outside the construction industry. Change is always better to come from within, as this is far more likely to be effective in its aims, however it is necessary to ensure that all act through legislation.

## 4.1 The Governments Soft Sell

The government has now published number of guides for the construction sector to follow. The actions that they propose are good steps forward and could be adopted by any construction company.

"10 THEMES FOR ACTION"

1. *Re-use existing built assets* – Meeting clients' functional requirements may not require new buildings and structures. Refurbishment and/or renovation which improves their sustainability may work better.
2. *Design for minimum waste* – Design out waste both during construction and from the useful life – and afterlife – of the building or structure. Think whole life costs. Involve the supply chain. Specify materials with care and consider more efficient use of resources. Think about using recycled materials.
3. *Aim for lean construction* – Work on continuous improvement, waste elimination, strong customer focus, value for money, high quality management of projects and supply chains, improved communications.
4. *Minimise energy in construction* – Be aware of the energy consumed in the production and transport of construction products. Adopt 'green' travel policies.
5. *Minimise energy in use* – Consider more energy efficient solutions in design including passive systems using natural light, air movement and thermal mass, as well as solutions involving energy produced from renewable sources.
6. *Do not pollute* – Understand your environmental impacts and have policies and systems to manage them positively. Use environmental management systems under ISO 14001 or EMAS.
7. *Preserve and enhance bio-diversity* – Look for opportunities throughout the construction process – from the extraction of raw materials, through the construction phase, to the landscaping of buildings and estates – to provide and protect habitats.
8. *Conserve water resources* – Design for increased water efficiency in building services and water conservation within the built environment.
9. *Respect people and their local environment* – Be responsive to the community in planning and undertaking construction. Consider your workforce.
10. *Set targets* – Measure and compare your performance with others. Set targets for continuous improvement.

## 4.2 EMS

Environmental Management Systems are increasingly being adopted by the construction sector. Through an EMS an environmentally conscious firm can make a commitment to identify, assess and improve their previous, current and future environmental performance. In addition to this commitment, firms will realise the potential for wider benefits from understanding and improving environmental performance. To this end, and in order to respond specifically to customer requirements construction companies have opted for

certification to standards such as the internationally recognised environmental management standard ISO 14001; using this as a means of testing and ensuring the effectiveness of their Environmental Management System (EMS).

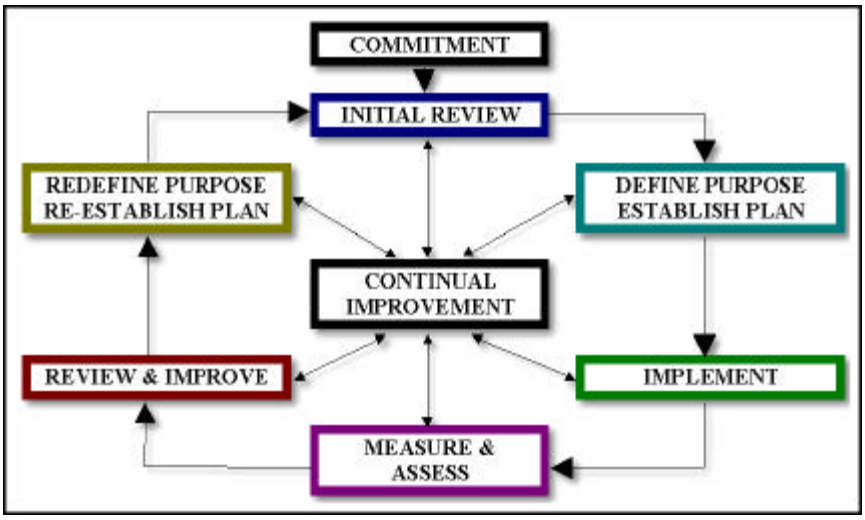


**Figure 1: ISO14001 accreditation process**

### *4.2.1 Environmental Management System Standard (ISO 14001)*

ISO 14001 is the International Environmental Management standard which embraces the principles set out at the June 1992 United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil during which over 100 countries agreed the need for the development of international standard for environmental management programmes. The International Organisation for Standardisation's 14000 series of environmental management system documents is one response to that need.

The general purpose of the ISO 14001 Guideline is to provide assistance to organisations, which are implementing or improving an Environmental Management System. It supports the goal of sustainable development.

### *4.2.2 Harts Builders*

The success of the Comely Green project has spurred Harts builders on to move towards ISO14001. Already having ISO9000 they see this as a logical next step. They are proposing to have a fully integrated management system (IMS) by 2003 that will include quality, environment and health & safety. This is a bold step for a company of this size and the reasons for doing it are largely customer driven.

## 4.3 Legislation

Environmental legislation has increased enormously in the last 5 years and the environment agencies have become more pro-active in implementing them. The result is that companies are monitored far more than they have been at any point in the past. Construction companies are influenced by dozens of different acts which can result in some confusion. The results however are promising as companies are forced to improve their environmental performance. Legislation to build sustainably does not yet exist, but the movement is in the right direction.

Housing insulation now has to meet the SAP60 calculation but this as a target is relatively simply attained using standard building design. The opportunity to raise the required minimum SAP value would not need the standard building design to be altered radically and should be a goal of the current government. By doing this, the amount of $CO_2$ being produced annually would fall considerably over the subsequent years. This of course does not take into account the fact that housing is only replaced on average every 100 years therefore, a programme of building refurbishments should also be encourage to further increase the speed with which building insulation is improved

Packaging waste regulations are just one of a series aimed at reducing the amount of materials being put to landfill. They have succeeded in pushing the packaging sector into examining the amount of packaging that they are using through a charging system which has stimulated the development of recycling facilities. Landfill tax has been applied to the construction industry in an attempt to reduce the amount of materials going to waste. It has been set at a level where it is not economically advantageous to fully sort the waste because of the very low values attached to aggregates but it has encourage the separation of wood from the other wastes.

## 4.4 Voluntary Standards

A number of green building standards are now around. BRE's EcoHomes is probably the most respected around as to obtain an excellent standard is very rare while it is possible to have a standard building project with some minor improvements obtain a pass. These standards can provide the badge that is required by developers to both improve their market image and also aid the value of a property. It is yet to be seen whether EcoHomes standard will be adopted as the standard way to build by a developer as it is currently only applied to the exceptional projects.

The success of these standards will only be seen once they have had time to be used. Opinions on such standards vary enormously. Because of the rigid framework that exists for the rating system, certain issues have been given a precedent over others. This results in issues such as water being given a relatively high importance for the whole of the UK. In Scotland it can be claimed that water should be given a lower priority than for the south of England. Yet, without this framework it would be impossible for developments of different styles, in different places to be compared.

## 5 CONCLUSION

If the government is to try to meet the targets that it has set itself by signing up to the Kyoto agreement it has to look to sectors other than just industry to achieve its goals. The current housing stock that exists in the UK is far more wasteful of energy than most industries. Domestic appliances as well as housing has not gone through the same waste and energy minimisation that industry has been actioning over the last 10 years. The fault cannot be laid at the feet of the developers as they are producing the desired product for the lowest cost.

Legislation on housing, both construction and design, currently requires little alteration to the developers plans. Health & Safety issues in the housing market have been addressed strongly by both government legislation and also by outside organisations. Outside organisations have applied pressure for changes in the sustainability of building design and materials and now look to the government to provide more pressure for change.

The Comely Green project has proven that with minimal additional investment, a housing development can be created that reduces both the short term and long term environmental effects. This project did not set out to use any new building techniques, new building materials or a new building design however the result is something that is new. Sustainable building design is common sense, rather than radical rethinking.

The influence of this project can be seen in the response of the developer who is now moving towards ISO14001 and also segregates wood waste on all sites to reduce the amount going to landfill. It is hoped that the development is also proof to other developers that sustainable development is not an expensive middle class preserve but a broadly applicable science. The long-term benefit of the project will only be realised by the residents through reduced energy costs and also a better built surroundings.

# *6 APPENDIX ONE – SUSTAINABLE MATERIAL SPECIFICATIONS*

Milestone One

# *7 APPENDIX TWO – SUSTAINABLE DESIGN SPECIFICATIONS*

Milestone Two

# *8 APPENDIX THREE – FOLLOW UP AUDITS*

## Milestones Six and Eight

# 9 *APPENDIX FOUR – FLAT LOG BOOKS*

Milestone Nine

## *10 APPENDIX FIVE – ECOHOMES REPORT*

Milestone Four

## *11 APPENDIX SIX – SUSTAINABLE CONSTRUCTION GUIDE*

Milestone Twelve