Plain English Guide to Sustainable Construction

Ben Stubbs

Section 1
The Need for Plain English

CONSTRUCTING EXCELLENCE
in the built environment

The Need for Plain English

Why has this guide been written?

Understanding the language of sustainable construction

Environmental awareness has been increasing rapidly over the past couple of decades. However, it is only in the last 10 years or so that the construction industry has really started to consider its environmental impacts. Decisive action to address those impacts is even more recent and full consideration of environmental, economic and social aspects of sustainability together ('the triple bottom line') is still rarely achieved.

As with any rapidly developing subject, there has been an explosion of ideas and terminology on the subject of sustainable construction. There are often several ways of describing the same techniques, technologies and processes which can lead to confusion.

This guide aims to bring together some of the ideas and language surrounding sustainable construction in a simple, accessible form. We hope it will help to improve all round understanding of current industry developments related to the various aspects of sustainable development.

Demonstrating the impact of the construction industry on sustainability

Awareness of the impacts that human activities have on the environment is growing fast. The media is particularly keen to report on the damaging effects of increased car use and aviation, for example. These activities do make a significant contribution to greenhouse gas emissions, and they are growing at an alarming rate. However, their overall impact is actually quite small compared to the contribution from the built environment.

Buildings and infrastructure clearly make positive contributions to many areas of our lives including employment, education, health and well being. They are also a vital part of a healthy economy. However, as well as being responsible for huge quantities of greenhouse gas emissions, they also have other environmental, social and economic impacts, many of which are often overlooked.

Explaining how the construction industry can be more sustainable

A growing sense of urgency in addressing environmental issues has prompted the development of a wide range of potential solutions. These include management systems, design innovations, technological developments and changes in working practices.

However, there is no commonly agreed approach to addressing sustainability in construction and this guide looks at a wide range of solutions. It doesn't endorse or recommend any particular products or methodologies; instead, it aims to provide a basis for making informed decisions on how to make construction-related activities more sustainable.

A starting point for thought and action

We hope that the ideas in this guide will provide a foundation for sustainability improvements in a wide variety of construction-related organisations.

In businesses which are yet to develop any sustainability policies, we hope that our explanations will help in the understanding of sustainable practices, procedures and products which are relevant to them.

Some businesses will have already implemented some of the ideas and may be looking to do more. Others may not realise the sustainability benefits of activities which are already routine for them.

However, we hope that even the most progressive organisations will find information and ideas which could form the basis for further improvements on their current practices.

Each of the sections of the guide is available separately in PDF format from the Constructing Excellence website and we will be updating these as new information becomes available.

Who is the Plain English Guide for?

Constructing Excellence recognised the need for a 'Plain English Guide to Sustainable Construction' after a large number of comments from their membership about the lack of clear, concise information on the subject.

The guide is, therefore, aimed at a broad range of businesses involved with construction activities. These include:

- Developers
- Consultants
- Designers
- Architects
- Contractors
- Sub-contractors
- Procurement managers
- Registered Social Landlords
- Clients
- Building managers
- House-builders
- Manufacturers
- Suppliers

Within these businesses it is designed to appeal to a broad cross section of staff, and not necessarily those who are involved with sustainability issues on a day-to-day basis. After all, every single member of staff can influence sustainability and is capable of reducing their negative impacts. Design and management systems can go a long way towards improving sustainability, but benefits can only be maximised if all construction workers, building operators and individual building occupants fully understand the systems and technologies they are working with.

Photograph: NHBC

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Front cover photograph: Lemon Tree House, Tower Hamlets: Sustainability was a key consideration from the early design stage. Copyright Avebury. www.avebury.com

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Section 2
Construction and Sustainable Development

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What is sustainable development?

Rapid population growth, economic development and the related increase in demand for resources are placing huge pressure on our planet. Developments during and since the industrial revolution have brought great advances in scientific understanding, industrial processes and benefits for human beings; however, they have also led to an increase in all types of pollution and an acceleration of environmental damage.

People, land management, resource use and the environment are all closely linked and have a major impact on each other. Increasing levels of construction activity will be essential to all aspects of development, so it is important that we consider now how future requirements can be achieved without making existing problems in land and resource use any worse.

Considering the way that we use the planet's resources has become part of the subject of sustainable development. Over the last couple of decades there has been a huge increase in research and public concern in this area which has slowly filtered through to the construction sector. There has also been a sharp rise in policy and regulations related to sustainable construction practices together with the development of related products and materials, management strategies and assessment methods.

There have been numerous descriptions of sustainable development. One of the best known was given by the former Prime Minister of Norway, Gro Harlem Brundtland; she described sustainable development as follows:

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

More simply it might be seen as living off our planetary income while not digging into our planet's capital[1].

Whichever version you choose, there are deep implications for the construction industry. The construction sector, together with the materials industries that support it, is one of the major global users of natural resources and contributes significantly to the current unsustainable development path of the global economy.

The table below shows how our patterns of resource consumption affect levels of sustainability.

Consumption of resources	State of environment	Sustainability
More than nature's ability to restock	Environmental damage	Not sustainable
Equal to nature's ability to restock	Environmental balance	Steady-state Sustainability
Less than nature's ability to restock	Environmental renewal	Sustainable development

One Planet Living

If everyone in the world lived as we do in Europe, we would need three planets to support us. This is because we consume resources at a much faster rate than the planet can replenish them. Sustainable living involves living within the earth's capacity – this has been developed into the idea of 'One Planet Living', a joint initiative of the WWF and Bioregional.

Maintaining our quality of life within the capabilities of our planet represents a major challenge. One planet living communities will need to consider the following:

1. Zero carbon production
2. Zero waste production
3. Sustainable transport
4. Sustainable materials
5. Local and sustainable food
6. Sustainable water
7. Natural habitats and wildlife
8. Culture and heritage
9. Equity and fair trade
10. Health and happiness

What is sustainable development?

Environmental, Economic and Social Sustainability

It is important to remember that the subject of sustainability covers a lot more than just environmental factors – economic and social aspects are frequently overlooked. Newspaper and television coverage tends to concentrate on the negative environmental impacts of global development; this reflects the rapid progress in scientific research and rising public interest on the subject of climate change.

However, a healthy and stable economy is vital if environmental problems are to be tackled. In any case, sustainable options will offer greater value for money over their lifetime.

Social considerations also have benefits in the form of improved well-being, reduced crime and community cohesion. The potential of the built environment to increase the productivity of employees and speed up recovery rates for hospital patients, for example, has clear economic benefits.

Together, these environmental, economic and social considerations are often referred to as 'the three pillars of sustainability' or 'the triple bottom line'. The diagram below shows how they are linked together. It demonstrates that development cannot be truly sustainable without consideration of them all.

The 'Three Pillars of Sustainability'

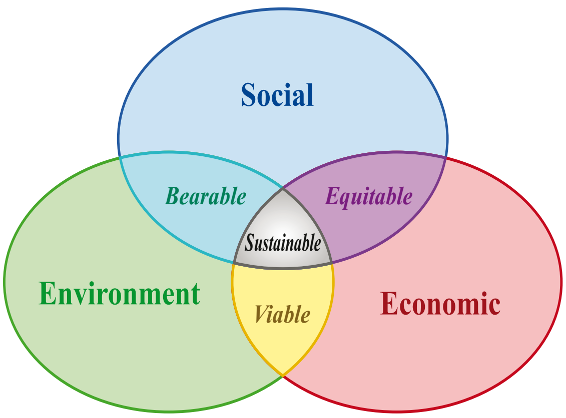

Image: Johann Dréo (2007)

The Stern Review

Sir Nicholas Stern was the Head of the Government Economic Service and adviser to the government on the economics of climate change and development. His review on the economics of climate change was published in October 2006 .

Stern concluded that if the world doesn't act now to address the problem of climate change, it will face devastating consequences. If temperatures rise by 5° Celsius, for example, up to 10% of global economic output will be lost; there is currently a 50% chance of this happening. In the worst case scenario, the global economy could shrink by 20%.

The costs of taking action now would be just 1% of the value of global goods and services (gross domestic product); the costs of not doing anything would be many times greater.

Some of the solutions offered by Stern are as follows:

• Reducing consumer demand for heavily polluting goods.

• Providing a more efficient global energy supply.

• Preventing deforestation, which is a major source of carbon emissions.

• Promoting cleaner energy and transport technology.

• Creating a global market for carbon pricing (see carbon trading), building on current schemes.

• Create a World Bank fund to help poorer countries to adjust to inevitable climate change.

Sustainable living is not just an ideal that we can aspire to in rich countries, gradually adjusting our lifestyles when it suits us. It is absolutely necessary for the healthy future of the planet.

If we don't begin to live within the planet's capabilities, resources will become increasingly scarce, the environment will be damaged beyond repair and it is the poorest nations which will suffer the most serious hardships. Many developing countries already have to cope with harsh climates and they are the least able to adapt to further deterioration of their living conditions. Even in Western Europe we are already seeing consequences of climate change, notably through the increasing number of extreme weather events.

As suggested in the Stern Review, sustainable development is completely possible and affordable. It will certainly require us to adjust our lifestyles and even make some material sacrifices, but these changes will be minor compared to those made during other periods in our history. Such changes should also lead to improvements in overall quality of life and new sources of wealth creation.

However, a coordinated effort is required at all levels of society, from international organisations and companies right down to individuals. The case for sustainable development has been proven and it is everyone's responsibility to 'do their bit'.

Moving towards sustainable construction?

The Environmental Impacts of Construction

Construction activities have a huge impact on our environment because heavily populated areas cover large parts of the earth's surface. The built environment is completely dependent on resources from the natural environment:

- Over 90% of non-energy minerals extracted in the UK are used to supply the construction industry with materials.
- Energy from fossil fuels consumed in the construction and operation of buildings accounts for approximately half of the UK's emissions of CO_2.
- The construction industry consumes around 6 tonnes of materials per year for every person living in the UK.

The construction industry has traditionally been driven by financial concerns that have often prevented proper consideration of environmentally friendly solutions. In addition, construction techniques have evolved over long timeframes and some areas of the industry are reluctant to abandon or change their tried and tested methods – particularly where they are shown to maximise profits. Within this context, progress towards environmental management procedures has been slower than in other sectors – particularly those which are more controlled by technological developments.

Against this backdrop, it is no surprise that changes in construction practices are now being seen as increasingly important in addressing the issues of environmental damage and overall sustainability. Environmental awareness is gradually improving but the industry needs to shake of a reputation of being reluctant to adopt environmental necessities, polluting and demand led.

What is sustainable construction?

Sustainable Construction aims to apply the principles of sustainable development to the construction industry. It involves the delivery of buildings, structures, supporting infrastructure and their immediate surroundings which:

a) maximise the efficient use of resources by using fewer raw materials and less energy, as well as causing less pollution and waste;

b) improve quality of life and offer customer satisfaction;

c) offer flexibility, with the potential to cater for future changes in use; and

d) provide and support pleasing natural and social environments; and

c) still deliver profits!

All these factors must be considered at the earliest possible stage of a project's development to maximise its sustainability during the construction phase and over its operational lifetime.

It is easy to forget that a building's impact lasts long after the construction phase. The efficiency of a building in terms of operation and maintenance is largely dictated in the early planning and specification phases. Sustainable project proposals should therefore carefully consider design, construction, operation and, ultimately, demolition phases.

As well as having direct impacts on sustainability, the location and structure of buildings also has indirect impacts by influencing the level of sustainable behaviour of occupants. Offices away from transport routes encourage car use; windows that can't be opened encourage the use of air conditioning; and poorly planned working environments lead to decreases in well-being, health and productivity.

However, not all of the impacts of buildings and other structures can be controlled by architects, designers and planners. End users, right down to the level of individuals, must have some understanding of operational and maintenance issues for full sustainability benefits to be achieved.

Sustainable Construction and the Three Pillars of Sustainability

The specific benefits of sustainable construction are as follows:

1. ENVIRONMENTAL

- Sustainable construction has a lower environmental impact. It uses products and processes which are more environmentally friendly.
- The whole lifetime of a building/project is taken into account, rather than just the construction phase.
- Sustainable construction aims to maintain and enhance the natural environment.

2. ECONOMIC

- Sustainable construction can also bring cost savings.
- Proper consideration of building design, construction and operation can reduce the overall cost of a building throughout its lifetime.
- Many sustainable construction projects are no more expensive than standard options if properly planned at the design stage; this is vital because the efficiency of construction projects is generally measured in terms of cost per square metre.
- Sustainable buildings, structures and infrastructure can help to encourage economic prosperity. Better living and working environments help to improve productivity.

3. SOCIAL

- Sustainable construction creates better environments for people to live and work in.
- Sustainable buildings can help to improve levels of well-being; this can have knock on effects in areas such as health and education.
- Carefully planned, sustainable buildings and estates promote lower levels of crime and other social problems.

Sustainable Communities

Sustainable communities are those which are planned, built or modified to encourage sustainable living. Whilst they tend to emphasise the environmental and economic aspects of sustainability, they should also include the social considerations. This includes thinking about how people interact and get on with each other, levels of crime and general well-being. The types of buildings in a community have a strong influence on how that community functions.

"Sustainable communities are places where people want to live and work, now and in the future. They meet the diverse needs of existing and future residents, are sensitive to their environment, and contribute to a high quality of life. They are safe and inclusive, well planned, built and run, and offer equality of opportunity and good services for all."

Sustainable Development Commission, 2007

Image above: The Green Building, Macintosh Village, Manchester.
Part of a £130 million flagship redevelopment by Taylor Wimpey.

Why bother with sustainable construction?

Apart from the clear environmental benefits of adopting sustainable practices, which are discussed in more detail in other sections of the Guide, there are numerous other compelling reasons why modern businesses should take action as part of overall efforts to improve their practices. Some of these are as follows:

Corporate Social Responsibility

The concept of Corporate Social Responsibility, or CSR, suggests that organisations (especially large businesses and industries) have an obligation to consider the interests of customers, employees and wider communities, as well as taking account of the environmental effects of their operations. This obligation goes beyond their responsibility to obey rules and regulations.

Because CSR is closely related to the principles of sustainable development, it means that an organisation's decisions shouldn't be based on financial factors alone. They should also take into account social and environmental considerations.

The huge effects that construction activities have on our lives and environment, as well as the size of many of the businesses involved, suggests that the adoption of CSR is especially important for the industry. This is highlighted by the rising public interest in environmental and ethical issues. Many investors, for example, have begun to take account of a company's CSR record, as part of their business research.

"Corporate social responsibility is the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large."

- World Business Council for Sustainable Development

Socially Responsible Investment (SRI) aims to deliver long-term social, economic and environmental benefits while, at the same time, achieving acceptable financial returns. Part of the thinking involved is that investments will perform better if they contribute to different aspects of sustainable development. As such, it may well be easier for organisations to attract investment if there is an agenda of social responsibility.

Considerate Constructors Scheme

The Considerate Constructors Scheme is a major CSR initiative which has been established by the construction industry in order to improve its image. It is open to companies of all sizes and across all parts of the industry.

The Scheme includes a 'Code of Considerate Practice' which aims to encourage best practice beyond statutory requirements. All sites that register are monitored against this Code.

The main areas covered by the scheme are the environment, the workforce and the general public.

Best performing sites are recognised at Annual National Awards.

Photograph: HBG UK Ltd

Compliance with current and future regulation

There has been a huge rise in the volume of environmental legislation over the past couple of decades. Concerns about environmental issues, as well as broader sustainability, suggest that this is likely to continue and it is bound to place increasing pressure on all parts of the construction industry.

Although there are usually costs involved in compliance with new laws, the costs of not complying are generally much greater, and it is in a company's interests to adapt their processes as early as possible. Where businesses are able to pre-empt new regulations, this can give competitive advantage. Since many regulations actually involve increased efficiency, there can also be cost savings down the line (e.g. landfill tax).

Photograph: Canary Wharf, London. Martin Pearse

The value of sustainable credentials

It is only a couple of decades since the consideration of the environment was considered a subject for 'eco-warriors'; the concept of sustainable development was generally confined to special interest groups and academics. However, the recent increase in public awareness of environmental and sustainable development issues, largely caused by an explosion in media coverage, has brought much wider interest. There is broader understanding of the effect that humans can have on the global environment and the future of the planet in environmental, economic and social terms.

Companies of all sizes have started to promote themselves based specifically on their action on environmental issues. For example, it is becoming increasingly common for businesses to talk about efforts to reduce their carbon footprint, their investments in sustainable technologies and their use of recycled materials. Even some oil companies, whose business largely depends on the burning of fossil fuels, are keen to demonstrate environmental credentials.

Being ahead of the game has clear advantages; for those organisations able to improve on current minimum standards and advance the level of best practice there can be valuable positive publicity, improved reputation and the potential for winning new work.

Consumers are also becoming increasingly picky about the sustainability of the products they buy; indeed it is damaging for businesses to be connected with any activities which are seen to cause harm to the environment. The use of independently verified environmental labelling schemes, such as the FSC (Forest Stewardship Council) for timber, can provide evidence of a company's performance in specific areas and set them apart from competitors.

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Endnotes:

[1]Roaf, S. 2004, Closing the Loop: Benchmarks for Sustainable Buildings, RIBA Enterprises Ltd., London.

[2]Stern, N. 2006, Stern Review on the Economics of Climate Change, [Online]. Available: http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm [Accessed: 18/10/07].

[3]DETR. 2000, Building a Better Quality of Life – A Strategy for More Sustainable Construction, HMSO, London.

[4]Sustainable Development Commission. 2007, Sustainable Communities and Sustainable Development, [Online]. Available: http://www.sd-commission.org.uk/publications.php?id=146. [Accessed: 18/10/07].

Photography credits:
Front cover: The Green Building, Macintosh Village, Manchester. Part of a £130 million flagship redevelopment by Taylor Wimpey. Photograph:Terry Wha. Page 1: Leto A. Page 2: Pingnews. Page 3: victoriapeckham. Page 4: (L) C Johnson, (R) Nicky Fern. Page 5: Patrix. Page 7: HBG UK Ltd. Page : Canary Wharf Towers by Martin Pearce.

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Section 3
Who is responsible for sustainable construction?

CONSTRUCTING EXCELLENCE
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Background: the need for regulation

Major changes will have to be made in all industries if we are to achieve an increasing number of environmental goals, not least the UK government's target of a 60% reduction in CO_2 emissions by 2050. For the construction industry to achieve greater sustainability and make the necessary changes in the way it operates, it must have some incentive to do so – economic or otherwise. Governments and policy makers therefore have a strong role to play:

- They should set a good example through their own building projects.
- They should create conditions to encourage innovation in technology and working practices.
- They must also set out firm regulation in order to prevent the damaging activities associated with many modern construction activities.

There have been significant increases in the activity of the UK government on sustainable construction which are connected to its various roles in the industry - as regulator, adviser, agent, client and funder of research and innovation.

The government is obliged to act on the subject, not least because the vast majority of its own emissions are related to buildings. In 2004, for example, the public sector accounted for 34% of new non-domestic building construction and 37% of non-domestic refurbishment (totalling 1.45% of UK GDP)[1]. As such, the sector needs to take the lead on carbon emissions reduction by setting an example to the private sector as well as through its significant purchasing power.

Initiatives range from government wide strategies through to individual taxes. 'Eco-taxes', such as the landfill tax and aggregates levy, are becoming well established in the UK and it is likely that future taxes will increasingly address water, raw materials, energy consumption and pollution.

However, policies which encourage more sustainable activities are not always enough and sometimes have to be supplemented by the use of more direct regulation; this includes the imposition of fines or direct charges for specific environmentally damaging activities. Construction organisations can minimise the impact of such regulation by acting early to anticipate changes and enhance their reputation for taking a positive stance on CSR (Corporate Social Responsibility) issues.

As well as the use of such 'punitive' regulation, the Carbon Trust also stresses the need for better governance and support mechanisms to make sure that sustainability targets can be met within the construction sector[2].

Constructing Excellence in the North East's 'Pocket Guide to Environmental Legislation' is a useful resource on current legislation affecting the construction industry in England and Wales[3].

Responsibility for Sustainable Construction

Defra - Nobel House. Photograph: elyob

Sustainable Construction Strategy

BERR has co-ordinated the production of the government's Sustainable Construction Strategy.

The new strategy will be published in 2008 and follows the review of sustainable construction in 2006 and an extensive period of consultation.

The original strategy, 'Building a Better Quality of Life' (2000), represented the construction industry's response to the UK Strategy for Sustainable Development (1999). It aimed to provide a 'catalyst for change' in construction across the UK and identified priority areas for action whilst suggesting indicators and targets to measure progress. One of the key objectives was to raise awareness and understanding of the subject area. The document also set out the government's expectations of how the industry would contribute to wider sustainable development.

Aimed at decision makers both within government and industry, the new strategy intends to be a single, coherent plan of action on sustainable construction, providing clarity on dealing with the challenging targets the industry is facing. It will aim to provide an effective framework to guide future government policies on construction. It will also place greater stress on balancing all 'three pillars of sustainability' – environmental, economic and social.

The subject of sustainable construction involves a large number of political interests. It directly includes policy areas covering climate, energy, transport, industry, agriculture and forestry as well as economic and regional policies; it also touches many others.

This wide spread is clearly reflected in the number of different governmental and non-governmental organisations currently working on the subject. It is easy to get confused about who is responsible for sustainable construction.

DEFRA

DEFRA is the government department that promotes sustainable development across government and is responsible for coordinating the agreement of targets related to sustainable construction. As a cross-government champion, it leads in the coordination of the UK's Sustainable Development Strategy.

DEFRA also provides funding for a variety of other initiatives through their BREW (Business Resource Efficiency and Waste) programme and through direct sponsorship of organisations including WRAP (Waste Resources Action Plan), the Carbon Trust and the Energy Savings Trust.

BERR (Department of Business, Enterprise and Regulatory Reform; formerly DTI) and related organisations

BERR has overall responsibility for construction on a national scale. Their Construction Sector Unit (CSU) works closely with DEFRA on sustainability issues, as well the CLG (Communities and Local Government) on building regulations. The CSU aims to improve the sustainability of construction through direct contact with the industry as well as by providing ongoing support for ministers.

Sustainable Development Commission (SDC)

The SDC is the government's independent advisory body on sustainable construction. They aim to put sustainable development at the heart of government policy by providing evidence-based public reports, advising ministers and other government stakeholders, responding to policy initiatives and undertaking watchdog appraisals of Government's progress on the subject. Key policy areas include climate change, business, economics, education, health, housing, communities and land use.

From 2005, the Commission took responsibility for Sustainable Development in Government (SDiG) reports which outline annual progress towards targets for sustainable development across the government estate.

Moving towards sustainable construction?

National Audit Office (NAO)

The NAO examines public spending on behalf of parliament. It has been responsible for a variety of studies which have had direct or indirect connections to sustainable construction.

Their recent report, 'Building for the future: Sustainable Construction and Refurbishment on the Government Estate', was highly critical of the limited progress towards more sustainable buildings occupied by central government departments and their agencies[4].

Communities and Local Government (formerly DCLG; ODPM)

Communities and Local Government (CLG) is the department responsible for building regulations and planning in England. As such, it has a key role in reducing CO_2 emissions, in line with broader government targets, and sustainable development principles are embedded in all their areas of activity.

CLG also has policy responsibility for the Code for Sustainable Homes which is covered in section ten of the Guide.

European Union

At a European level, the treaty of the EU (1992) included a high level of environmental protection and a series of environmental action plans have been used to apply EU environmental policy.

Progress on sustainable construction has been dominated by the recent introduction of the Energy Performance of Buildings Directive (or 'Buildings Directive') which entered into force in January, 2006. It directly addresses greenhouse gas emissions with the requirement that all member states introduce a general framework for the energy performance of buildings and enforce minimum standards of performance on new builds and refurbishments. The directive also specifically requires many buildings to have a clearly displayed energy rating which, it suggests, should increase the value of including energy saving materials and components on all commercial buildings. At the domestic level, dwellings for sale now need to have an energy performance rating, similar to the ratings for white goods; these form part of the government's Home Information Packs (HIPS)

The Buildings Directive will have a major impact on existing buildings and future projects by necessitating and strengthening environmental considerations, as well as affecting the profile and reputation of many builders when energy ratings are particularly high or low.

Regional initiatives

From regional assemblies down to the level of local councils, there has been an explosion of initiatives on the subject of sustainable construction; these range from recycling targets through to broad planning obligations. In addition, the Government's new Sustainable Construction Strategy is expected to place even greater emphasis on regional delivery.

Regional Sustainability Frameworks have been deve loped across the country and cover areas such as neighbourhood renewal, crime reduction, planning and transport, waste, energy and climate change.

The Merton Rule

The 'Merton Rule' was pioneered by the London Borough of Merton and requires the use of renewable energy on building projects in order to reduce annual carbon dioxide emissions.

Further similar initiatives throughout the country have been strengthened by Yvette Cooper (Minister for Housing) announcing in 2006 that:

"The government expects all planning authorities to include policies in their development plans that require a percentage of the energy in new developments to come from on-site renewables."

Merton's original target was to achieve a 10% reduction in CO_2 through the use of renewable technologies on all new major sites. In other areas the figures have varied; Kirklees Council, for example, have proposed that by 2011, 30% of energy consumption in every one of its new buildings must come from renewables.

Other organisations

In addition to those mentioned above, there are a huge number of organisations catering for an enormous number of construction-related subjects; they cover industry-wide issues right down to tiny interest groups.

It would be impractical to cover all of these organisations within this guide. However, links to some of the organisations which have made notable contributions to the sustainable construction agenda are given below:

Association for Environment Conscious Building (AECB) (also the Sustainable Building Association) - http://www.aecb.net/

Building Research Establishment (BRE) - http://www.bre.co.uk/

Carbon Trust - http://www.carbontrust.co.uk/default.ct

Chartered Institute of Building Services Engineers (CIBSE) - http://www.cibse.org/

Commission for Architecture and the Built Environment (CABE) - http://www.cabe.org.uk/

Energy Savings Trust - http://www.energysavingtrust.org.uk/

English Partnerships (EP) - http://www.englishpartnerships.co.uk/

Federation of Master Builders (FMB) - http://www.fmb.org.uk/

Green Building Council (UKGBC) - http://www.ukgbc.org/

Green Streets - http://www.greenstreet.org.uk/

Institute of Civil Engineers (ICE) - http://www.ice.org.uk/

Royal Institute of British Architects (RIBA) - http://www.riba.org/

Royal Institute of Chartered Surveyors (RICS) - http://www.rics.org.uk/

Strategic Forum for Construction - http://www.strategicforum.org.uk/

Sustainable Homes Ltd. - http://www.sustainablehomes.co.uk/

The House Builders Federation - http://www.hbf.co.uk/

NHBC (National House-Building Council) - http://www.nhbc.co.uk/

Constructing Excellence

Constructing Excellence was formed by the union of a number of DTI and industry funded best practice organisations to help reduce confusion about where firms should go for advice or to participate in the industry improvement agenda. It can trace its roots back to the Egan and Latham reports of the 1990s which called for a step change in construction industry performance.

Constructing Excellence is a non-profit making organisation and aims to achieve an improvement in the performance of the construction industry by tackling market issues in the sector and encouraging continuous improvement through focussed programmes. Advice and assistance is provided from the level of individual businesses and organisations upwards and covers the whole construction network. Key activities include the following:

- Key Performance Indicators (KPIs)
- Influencing and advising on government policy
- In-house publications
- Workshops and presentations
- Consultation: private and public sectors.
- Demonstration projects – showcasing examples of best practice in a variety of areas.

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Endnotes

[1] Carbon Trust 2005, The UK Climate Change Programme: potential evolution for business and the public sector, The Carbon Trust, London.

[2] See 1, above.

[3] Available from: Constructing Excellence in the North East. catriona@constructingexcellence-ne.org.uk. 0191 383 7435

[4] The full report is available at:http://www.nao.org.uk/publications/nao_reports/06-07/0607324.pdf

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Plain English Guide to Sustainable Construction

Ben Stubbs

Section 4
Energy , Pollution and Climate Change

CONSTRUCTING EXCELLENCE
in the built environment

Energy, Pollution and Climate Change

The construction industry is responsible for the intensive use of energy both directly, in the creation of buildings and infrastructure, and indirectly, in the operational phase. As well as the carbon dioxide which is produced, a variety of other pollution is caused by construction processes and buildings in use.

However, thoughtful planning and design can have a major impact on reducing energy use and pollution over a building's entire lifetime. The number of more sustainable solutions is growing rapidly and many of these can provide substantial financial savings, as well as environmental benefits. This is particularly the case when they are considered at the earliest possible stage of a project and where long-term benefits are fully taken into account.

This section of the Guide looks at some of the major pollution impacts associated with the industry's activities and a variety of solutions which can help to reduce them.

Image: Artists impression of Cross Street South, Birmingham, a development of environmentally friendly, energy efficient homes, courtesy Bromford Housing Group

Greenhouse Gases

Embodied and operational energy

Embodied energy refers to the amount of energy required to design, manufacture and supply a product, material or service to the point of use. In terms of buildings, this covers the whole design and construction phase and includes the manufacture of all individual building components as well as energy used by machinery and in transportation.

Operational energy, on the other hand, refers to the energy used by a building 'in use'. This includes all day to day running and maintenance activities including heating, lighting, servicing of equipment and systems and ongoing upgrading and refurbishment.

Carbon Dioxide (CO_2)

- The construction and maintenance of buildings and other structures is responsible for around half of UK CO_2 emissions.
- Housing alone generates 27% of UK emissions, of which 73% is used for space and water heating.
- Around 10% of UK emissions are associated with the manufacture and transport of construction materials, and the construction process[1]

Why is CO_2 so harmful to the environment?

- Carbon Dioxide (CO_2) is currently the most significant greenhouse gas because it accounts for 60% of the 'enhanced greenhouse effect' which, in turn, is responsible for man-made global warming. The greenhouse effect means that the sun's rays are trapped and build up in the atmosphere, causing temperatures to rise – the 1990's was the warmest decade for the last millennium!

- Since the industrial revolution, we have been burning fossil fuels (coal, oil and natural gas) at an alarming rate. These fuels had kept CO_2 'locked away' in the earth's crust for millions of years but, as we have burned them, the gas has been released rapidly.

- As well as burning fossil fuels to run vehicles, heat our homes and provide power for industry, CO_2 is also released when trees are cut down or burned. Living trees are also important for soaking up CO_2; the fewer there are, the more the gas can build up. This is why deforestation, the rapid destruction of the world's forests, is so alarming.

- Since the start of the industrial revolution, CO_2 in the atmosphere has increased by around 30% , and is likely to have doubled by 2100 at the latest. Although the precise effect of this is not fully understood, the vast majority of scientists agree that it will certainly lead to an increase in global temperatures of between 1.4 and 5.8 degrees Celsius . The possible future effects of this are increasingly reported in newspapers and on TV and we are already seeing some serious consequences: melting ice; rising sea levels; more severe weather including hurricanes, droughts and famine; and the extinction of numerous species of plants and animals.

- Some of the regions which are likely to see the worst effects of climate change are those which already suffer severe hardships. These include many poorer countries in parts of Africa and South Asia. In the UK, some people welcome the prospect of warmer weather, but this will also be accompanied by heavier rainfall and more destructive flooding. More uncomfortably hot days and serious droughts in the summer are also likely.

- Most scientists believe that, unless we radically cut down the amount of CO_2 we are releasing, we will soon reach a point beyond which climate change will run out of control. This is sometimes referred to as the 'tipping point'.

Greenhouse Gases

Water Vapour

Water vapour, the gas phase of water, would seem to be relatively harmless; it forms clouds and is responsible for most of the Earth's natural greenhouse effect which keeps the planet at a habitable temperature. However, any increase in global temperature will lead to higher levels of evaporation; in turn this will increase the water vapour in the atmosphere, increasing the greenhouse effect and pushing up temperatures still further.

Methane

Methane is a naturally occurring gas and burns very cleanly, making it an attractive fuel. Unfortunately though, it is very difficult to collect and transport to where it is needed. It is also a very powerful greenhouse gas – 21 times more powerful than CO_2 in its potential to cause global warming. It accounts for 20% of the enhanced greenhouse effect. Methane concentration has increased by 150% since the industrial revolution[2] .

Although the Earth's crust naturally contains huge amounts of Methane, human activity is also producing even more. The disposal of organic waste in landfill sites, for example, has produced huge quantities of methane which can lead to explosions unless carefully managed. The livestock sector (particularly cattle, chickens and pigs) produces 37%[3] of all methane caused by human activities.

While all plants produce some methane (more than 1/3 of the total), as the climate warms, they produce more and more!

Nitrous Oxide

As a greenhouse gas, nitrous oxide is 296 times more powerful than CO_2 when considered over a 100 year period[4]. It is no surprise, therefore, that controlling it is part of the wider effort to limit global warming.

Industrial sources make up 20% of man-made emissions of the gas, with the vast majority coming from agriculture.

Ozone

Although the ozone layer in the high atmosphere (15 - 35 km above the earth) is vital for filtering out harmful ultraviolet radiation, at surface levels ozone is a pollutant which is harmful to human health and can damage agricultural productivity. It also acts as a greenhouse gas in the lower atmosphere. At low levels ozone is formed indirectly by industrial processes and vehicle emissions.

Photograph: sunfox

More pollutants

As well as the greenhouse gases described previously, the construction industry is responsible for the production of many other types of pollutants including chemical substances, noise, heat, dust and light. When these are released into the environment they can have negative effects which may include endangering human health, harming living resources and ecosystems or interfering with amenities or other legitimate uses of the environment.

The rapid development and increase in the use of machinery in construction allowed for huge increases in the speed and intensity of activities during the second half of the 20th Century. However, this has caused noticeable local air pollution close to building sites in the form of dust, spillages of fuel and toxic elements and the release of 'micro-particles', all of which affect the environment and public health.

There have also been less obvious effects on the levels of pollutants which operate over much greater distances. Industrial processes have led to the release of gases into the atmosphere which have caused problems such as damage to the ozone layer and acid rain.

A variety of pollutants, which have specific links to construction, are described below.

Volatile Organic Compounds (VOCs)

VOCs are emitted as gases from a number of chemicals used in construction products. These include paints and lacquers, paint strippers, wood preservatives, stored fuels and various building materials and furnishings.

The health effects of VOCs vary greatly but, at their worst, they can include eye, nose and throat irritation; headaches; nausea; and damage to the liver, kidney and central nervous system. They can also cause cancer in humans as well as animals. When released into the environment, they cause damage to soil and groundwater, and the vapours also contribute to local air pollution and levels of greenhouse gases.

The monitoring of VOCs in the UK is not well developed. However the EU's VOC Solvents Directive has established emissions limits for VOCs, particularly with regards to the s olvent content of paints and varnishes.

Sulphur Dioxide – SO_2

Sulphur Dioxide is produced naturally by volcanic activity, but it is the emissions from industrial processes which have been the focus of concern for the past few decades. A mixture of smoke and SO_2 from burning coal was the source of urban smogs which caused severe problems with visibility in London, as well as chronic health problems, before the Clean Air Act of 1956. China is now the world's largest SO_2 polluter and has seen a 27% increase in emissions since 2000[5]; smog may even affect some events at the 2008 Beijing Olympics.

Suphur Dioxide emissions from the increased use of fossil fuels during the 20th Century were also largely responsible for acid rain and associated environmental disasters. Adverse effects have included impacts on forests, freshwater and soils, killing off insects and aquatic life forms and causing damage to buildings and human health.

However, a well-coordinated response to this problem has led to a significant decrease in emissions in western countries, particularly due to the process of 'flue-gas desulphurisation'.

The UN Convention on Long Range Transboundary Air Pollution (LRTAP) of 1979, and particularly its Gothenburg Protocol of 1999, have been instrumental in reducing the effects of acid rain through reductions in sulphur emissions (as well as other transboundary pollutants).

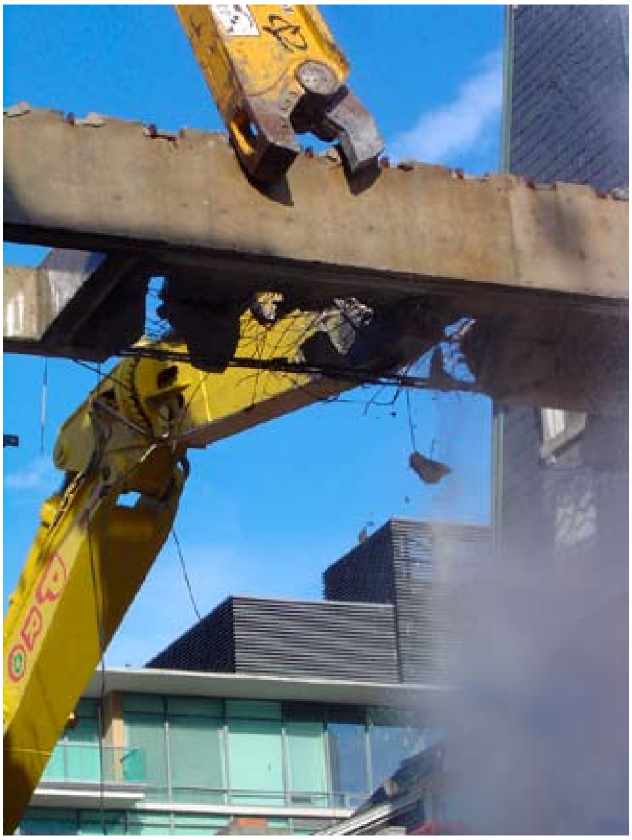
The Effects of Acid Rain. Photograph: Twelve Paws

More pollutants

Spillages

Many thousands of industrial spillages occur each year. These are often related to construction activities, originating from factories, building sites, transport activities and waste disposal sites. Not only does pollution from spillages cause environmental damage, but it can also result in prosecution.

Some of the most common sources of construction-related spillages include drainage systems, wrongly connected effluents (eg toilets and sinks), forecourts and delivery areas, cleaning activities, sewage disposal and chemical storage. Consequences can include groundwater contamination, soil pollution, public health problems and serious damage to plants and animal life.



Dust

Dust from construction work can have a dramatic effect on the local environment. As well as the huge amounts of dust resulting from demolition and building work on site, sources also include quarrying and mining, factory processes and transportation.

Dust can have an obvious visual impact on areas surrounding buildings sites, but also presents problems for public health and wildlife. Sources such as asbestos, lead paint and other dangerous chemicals can have particularly serious long-term health effects.

The environmental impacts of concrete

Concrete is the most widely used manmade material on the planet. However, its production requires very large quantities of fuel and is responsible for heavy CO_2 emissions. The extensive use of 'virgin' aggregates and sands (i.e. not reused or recycled material) as key ingredients also has major environmental effects on the landscapes they are taken from. Recycled and manufactured aggregates have recently been used as an alternative, but these only make up a small proportion of the total so far.

Cement, which is the key binding component of concrete, has serious environmental impacts from the very start of its production process. It causes airborne pollution from dust, gases, noise and vibration during quarrying, as well as damage to the landscape. Its production also has heavy energy requirements.

Canary Wharf Station Photograph: Rachel Ninis

Reducing energy use and the effects of pollution

Drax coal-fired power station, North Yorkshire. Photograph: La Petite Claudine

Achieving targets for global reductions in CO_2 emissions will be a major challenge as demand for energy increases, and particularly in the light of accelerating development in countries such as China and India. However, the potential for using energy more efficiently should not be underestimated. We already have a huge range of options for reducing energy use in existing homes, offices and other commercial buildings.

Cutting down on wasted energy should always be the top priority in reducing energy use, as set out in the 'energy hierarchy [6]' which was developed by the Mayor of London's office. This is also the cheapest and simplest way of achieving significant efficiency improvements.

The use of the hierarchy is recommended when making business decisions about building specifications, procurement and internal energy management. It can lead to substantial cost savings and reductions in environmental impacts.

The following pages of the Guide consider some of the ways that the construction industry can bring about reductions in wasted energy, with a focus on improving efficiency. It also covers the main options for the incorporation of renewable energy generation.

The Energy Hierarchy

1) Use energy efficiently.
Firstly by reducing uvnnecessary energy use (e.g. turn lights and equipment off when not in use, design buildings to avoid the need for air-conditioning, use bicycle couriers wherever possible, turn heating down).
Secondly by using energy efficient technology.

2) Use renewable energy.
Firstly by employing renewable energy technology where feasible, and secondly through purchasing power by signing up to a 'green tariff'.

3) Supply remaining energy efficiently using technologies such as combined heat and power and efficient boilers.

1. Using energy more efficiently

Lichfield Garrick: A fully naturally ventilated arts space

Making the most of the building 'envelope'

The building envelope is the separation between the inside and outside of a building. It forms a protective shell for privacy, security and to help regulate the internal climate and air movement. It is also important for the structure and strength of the building and controlling moisture.

One of the most common reasons for wasted energy in buildings is their inability to cope with large variations in temperature, and this is largely because of badly designed or inadequate building envelopes. There may be insufficient insulation or a poor choice of materials for windows, doors, walls, floors and roofs.

Natural ventilation

Air conditioning, which has high energy requirements, was not commonplace in UK office buildings until the 1970s and remains rare in private homes. However, we now have rising expectations of our living and working environments and a carefully controlled climate has become a high priority, particularly in offices.

In the drive for more sustainable buildings, there will have to be a significant change of attitude if a return to natural ventilation systems is to become more acceptable. The demand for precise temperature and humidity conditions must be abandoned in favour of a range of comfort levels acceptable to most building occupiers and uses.

Natural ventilation is one of the more obvious and least expensive solutions for the efficient cooling of buildings. It is also considered much healthier than air conditioning, which is often used on buildings which are 'sealed' (they have no operable windows). Many traditional older buildings, both domestic and commercial, were designed to be naturally ventilated in any case; buildings in hotter countries have been naturally ventilated for centuries.

However, natural ventilation systems must be planned very early in the design stage of projects if they are to be effective. The aim should be to have an airtight building envelope while controlling outdoor air supply to provide the required comfort levels.

Features of naturally ventilated buildings include operable windows as well as exhaust vents located high in the building and intake vents low in the building to encourage air flow. Open building plans also help to facilitate air movement.

Benefits include lower energy consumption, reduced noise from mechanical systems and greater control for building occupants. There are also savings in construction costs. However, building occupants must accept that there will be greater temperature swings and that they must take responsibility for opening and closing vents and windows to optimise comfort levels.

In order for natural ventilation to be effective for cooling buildings, heat gains from sunlight must be kept to a minimum. If this is done effectively, less air flow is required to remove heat and there is a reduced need for mechanical cooling systems. The use of thermal mass and solar shading (see below) can be very effective in minimising these gains.

Where natural ventilation needs to be enhanced, "mixed mode" ventilation may provide the solution. However, this does require electric motors to draw the air into the building as necessary. Mixed mode ventilation may be complemented by heat exchange systems for heating during winter months.

Wind Catchers at BedZed Zero Emissions Development

Stack Ventilation

Stack ventilation makes use of the difference in temperatures between internal and external environments to drive a flow of air through a space. Options can be divided into two main categories:

1. Mixing Ventilation (i.e. wind catchers): Air is introduced into a building and mixed throughout the space.
2. Displacement Ventilation: Warm air collects and escapes from the top of a building, while cooler air is drawn in at lower levels.

Wind catchers (also known as cooling stacks) can be located on, or as part of, a building's roof to provide passive cooling and ventilation. As such, they can avoid the need for mechanical cooling systems altogether. They have been effectively used in traditional Persian architecture for centuries.

When they are open, cold air can be caught and forced down inside the building, dispersing the hot air and allowing it to escape. They can also be combined as daylight funnels when lined with suitable reflective material, increasing natural light at all levels.

Thermal Mass vs. Lightweight Construction

The thermal mass of a building refers to its ability to absorb heat. Utilizing the thermal mass of a building can be an efficient way of helping to maintain comfortable and stable temperatures. It is particularly effective on new buildings when materials use is planned at the earliest possible stage.

Materials with high thermal mass, such as concrete, brick, stone and tiles, act like heat sponges. They absorb heat during daytime in the warmer summer months, releasing it at night time and keeping the space relatively cool and comfortable. Cooling the thermal mass can be improved by ventilation at night. In the colder winter months, heat from the sun can be trapped in the thermal mass, as well as by using large glazed walls and conservatories; this is known as passive solar gain. Heat is then re-released from the thermal mass during the night, slowing down cooling when central heating is switched off.

The benefits of thermal mass are limited if floors are carpeted and walls are drylined, both of which stop the effective transfer of heat. Sometimes it may be appropriate to use ceilings as the main thermal mass source as they are less likely to be refinished.

There is currently a major debate between the relative effectiveness of thermal mass and lightweight, 'quick response' construction. Although lightweight building may require more energy for climate control, building them requires much less energy than a 'thermally massive' building. Effective insulation can minimise heat loss from lightweight buildings during colder periods. This trade off between the energy requirements for construction and operational phases means that the use and expected lifetime of individual buildings must be carefully considered in decision making.

Active Solar Sytems

Active Solar systems use electrical or mechanical equipment for the transfer of heat using water or air, and usually involve fans or complex pump systems. Solar thermal panels and tubes, for example, form part of active solar heating systems. It is sometimes possible to use PV panels to power active systems to make them carbon neutral.

Avoid wasting energy

Solar Shading

Solar shading is often used alongside thermal mass and natural ventilation to keep buildings cool. It involves any device that stops sunlight directly penetrating windows or other external glass building components. Blinds and/or tinting, for example, can be used to minimise solar gain when the weather is hotter.

Many shading products are also placed on the external façade of a building adjacent to windows. Permanent, fixed external shades are often referred to using the French term brise soleil; others can be raised or lowered into position according to the season or variations in sunlight. These products have the added advantage of adding visual improvements to many buildings and are available in a wide range of materials. It is also possible to incorporate solar panels into solar shading.

Solar shading on the new offices of East Thames Group

However, while solar shading can be effective, it is usually better to avoid the use of glass roofs where possible and window areas should be carefully planned where there is the potential for extended exposure to summer sunlight. Shading may also increase the need for artificial lighting inside buildings because of the reduction in natural light.

The use of light-coloured exteriors which reflect sunlight can also help to keep buildings cool; it is particularly effective when used alongside thermal mass and solar shading. Trees and shrubs also provide extra shading as well as some protection from the wind.

Chilled beams

Chilled beams are a relatively recent innovation. They circulate building air without the need for noisy and expensive ductwork and air handlers. Usually placed close to or within ceiling spaces, they are cooled using external sources such as recirculated water. They cool the air below by acting as a natural 'heat sink' for naturally rising warm air, absorbing it and taking it away. The cooled air then naturally drops back to floor level where the cycle begins again. Active chilled beam systems use fans or other mechanical devices to aid circulation; passive systems are completely self-supporting.

Insulation Materials

Insulation aims to stop heat flow into or out of a building. Sometimes the same materials can be used to keep buildings warmer in cold climates and cooler in hot climates.

However, no substance can stop heat transfer completely. Insulation should therefore minimise the 'thermal bridging', which occurs particularly when poor insulators, such as wood and glass, are part of the building envelope. Unless thermal bridging is properly considered, heat will flow in or out of a building very easily.

Insulation can have an enormous impact on the energy requirements of new buildings when designed in from the earliest possible stage and has the added benefit of improving soundproofing. It can also be a relatively cheap, simple and effective solution for increasing the energy efficiency of existing buildings of all types and ages.

The most obvious places where insulation can have an impact are cavity walls and loft spaces, but there are a number of other options. These include under floors, and around and within window units and doors.

However, some insulation products are not without their drawbacks. It is important to keep in mind the energy and waste involved in the production of many standard insulation materials. Some products can also be unpleasant to use and have the potential to cause lung, throat and eye irritation, particularly during installation.

As well as choosing appropriate insulation materials, the position of individual building elements, such as windows, doors and heaters, is also very significant in improving insulation and lowering energy requirements.

Sustainable Options

The number of materials used for insulation is enormous. However, some of the options with low environmental impacts are given below.

Rockwool (also Mineral Wool; Stone Wool)

Rockwool is produced from molten stone at temperatures of around 1600 degrees Celsius. Production techniques include blowing air or steam through the molten rock, or spinning it on high speed wheels (like candy floss!). This produces a mass of fine, intertwined fibres which are excellent insulators when packed closely together.

Rockwool is also particularly effective in sound insulation and providing a barrier to fire.

Despite the high temperatures needed for production, over its lifetime Rockwool claims to save 100 times more CO_2, SO_2 and NO_2 than is emitted during production[9]. It is also an abundant natural resource.

Sheepswool (e.g. Thermafleece)

Wool is also a natural fibre from a fully renewable source. It can absorb moisture without affecting its efficiency and is ideal for use in roofs and timber frame walls, allowing water vapour to migrate through the structure. It presents no health hazard and can be installed without protective clothing.

Thermafleece, which is made from sheepswool, provides an effective insulation material for both new build and refurbishment projects. It boasts a particularly low U-value of 0.039W/m^2.K thanks to its high density. In addition, thermafleece also claims to use only 14% of the embodied energy that is used to manufacture glass fibre insulation, and it can be easily recycled at the end of its useful life[10] .

However, a large increase in the demand for sheepswool insulation would not be without its downside. The potential for increased methane emissions from sheep could make a significant contribution to the amount of greenhouse gases in the atmosphere! Production capacity is also limited.

Photographs:
(L) Thermafleece: Sheepswool insulation, courtesy The Green Shop
(R) Warmcel: Insulation made from recycled newspaper

Recycled Paper Insulation (e.g. Warmcel)

Warmcel is made from 100% recycled newspapers and therefore uses much less energy than conventional insulation materials. It is significantly cheaper than Thermafleece, has an impressive U-value of 0.036W/m2K and presents no health hazard[11]. The addition of simple inorganic salts also makes it resistant to fire.

However, Warmcel is only recommended where a roof has good secondary protection against water, such as felt.

In addition to the materials mentioned above there are a number of others which are, or claim to be, sustainable in one way or another. Some of these may appear to be less than ideal in environmental terms; however, it is important to consider the exact requirements of individual buildings, as well as the lifetime of the product, when making decisions on which one to choose.

Superinsulation

Superinsulation involves designing houses so that they don't need separate heating systems on a day-to-day basis.

Superinsulated houses generally have very large amounts of insulating materials with small backup heating systems. They can be effective even in very cold climates, although success is dependant on very careful attention to detail during the construction phase.

Superinsulation can be very effective when combined with passive solar design and this provides the background to the development of the German Passivhaus approach.

Although there is no set definition of superinsulation, key features generally include the following:

- **Very thick insulation**
- **Detailed attention to insulation where walls meet roofs, foundations and other walls**
- **Airtight construction (especially surrounding doors and windows)**
- **Heat recovery ventilation**
- **No conventional heating system (only small backup heaters)**

Avoid wasting energy

Measuring Insulation: U-values

U-values are an important concept in building design. They describe the ability of a material to conduct heat from the inside to the outside of a building, or vice-versa. This is the opposite of 'thermal resistance' (measured by R-values), which describes the ability of a material to stop heat transfer.

U-values are measured in 'Watts per metre squared Kelvin' (W/m2K). This indicates the amount of heat lost in Watts (W) per square metre of material when the temperature is one degree lower outside. In other words, if a material has a U-value of 1, for every degree of temperature difference between the inside and outside surface, 1 watt of energy would flow through each metre squared of its surface[7].

The lower the U-Value, the better the insulation provided by the material.

For comparison, the u-value of a straw bale is 0.13 and a 225mm brick wall has a u-value of 2.0.

Building regulations set out minimum requirements for all elements of new buildings. Although the latest revision of Part L uses other ways of measuring energy efficiency, maximum U-values were stipulated in previous versions as follows[8]:

• Walls	0.35
• Floors	0.25
• Roofs	0.25
• Windows, roof windows, roof lights and doors	2.2

(Source: www.planningportal.gov.uk)

However, U-values have nothing to do with how safe a material is to use. Styrofoam, cork, wood and polyester, for example, are good insulators but will burn or smoke dangerously if exposed to excessive heat or fire.

Efficient Lighting Systems

Artificial lighting consumes a huge proportion of the energy we consume worldwide but in many buildings most of this is an unnecessary expense due to inefficient and excessive illumination. In the UK, for example, we waste enormous amounts of electricity each year by leaving lights switched on unnecessarily. However, where lighting is necessary, there are a number of increasingly efficient options:

Low energy fittings

Traditional lightbulbs waste an enormous amount of energy by turning it into heat rather than light; this can also increase the 'thermal load' in living and work spaces which drives up temperatures. Energy-saving lightbulbs, on the other hand, work in the same way as fluorescent lights, using less energy and generating less heat. According to the Energy Saving Trust, one Energy Saving Recommended lightbulb can therefore save £60 over its lifetime. They use only 25% of the electricity of conventional bulbs to generate the same amount of light and last up to 10 times longer [12].

Although early energy efficient lightbulbs tended to be rather ugly and cumbersome, a large range of more attractive options is developing.

Efficient lighting for an increased number of applications is also becoming available and costs are coming down as demand increases.

Intelligent lighting systems

Heat sensitive and movement sensitive lighting sensors have been available for many years and have been particularly useful for external security systems. However, increasingly sophisticated, modern systems can now sense occupancy in separate areas of houses, offices or industrial buildings, as well as changes in natural lighting. Artificial lighting levels can then be adjusted automatically. Some systems can even adjust lighting to different 'moods' depending on the changing requirements of the space in which they operate.

Use of natural light sources

Where and when there is plenty of natural daylight, it is not always necessary to use artificial lighting at all. The thoughtful use of windows, rooflights, blinds and shutters offers a great deal of control over a building's lighting, while also improving ventilation and shading.

Velux-type roof lights, for example, can make an enormous difference to homes and offices by providing extra daylight and ventilation. Some of them even incorporate solar photovoltaic cells.

'Light chimneys' use reflective materials to bring light from a skylight into the heart of a building. They conduct sunlight over distances many times greater than their width and can make a significant difference to living and working environments.

Velux roof light Photograph: Robert Brook

Efficient Heating Systems

Even though there are a number of renewable energy options for heating homes, as outlined in the next section, these are not always suitable or cost effective for many existing buildings at present. However, there are a number of modern heating systems which can offer huge improvements in efficiency, while being practical and affordable.

Heating Controls

One of the easiest ways to improve the efficiency of existing heating systems is to fit simple devices such as thermostats and digital timer switches. These give building occupants a much greater degree of control over a building's climate and can result in substantial energy and cost savings.

Timer switches allow heating and hot water to be set to come on at specified times and some can even be operated remotely, via phone or internet for example. Thermostats automatically switch the heating off when a certain temperature is reached. Radiator thermostats allow the temperature of each room to be controlled separately.

Efficient boilers

Old boilers are a major cause of energy inefficiency and high fuel bills - particularly those over 15 years old. By law, new gas boilers must now be condensing boilers which convert much more of the fuel they use into useful heat.

Although replacing an existing boiler can be expensive, cost savings of up to a third can make it a worthwhile exercise[13].

Boiler performance is now rated in the same way as white goods. The best 'A' rated condensing boilers are around 90% energy efficient, compared to 60-70% efficiency of older models. Some are also available in LPG (Liquefied Petroleum Gas) versions or can be converted to run on LPG.

Photograph: Energy Saving Trust

Micro CHP Systems (also known as cogeneration)

Rather than using fuel just to heat rooms or water, micro-CHP (combined heat and power) systems power an engine to convert some of the energy into electricity. This is then used in houses and small businesses and any excess can be sold back to the national grid.

However, CHP systems are not yet widely available and don't have a proven track record for domestic use. More work is needed to improve their overall efficiency which isn't always as good as condensing boilers. There are also some concerns about the excessive amounts of heat which are produced.

Underfloor heating

Underfloor heating uses electric cables or circulating heated water for central heating, as an alternative to conventional radiators. It can be used with wood or concrete floors, with all types of floor covering and at all levels. However, the choice of floor covering does affect performance.

Systems can provide improved comfort for building occupants as well as visual benefits by removing the need for radiators. Most can be controlled on a room-by-room basis. The way that the heat is delivered also allows improvements in energy efficiency and lower heating bills.

Underfloor heating can offer the best energy efficiencies, and therefore environmental benefits, when combined with ground source heat pumps (see below) and high levels of insulation.

Energy Efficient Appliances

In many new building projects, appliances such as ovens, dishwashers, fridges and freezers are often designed in at an early stage. Because of this, it is increasingly important to consider their energy efficiency in order to reduce the running costs of the building once it is occupied.

According to the Energy Saving Trust, £3bn is spent powering consumer electronic and computer products in the UK every year (30% of the average household electricity bill)[14]. Their Energy Saving Recommended logo scheme is used to identify products which are the most efficient in any category, from kitchen appliances to digital televisions. The scheme currently operates across 29 product groups and covers over 2500 products.

Under the EU Energy Labelling Scheme, which is compulsory for all white goods and home appliances, selecting 'A' rated (or better) products has become the norm for consumers. The scheme gives ratings from A to G and primarily shows energy efficiency. It has become widely recognised and respected, and is being extended to an ever increasing number of products.

The monitoring of energy use is also one of the key factors in managing and reducing consumption. By taking regular meter readings and keeping records it is possible to identify peaks and troughs in usage which, in turn, can help in optimising energy use. In commercial buildings, awareness campaigns can be useful in modifying the energy use of occupants. Any resulting change in consumption can then be quantified and fed back to staff.

There are also a growing number of technologies which allow building users to monitor the energy consumption of individual appliances.

Underfloor heating being installed. Photograph: Polypipe

Monitoring Energy Use

Domestic Monitoring and Smart Meters

A range of domestic monitoring devices is being developed to assist homeowners in regulating their energy consumption. These include single socket, plug-in meters, which monitor the power usage of single devices, through to systems which give detailed information on energy use throughout the house.

The government recently launched a trial of smart meters in 8000 homes and is expecting them to provide a strong incentive for reducing energy use. The devices will show how much electricity is being used in the home at any particular moment (they are also available for monitoring water and gas use). They should help to reduce wasted energy by giving instant information about the consumption of various devices as they are switched on and off. Unlike existing meters, the information provided will be easily accessible and understandable to householders, who will be able to adjust their consumption accordingly. More sophisticated devices can even allow data to be accessed over the internet and give detailed reports and advice on reducing energy demand and costs. By sending information direct to energy suppliers, the devices can also put an end to estimated bills.

The simplest devices are wireless and can be easily attached around the power cables of individual appliances to give details on power use, electricity cost and personal carbon footprints. They are available online and from some high street stores; prices start from less than £50.

Energy Performance of Buildings Directive (EPBD) and HIPS

At the EU level, progress on sustainable buildings has recently been dominated by the introduction of the Energy Performance of Buildings Directive (or "Buildings Directive") which came into force in January 2006. It directly addresses greenhouse gas emissions by requiring all member states to introduce a framework for the energy performance of buildings. They must also enforce minimum standards of performance on all new builds and refurbishments greater than 1000m2; such buildings account for 70% of emissions from non-domestic buildings.

From 10th September 2007, Home Information Packs (HIPS) were introduced in the UK as a response to the Buildings Directive, although plans to measure the energy efficiency of buildings have been under consideration in the UK for several years. The packs will include Energy Performance Certificates for properties which follow a similar system to the rating of fridges and other white goods. To start with, HIPS only covered properties with three or more bedrooms, but from December 2007 all dwellings have been covered.

Sub-meters on Non-Residential Buildings

Energy use in non-residential buildings is often overlooked because overhead costs are simply accepted without being questioned. However, as with domestic buildings, once a more detailed picture of energy consumption is available, it is possible to recognise the potential for simple cost savings.

Electricity sub-meters offer businesses the possibility of monitoring energy use in their buildings in more detail. Usage data can be broken down by area, department or even function. As with domestic smart meters, they can reduce energy use by encouraging management decisions on increasing efficiency. Promoting awareness of the data can also help to modify user behaviour.

In some buildings, sub-meters form part of sophisticated building management systems which are able to control all aspects of energy use (and possibly water use) from a central computer. This could include heating, hot water, air conditioning and other ventilation systems.

Domestic smart meter. Photograph: Gilgongo

2. Renewable Energy Options

Renewable energy comes from sources which are 'inexhaustible'; they are naturally replenished. Energy from fossil fuels, on the other hand, which is 'non-renewable' and will eventually run out completely. Whilst improving efficiency is the best way to reduce carbon emissions and reliance on energy from fossil fuels, the use of renewable energy is the next best thing and has enormous potential in the UK. The energy is generated without producing carbon emissions although there are some emissions from the manufacture and maintenance of equipment.

Photograph: PRP Architects

Renewables, such as solar, wind and water power, as well as biomass, have been used traditionally throughout human history and have remained important for less developed countries. However they have not been seriously considered for the mass generation of electricity until recently. Renewable energy has become more popular because it can be generated without causing significant greenhouse gas emissions and contributing to climate change.

The UK is now aiming for 20% of electricity generation from renewable sources by 2020. Many local authorities are including guidance on the use of renewable energy in their local plans and it is not unreasonable to expect central government to set an example through their own operations.

However, developments for on-site generation of renewable energy in office buildings are in their infancy despite some high profile attempts to use solar panels, wind turbines and other options. Nonetheless, the technology is available and as demand rises, such options are likely to become increasingly practical as they become more efficient and cost effective.

Planning permission for many commercial buildings may now require that a percentage of energy requirements is met through on-site 'microgeneration' technologies (e.g. 10% or more). Apart from being zero carbon in operation (excluding Biofuels which should be carbon neutral), these renewable sources have other benefits including reducing the demand placed on the national grid and power stations. They also cut down on the amount of electricity which is lost in transmission (up to 8% in the UK).

The government's drive towards zero carbon homes in the UK by 2016 is bound to see an accelerated uptake of a variety of these technologies. (See Section 3 – 'The Merton Rule')

Soutra Wind Farm, Scottish Borders Photograph: Startagain

Wind turbines

In the UK we have 40% of Europe's wind energy but this is largely an untapped resource, currently providing only 0.5% of our electricity requirements[15].

Wind turbines can be used to convert energy from the wind into electricity with no carbon emissions. They come in a number of different forms and sizes and can be placed in a wide variety of locations. Small units can be placed on individual houses whereas vast 'wind farms' can cover huge areas of countryside or be placed out at sea (offshore). At best, smaller wind turbines can allow families and businesses to save money on their electricity bills and even sell any excess back to the national grid.

However the location of wind turbines is crucial. They should clearly be positioned in places which get a lot of wind, but this is not always the case. In built up areas, for example, they are unlikely to be effective unless they are on the top of tall, exposed buildings. Unfortunately, many turbines are being installed in areas where wind speeds are much too low to produce a useful level of energy return.

Groups of larger wind turbines in 'wind farms' offer the greatest potential and form part of the government's plans for increasing renewable energy generation. In December 2007, the Energy Minister, John Hutton, announced plans to build 7000 offshore wind turbines around Britain's coastline.

Photovoltaic cells

Photovoltaic cells, or PV's, produce electricity from sunlight, the most plentiful energy source on the planet. Even without direct sunlight some power can be generated. The necessary equipment has no moving parts and therefore requires minimal maintenance. Electricity is generated silently and without producing any greenhouse gas emissions.

Photograph: The Udall Legacy Bus Tour

As with wind turbines, there has been a huge increase in demand for PVs arranged as 'solar panels'. These systems can be installed either on existing buildings, or in place of conventional tiles on new buildings. They can also cater for all types of roofs and climate conditions.

Solar Thermal

Solar Thermal systems convert the sun's energy to heat, rather than electricity, which can be used to heat domestic hot water supplies.

These systems can complement other heating systems which store hot water in a cylinder. The technology is well developed and, according to the Energy Saving Trust, systems can provide around a third of the hot water requirements of a home [16]. This allows for substantial savings on heating costs, as well as environmental benefits.

Photograph: RJL20

Hydro power

Hydro power systems use running water to turn a turbine which produces electricity. Although it is clearly necessary to be close to flowing water, even a small stream can produce a useful amount of power. Supplies also tend to be more steady and reliable than other renewable energy sources.

System costs can be high but often less than a connection to the national grid, particularly in remote places.

Renewable Energy Options

Heat Pumps

Ground source heat pumps (also known as geothermal exchange pumps) involve buried ground 'loops' which transfer heat from the ground to provide water and space heating for buildings.

The ground loops contain a mixture of water and anti-freeze which is pumped around the system, absorbing heat from the ground. Electricity is needed to drive fluid around the system to achieve this transfer. In boreholes, they can be arranged vertically, or in trenches they can be arranged horizontally or in spirals.

The pump itself works in the same way as a fridge, extracting heat from the inside; however it makes use of this heat throughout the home. Heat is generally delivered to rooms via underfloor heating or radiators and can also help to heat tank water.

Ground source heat pumps are a good option where gas is not available and where they are replacing the use of more expensive electricity, oil, LPG or coal. However, they usually require plenty of space for burying the ground loops and their effectiveness also depends on the levels of insulation in the building they are servicing.

Air and water source heat pumps simply extract heat from air or water at the point of use. Air source pumps are fitted outside houses or in roof spaces and work better at higher temperatures. Water source pumps can be used when homes are near rivers, streams and lakes.

As well as heating buildings, heat pumps can also be used to cool buildings when the system is reversed and excess heat is transferred to the ground, air or water.

Biofuels

Biofuels (sometimes called biomass energy) usually use plant material to generate heat, electricity or power for vehicles and machinery. The sun's energy is captured by plants when they grow and can then be released, either by direct burning or after conversion to liquid fuels or gas.

Although burning biomass releases CO2, this is balanced by the capture of CO2 during the growth phase of the plants, over a relatively short period. Unlike fossil fuels, biofuels are therefore 'carbon neutral'. However, it is very important that the plant material comes from sustainable sources; the clearance of rainforests to produce biofuels in some parts of the world is deeply worrying because the trees cannot be replaced quickly or easily.

Biomass has long been used to provide energy for stand-alone wood burning stoves for space heating and cooking. Although modern, automatic-feed stoves require wood pellets, others can be fuelled by untreated logs.

In both commercial and domestic buildings, biomass can be used in heating systems, by fuelling biomass boilers. These can easily be installed in new buildings and in existing buildings they can often be fitted in the same position as a previous, conventional boiler. Fuel for the boilers comes in the form of wood chips, wood pellets or cereals

Biomass Boiler. Photograph: PRP Architects and produces heat for hot water and central heating. Modern systems are highly efficient and easy to maintain; the Energy Saving Trust suggests that an average boiler could save up to 8 tonnes of CO2 each year or £200 in energy bills [17].

However, biomass heating isn't suitable in all homes, particularly where there is a lack of space for storing the fuels or a lack of access to the boiler. The consideration of ventilation is also important and the Clean Air Act states that wood can only be burned in exempted appliances in many areas.

Planning Considerations

Proposals in 2007 Planning White Paper aim to put tackling climate change at the heart of building new communities. Plans 'must take account of the environment as well as setting out the sorts of development needed to help people live and work in the area[18].' Planning Policy Statement 1 (2005) also sets out the government's overarching planning polices on the delivery of sustainable development through the planning system[19].

Despite these developments, as well as specific targets for the reduction of CO2 emissions, it is not always easy to get planning permission for the most sustainable building designs and technologies. In particular, the look of certain microgeneration technologies, such as wind turbines and solar panels, can be a source of controversy; they often meet with opposition from significant numbers of the public. Many people also remain unconvinced about their long-term environmental and economic benefits. Local planning authorities can therefore be reluctant to approve plans for the most progressive sustainable options.

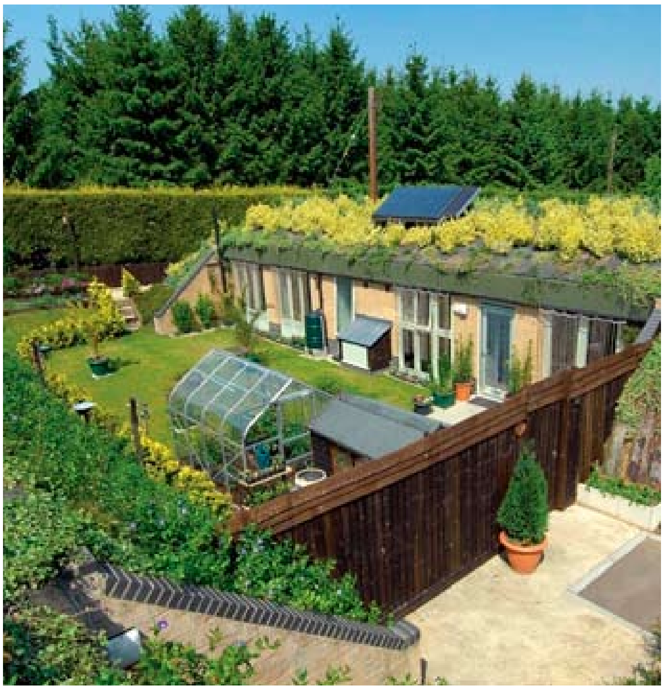
However, changes are expected in the near future. The recent Energy White Paper (May 2007)[20] proposes new measures which will allow wind farm (and nuclear power station) developments to be approved more quickly. Some minor home improvements, including the addition of small wind turbines, may no longer require separate planning permission at all. The Paper also refers to the current 'cost, delay and uncertainty created by the energy planning system and the impact on our energy policy goals'; in other words, complicated procedures for planning permission prevent progress towards the uptake of more sustainable building technologies.

Carbon trading

Carbon Trading has developed as a way of limiting CO2 emissions on a variety of scales. Schemes can operate between companies or on regional or global scales. The Kyoto Protocol involves the biggest scheme in existence today and the EU also has its own scheme.

Carbon trading works by giving companies, cities, regions or countries, a limited number of carbon credits; these represent the maximum amount of CO2 they are allowed to produce. Those who use less than their allowance are able to sell their excess credits to others; those who use more must buy additional credits from those who pollute less.

However such schemes are not without controversy. Critics question the ethics of effectively being able to pay to continue polluting.



Honingham Earth Sheltered Housing Scheme, Norfolk

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[1] BERR (2007), Climate Change/Energy [Online] Available at: http://www.berr.gov.uk/files/file37180.pdf. [Accessed: 22/10/07]
[2] BBC (2007), Methane [Online]. Available at: http://www.bbc.co.uk/climate/evidence/methane.shtml. [Accessed: 22/10/07]
[3] LEAD (Livestock, Environment and Development Initiative) (2006), Livestock's Long Shadow [Online]. Available at: http://www.virtualcentre.org/en/library/key_pub/longshad/A0701E00.htm [Accessed: 22/10/07]
[4] IPCC (2001), Third Assessment Report. IPCC, Geneva.
[5] United Press International (2006), China has its worst spell of acid rain. [Online]. Available at: http://www.upi.com/NewsTrack/Science/2006/09/22/china_has_its_worst_spell_of_acid_rain/7049/ [Accessed: 22/10/07]
[6] Mayor of London (no date) [Online]. Available at: http://www.london.gov.uk/mayor/environment/air_quality/business/biz_energy.jsp
[7] Low Energy Architecture Research Unit (2007), Transmittance or U Value [Online]. Available at: http://www.learn.londonmet.ac.uk/packages/clear/thermal/buildings/building_fabric/properties/transmittance.html [Accessed: 25/10/2007]
[8] Borough Council of King's Lynn and West Norfolk (2007), Building Regulation Approved Document L1B [Online]. Available at: http://www.west-norfolk.gov.uk/default.aspx?page=22863 [Accessed: 25/10/2007]
[9] Rockwool (2007) [Online]. Available at: http://www.rockwool.co.uk/sw58925.asp?csref=1in4_RW_home_GR [Accessed: 25/10/2007]
[10] Thermafleece (2007) [Online]. Available at: http://www.secondnatureuk.com/files/bba.pdf [Accessed: 25/10/2007]
[11] Green Building Store (2007) [Online]. Available at: http://www.greenbuildingstore.co.uk/ins-warmperf.php [Accessed: 25/10/2007]
[12] Energy Saving Trust (2007), Energy Saving Light Bulbs [Online]. Available at: http://www.energysavingtrust.org.uk/energy_saving_products/types_of_energy_saving_recommended_products/energy_saving_light_bulbs [Accessed: 03/09/2007]
[13] Energy Saving Trust (2007), Boilers and Heating Controls [Online]. Available at: http://www.energysavingtrust.org.uk/energy_saving_products/types_of_energy_saving_recommended_products/boilers_and_heating_controls [Accessed: 03/09/2007]
[14] Energy Saving Trust (2007), A Guide to Choosing Consumer Electronics [Online]. Available at: http://www.energysavingtrust.org.uk/energy_saving_products/a_guide_to_choosing_consumer_electronics [Accessed: 26/11/07]
[15] Energy Saving Trust (2007), Microwind [Online]. Available at: http://www.energysavingtrust.org.uk/generate_your_own_energy/types_of_renewables/microwind [Accessed: 25/10/2007]
[16] Energy Saving Trust (2007), Solar Water Heating [Online]. Available at: http://www.energysavingtrust.org.uk/generate_your_own_energy/types_of_renewables/solar_water_heating [Accessed: 25/10/2007]
[17] Energy Saving Trust (2007), Biomass [Online]. Available at: http://www.energysavingtrust.org.uk/generate_your_own_energy/types_of_renewables/biomass [Accessed: 25/10/2007]
[18] HM Government (2007), Planning for a Sustainable Future – White Paper. Crown, London.
[19] Planning Portal (2007), [Online]. Available at: http://www.planningportal.gov.uk/england/professionals/en/1020432883348.html [Accessed: 26/10/2007]
[20] DTI (2007), Meeting the Energy Challenge: A White Paper on Energy. Crown, London

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Plain English Guide to Sustainable Construction

Ben Stubbs

Section 5
Water

CONSTRUCTING EXCELLENCE
in the built environment

Water

With weather patterns becoming more unpredictable both in the UK and globally it is increasingly important to consider the conservation of clean, fresh supplies of water - not least in the design and use of buildings.

The huge industrial demands on water supplies are a growing cause for concern and the construction sector has particularly high requirements, especially in the manufacture of materials such as steel and concrete. Most construction activity needlessly uses clean, drinkable water supplies and there is no reason why many processes coudn't use water treated to less exacting standards. If such high consumption continues, we will face a future where water companies won't be able to guarantee continuity of supply through a dry summer.

Once a building is in use, demands for mains-supplied water can be a further major drain on resources. High density office buildings in urban areas, for example, often have very high requirements. Because of this, measures to limit water use, such as hosepipe bans, are likely to become much more common.

However, solutions for both commercial and domestic water savings are developing rapidly. Simple and efficient sanitary fittings have now been available for many years and some of them have become the 'standard' option on most building projects. In addition, building designers are now able to specify the use of water efficient construction materials, rainwater collection and storage devices, and 'grey' (recycled) water systems in their buildings.

Water-Efficient Construction

Construction site activities often place very high demands on water supplies. However, there are a number of measures which can be taken to minimise excessive water use. These include the following:

- Onsite water conservation awareness programmes.
- Monitoring of consumption, including the installation of submeters which can record water use in different areas or for different uses.
- Use of pressure reducing valves to reduce excessive flow in toilets, showers and canteens.
- Minimisation of leakage by using more durable service pipes.
- Leak detection tests followed by prompt repairs where necessary.
- Use of recycled or grey water for washing vehicles and other applications.

Flexible Plumbing Systems

Flexible plumbing systems are now becoming common in new homes and in the refurbishment of existing buildings. They generally use flexible plastic pipes together with a variety of advanced fittings.

These types of systems were originally designed for specialist uses – for example, where limited access or fire risk made it dangerous to use blow torches. However, their simplicity and versatility has led to widespread adoption across the UK.

User benefits also include silent running (they absorb and suppress sound), no corrosion or scale-up and better insulation. If the water freezes inside, the pipes are able to expand, reducing the chance of bursts.

Manufacturers highlight the durability of their products with some companies offering guarantees of up to 50 years. Consequently there is great potential for sustainability improvements in buildings. However, increases in the use of recycled content would be desirable.

Sanitary fittings

Sanitary fittings, in the form of low-flush and dual-flush toilets, waterless urinals and spray taps provide realistic, cost effective options for saving water in operational buildings. In addition, simple and cheap pressure/flow reduction devices can also provide water savings of up to 20%[1].

Toilet Facilities

Dual-Flush and Low-Flush Toilets are now very common in the UK; indeed they are an obvious way of complying with Water Supply Regulations. Dual-flush versions use different amounts of water for liquid and solid waste.

For existing toilets, retrofit devices can be fitted to reduce water use. These may simply reduce the amount of water in the cistern (i.e. to displace the water). Thames Water offers free '***Hippos***'; small plastic bags which are fitted in the toilet system to retain water each time you flush. It is also possible to modify flushing mechanisms to reduce flush volume.

In public toilets, the use of waterless urinals is becoming more common. The absence of flushing saves substantial volumes of water; there are also fewer moving parts to go wrong. Manufacturers claim that their systems are odour free, bacteria free, vandal resistant and require minimum maintenance.

Efficient Taps

Taps can save water by delivering it more efficiently or in a more controlled manner. Flow rates can be restricted or automatic shut-off mechanisms can be used.

Dual flush toilet flush Photograph: exfordy
Spray Tap Photograph: Storm Crystal International

Aerated taps limit the flow of water without reducing water pressure and can offer water savings of more than 50% compared to standard fittings. The most common types either introduce air into the water to soften the stream or include spray fittings which spread the water over a wider area; the latter are ideal for use in public toilets and are usually combined with automatic shut-off mechanisms. Aerated taps are generally not suitable where higher quantities of water are required quickly – when filling kettles or pans, for example. However, some versions can now act like a normal tap when deliberately turned on high.

In addition to these there are a variety of devices for use in public toilets which can sense when people are present and need water. These included foot-operated mechanisms and electronic sensors.

Efficient Showers

Inefficient showers can use more than 20 litres of water every minute whilst some modern alternatives use less than half this amount, while still offering the same level of performance. Compared to some power showers the savings are even greater. Reducing water quantities also means lower energy use because of reduced demands on heating systems and there are now systems which can even recycle the heat from waste water.

As with taps, automatic shut off devices can be used to regulate demand in public facilities such as gyms and swimming pools where water could otherwise be left running by some users.

In private homes, it is possible to use more sophisticated fittings such as aerated showerheads which mix air and water to deliver a powerful shower with a low flow rate.

Flow Controllers and Flow Limiting Devices

Flow restricting valves can be inserted into water supply pipes to reduce the flow of water. They can ensure the minimum necessary flow whilst also keeping the flow constant despite variations in pressure. In addition, such devices can be used to detect leaks and for water management purposes.

Water

Other Flow control devices include time controllers, which switch water on and off at specified times, and volume devices which turn off the water once a preset volume is reached. These are often used for taps and showers as described above.

Grey Water Recycling

Grey water recycling systems have great potential for water saving in buildings in use. They involve the treatment and reuse of water from bathroom and laundry facilities. This water can be used for flushing toilets, outside taps (for watering gardens) and some systems use it for washing machines. However, it is never clean enough to drink.

These systems are becoming more common and the costs are coming down, although they are still too expensive for many projects where budgets are limited. It is also more difficult to install grey water systems in existing buildings or where there is very limited space.

Rainwater Harvesting Systems

Rainwater harvesting involves the storage of rain from roofs, and other places from where it can be easily collected, for later use. It often involves the use of storage tanks but some systems are also used to top-up natural reserves of water in the ground (groundwater).

Rainwater filters can be fitted to downpipes or underground drainage pipes to get rid of leaves and other debris. Clean water is then stored in tanks and pumped to toilets, washing machines, garden taps or utility rooms when it is needed.

At their best, these systems can provide valuable extra supplies; this may become increasingly important in areas like the South-East of England where there is increased pressure on existing supplies.

Ecoplay grey water recycling system Photograph: PRP Architects

Eco-Vat rainwater harvesting system Photograph: Polypipe

However rainwater harvesting remains relatively rare, particularly in urban areas, and the potential impacts of keeping water from reaching drainage systems are not fully understood. Systems also have to be planned and designed at a very early stage of building projects so that suitable storage tanks can be installed. It is particularly difficult to fit them on existing buildings because a separate plumbing system is required to prevent the contamination of drinking water.

The cost of installation is also a barrier at the moment but this may well become less of an issue if the price of water rises significantly.

SUDS – Sustainable Urban Drainage Systems

Traditional urban drainage usually involves moving water from where it falls to drains and watercourses as quickly as possible. This can cause sudden rises in water levels and flow rates which, in turn, can cause flooding. It can also lead to increased pollution as oil and other toxic materials are quickly washed into rivers and streams.

As an alternative, SUDS aim to copy natural drainage patterns by using carefully selected surface materials and managing the flow of rainwater. They have the potential to reduce the impact of flooding on new and existing urban developments.

Unlike traditional storm water drainage systems, they can improve groundwater quality by effectively filtering rainfall; this can significantly reduce the impact of pollution. Sometimes, SUDS can also be successfully linked to rainwater harvesting systems.

Concrete paving blocks provide one solution for SUDS, and can be attractive as well as durable and cost effective. Water is able to flow between individual blocks and filter down into the soil below. Alternatively, porous concrete paving slabs allow rainwater to drain through the paved surface in a controlled way.

Some systems incorporate networks of tanks and pipes underground which capture water for non-potable purposes such as toilet flushing or watering gardens.

Semi-permeable paving Photograph: Thingermejig

Water

Water metering

Water meters work in the same way as gas and electricity meters. At the domestic level, they record the amount of water which is used for drinking, washing, flushing or watering the garden.

They can make a significant contribution to managing the demand for water and also raise awareness of how much water people are using, discouraging wasteful behaviour. Because people are charged for the amount of water they use, meters offer an opportunity to achieve cost savings. They can also have an impact on the type of water fittings and appliances people buy.

According to the Environment Agency, meters lead to a 5-15% reduction in household water use[2].

Currently, water meters are only installed in a limited range of circumstances (e.g. on request; for new buildings; following extensions/loft conversions; when people move home). However, the Environment Agency has called for regulations to help water companies install them more cost effectively in areas where water is scarce.

Leak detection and supply shut-off valves

Whilst the above developments all offer realistic ways of reducing water consumption, there is much greater potential in reducing the amount of water that is wasted through leakage. In the period to March 2006, Thames Water alone was losing 894 million litres of water per day according to the regulator, Ofwat. This was enough to fill 344 Olympic-sized swimming pools![3]

In the battle to conserve water supplies, a major effort is needed to fix these leaks as soon as possible. This must involve increased, consistent levels of investment in the repair and replacement of pipes, as well as much better ongoing leak detection.

Supply shut-off valves play a critical role in restricting water loss. Where leaks occur, it is important to be able to easily stop the flow of water so that water loss is minimised and repairs can easily be carried out. Shut off valves can control supplies to individual taps, whole houses, or even streets and wider areas.

Photograph: Alan Stanton

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Endnotes

[1] Institute of Structural Engineers (1999), Building for a Sustainable Future: Construction Without Depletion. SETO, London.

[2] Environment Agency (2007), Water Metering [Online]. Available at: http://www.environment-agency.gov.uk/subjects/waterres/286587/1466399/?lang=_e [Accessed: 26/10/2007]

[3] Hawkes, S (2007), Ofwat condemned over Thames Water [Online]. Available at: http://business.timesonline.co.uk/tol/business/industry_sectors/utilities/article1294526.ece [Accessed: 26/10/2007]

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Ben Stubbs

Section 6
Waste and Materials
(including modern methods of construction)

CONSTRUCTING EXCELLENCE
in the built environment

Waste and materials

The effects of construction activity on waste production are enormous. The industry produces 109m tonnes of construction waste each year (24% of total waste), of which up to 13% is delivered and unused[1]. It produces three times more waste than all UK households combined. Although around half of this waste is reused or recycled[2], the amount that is simply disposed of remains alarming.

Some of the main types of waste resulting from the construction process are as follows:

- Wood
- Concrete
- Brick and Block
- Asphalt
- Glass
- Paint
- Roofing Materials
- Tiles
- Insulation
- Plastic
- Lead Pipes
- Ferrous and Non-Ferrous Metals

Much of this waste is potentially hazardous and disposal should be carefully planned. However, whatever the nature and characteristics of the waste may be, it all has one thing in common: it represents a loss of resources, loss of money and reduced sustainability. In particular, traditional waste disposal, such as landfill and incineration, can cause serious environmental damage.

Landfill

Historically, landfill sites have been the most common method of organised waste disposal. According to a recent report by the Wates Group (2006), the UK construction industry sends 36 million tonnes of waste to landfill sites each year[3].

Potential environmental impacts are as follows:

- Leakage: this can lead to serious soil and groundwater contamination, sometimes long after a site is closed.
- Methane emissions where plant and animal waste is included. Methane is a powerful greenhouse gas.
- Odour problems.
- Damage to roads caused by heavy vehicles.
- Noise pollution from vehicles and machinery.
- Local air pollution, particularly in the form of dust.
- Nuisance and disease (e.g. from rats and flies).

Fly-tipped waste. Photograph: Alan Stanton

Incinerator chimney. Photograph: Jon W

Although most modern landfill sites have been able to address many of these problems, the capacity of existing sites is rapidly running out and concerns about long term risks still remain.

Landfill practices are changing because of the EU's Landfill Directive. In the UK this has prompted the introduction of the landfill tax which has risen significantly since its introduction. In 2008, the standard rates rise to £32/tonne for active and £2.50/tonne for inactive waste[4]. Landfilling is therefore becoming more and more expensive and alternative forms of disposal have become a high priority.

Fly-tipping of construction waste has risen sharply as a result of the landfill tax; this involves the illegal dumping of waste away from approved sites. However, the penalties for offenders can be serious, including high fines and even jail sentences. Police also have the powers to seize vehicles used for fly-tipping.

Incineration

Incineration provides an alternative to landfilling and involves the burning of waste at high temperatures. It can be used for standard waste, but is also the preferred option for the disposal of hazardous substances, such as poisons or those which have the potential to cause disease, because they can be totally destroyed.

The wide availability of landfill sites in the UK means that incineration technology has lagged behind the rest of Europe. However, the introduction of the landfill tax means that this is likely to change and the government expects incineration to play a much greater role.

Although modern incinerators are much less polluting than their predecessors, they still produce harmful gases such as CO_2, sulphur dioxide (which is responsible for acid rain) and dioxins which are seen as serious health hazards. Incineration also produces particles, which can cause a number of respiratory problems such as asthma, and even lung cancer. The ash may also contain toxic metals.

However incineration does have some advantages over landfilling:

- The resulting heat can sometimes be used in the production of electricity or for heating water in district heating systems.
- In some cases it is possible to store gas emissions in underground spaces.
- Modern incinerators can include 'materials separation' facilities, which remove hazardous or recyclable materials before burning.
- Fly-ash can be recycled for use in the production of concrete.

Waste Solutions

The Waste Hierarchy: Reduce, Reuse Recycle

Because the construction industry has traditionally produced such huge amounts of waste, radical improvements in the efficiency of procurement processes, resource use and waste management are required if progress towards greater sustainability can be made.

Options for waste management are often ranked according to their potential for sustainability benefits. This ranking is sometimes called the waste hierarchy and is set out below:

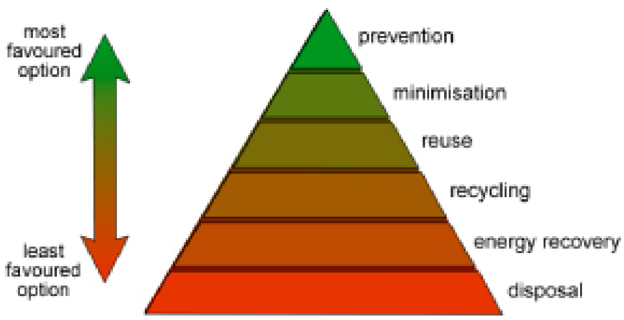


Image adapted from graphic by Sligo County Council.

Prevention

Take measures to prevent waste being created in the first place, perhaps by using Site Waste Management Plans (see below).

Reduce/minimisation

There is enormous scope for cutting down on waste in the construction industry simply by reducing the traditional over-ordering of materials. There is also scope for using materials more efficiently on site. These measures could dramatically reduce the amount of waste that is sent to landfill, as well as demands for virgin material.

Reuse

Where waste is produced unavoidably, the best solution is to reuse it without changing its form. A great deal of construction 'hardware', ranging from precast concrete slabs to individual fixtures and fittings, could simply be transferred for use on other jobs. Although this is a good option, it is not the most sustainable because of the energy required to move the material from one place to another.

Recycle

According to the Concrete Centre, 42 million tonnes of construction and demolition waste was recycled in the UK in 2001, an increase of 382% since the early 1990s. The use of recycled/secondary aggregates also increased by 94% between 1989 and 2002[5].

It is possible to recycle many types of construction and demolition waste. Rubble, for example, can be crushed and used as aggregate and to create new materials; waste wood can also be recovered and stripped for reuse or reprocessed. There is also potential for the recycling of various types of glass, metals and plastics.

Like reducing and reusing, recycling helps to protect the environment by decreasing the extraction of virgin material and waste sent to landfill. However, a great deal of energy may be required in the reprocessing of the materials, so this is not an ideal option for effective resource management.

Energy Recovery

Waste materials can be used directly in the generation of heat or electricity, often as part of the incineration process. They may also be used to create useable fuel such as methane, methanol or ethanol.

Disposal

Sending waste for landfill or incineration (without energy recovery) should be the least favoured option and should only be used when all the other options have been ruled out. The government's new Sustainable Construction Strategy is expected to aim for zero waste to landfill by 2020.

Despite the range of options already available for more sustainable waste management, putting an end to the traditional over-ordering of materials will require a significant cultural change, effective support from management and more concentrated planning efforts.

Waste Segregation

The first and most important step in managing waste is implementing effective waste segregation procedures.

Materials should ideally be divided between a number of dedicated skips. To help with this, the Institute of Civil Engineers has developed a colour coding scheme in collaboration with the Construction Confederation and the Scottish Waste Awareness Group (SWAG) (below)[6]. This is seen as important for raising waste awareness, improving waste separation, reducing landfill and providing cost savings.

Although waste segregation is much easier for larger organisations and on larger sites, even small projects can benefit from efficiencies by carefully considering how their waste is disposed of. Annual rises in landfill tax means that segregation for waste minimisation and recycling are not just a green option; they also make economic sense.

Site Waste Management Plans (SWMPs)

The introduction of Site Waste Management Plans is likely to have a positive effect on construction waste practices by providing a structure for organized waste management at all stages of a project's delivery. Although they have been voluntary, SWMPs are due to become a legal requirement for all construction projects over £200,000[7].

At their core the plans will include arrangements for monitoring and reporting on resource use including the type and quantity of waste. They will identify the individuals responsible for resource management, types of waste generated, resource management options and appropriate, licensed contractors.

SWMPs should provide a structured approach to management and recycling on site as well as reducing costs of waste management and increasing profit margins. They should also make it easier to comply with laws on materials and waste.

SWMPs should also help to prevent rising levels of waste crime including fly-tipping. Those responsible for the plans on-site will need

Metals (Blue)

Timber (Green)

Plasterboard (White)

Packaging – including plastics, cardboard and timber (Brown)

Inert (non-hazardous) Waste (Grey)

Hazardous Waste (Orange) – also includes graphics to show the nature of the hazard.

General Mixed Waste (Black)

to know where their waste is going, and that it is being managed by legitimate and responsible carriers; illegal operators should therefore be excluded from the process.

Waste management tools

The proposals for Site Waste Management Plans have prompted the development of a number of tools which aim to help in their operation. These range from mapping systems, which help in the location of the closest suitable waste disposal sites, through to comprehensive systems for comparing performance across sites, projects and contracts.

These systems generally involve setting performance targets in areas such as recycling and segregation of waste, followed by monitoring processes at various levels from individual sites to whole companies and partnerships.

SMARTStart is an example of one set of tools that allows waste targets to be monitored and adjusted throughout a project's lifetime to reflect changing conditions and markets. As a result, it should help maximise opportunities for waste minimisation, reuse and recycling.

CoRE: Construction Resource Efficiency

CoRE was set up under DEFRA's Business Resource Efficiency and Waste (BREW) programme. It is currently taking place in the East of England, London and the South East of England, because of the high levels of construction activity happening in these areas.

CoRE aims to help construction companies address the issues of the waste agenda. It provides opportunities for:

- obtaining access to the SMARTStart waste monitoring system, which enables benchmarking and analysis of waste disposal options and costs;
- supporting companies who wish to take their waste monitoring activities further; and
- accessing focussed support from programmes such as WRAP (Waste and Resources Action Programme), Envirowise and NISP

More information is available at: http://www.smartwaste.co.uk/core.jsp

Modern Methods of Construction (MMC)

MMC typically involves the manufacture of major building components off site in a specially designed factory; this is why it is often referred to as offsite manufacturing. The aim is to achieve maximum efficiency and minimum waste. However, sometimes it is more appropriate to do some of the work onsite where certain innovative methods are also described as MMC; these include the use of ready-mixed concrete which can be poured into moulds.

In all cases English Partnerships describes MMC as involving 'efficient project management processes, with a view to providing more product, of better quality, in less time.[8]' There are positive impacts in terms of site waste reduction, energy and water use, and in the reduction of commercial vehicle movements. The greatest benefits are achieved when the decision to use MMC is made at the early design stage.

MMC-type solutions are by no means new; prefabricated buildings were common after the two world wars as well as in the 1960's and 1980's. However, the quality was often poor during these periods and the perception that 'prefab' is inferior to traditional construction methods is proving hard to shake off, particularly in the housing sector.

Nevertheless, more recently there have been major improvements in the quality of MMC buildings and components. Today's MMC techniques can offer the following benefits:

- Faster construction and improved delivery times
- Fewer budget overruns
- Higher quality
- Less negative impact on the environment: reduced waste, vehicle movements, noise and dust (although statistics are lacking on some of these).
- Better health and safety
- Improved people management.

Photographs:
(R) Post-war prefabs, Catford, London. Photograph: Jon

Types of MMC (Taken from definitions adopted by the Housing Corporation[9])

Panels

These include ready-made walls, floors and roofs which are produced in a factory and transported to the site where they can be assembled quickly - often within a day. The most common panel systems are 'open panels' (or frames) which consist of a skeleton structure. Services, insulation, cladding and internal finishing are added onsite. However, some panels come in a finished form and may even include doors and windows; these are usually called 'closed 'panels' and can offer the fastest construction times.

Modular/Volumetric Construction

This involves the production of ready-made rooms which are also known as 'pods'. They can be combined together to form a whole building. Modules may be brought to site in a variety of forms ranging from basic structures to those with all internal and external finishes and services installed. A family house could be made up from as few as four modules plus roof module(s).

The Building Research Establishment (BRE) suggests that waste savings of up to 52% can be achieved using this type of construction, when compared to traditional methods[10].

Hybrid systems

These include a combination of the panels and modules. Typically, modules are used for rooms which require a large number of different services, and which are common to many different buildings – particularly kitchens and bathrooms. The rest of the dwelling is constructed using panels. Hybrid solutions add a degree of flexibility on complex sites. The amount of factory-based fabrication varies.

Modern Methods of Construction (MMC)

Sub-assemblies and components

MMC techniques are sometimes used for only part of a construction project. These typically cover components such as floor and roof cassettes, pre-cast concrete assemblies and wiring systems. Some more traditional manufactured units such as windows, doors and roof trusses can also be included in this category.

Materials for MMC

The innovative nature of MMC means that the types of materials being used are changing constantly. However, the materials discussed below cover the vast majority of current work within MMC.

Timber Frames and Panels

The timber frame is the 'original' modern method of construction and is a mainstream, low risk option for developers or housing associations interested in embracing MMC. For timber-framed systems BRE has calculated waste savings of 6-11% compared to traditional methods[11].

The level of pre-fabrication for timber frame systems ranges from simple open-frame wall panels and trussed rafters (or other roofing systems), to closed panel building systems comprising plasterboard, insulation, breather membranes, timber floor cassettes etc – in other words, all but the interior fit-out.

Wallboards can be manufactured in such a way as to remove the need for joints in the walls of the modules. This allows reduced assembly times and reduced waste.

Construction is generally rapid and light as well as very versatile in terms of aesthetic design requirements.

A panelised system can also significantly reduce the number of vehicle journeys required. Materials are generally approved by the FSC (Forest Stewardship Council) or PEFC (Programme for the Endorsement of Forest Certification) and the incorporation of high levels of insulation can dramatically cut CO_2 emissions.

Steel

The use of offsite steel frames affords all the benefits of other forms of MMC including faster construction, reduced site activity, fewer commercial vehicle movements and less waste (22% less waste according to BRE[12]). In addition it is particularly suitable on confined sites with limited working and storage space.

Of particular note are the significant developments in the use of light gauge steel. For residential buildings, light steel framing systems allow rapid, dry site construction, providing a stable structure and high levels of insulation and air-tightness. They also have the potential to reduce onsite labour costs.

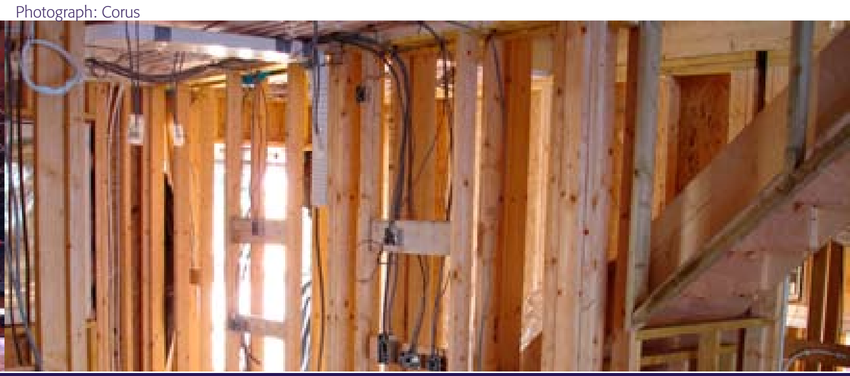
The development of high performance, coated, steel cladding systems has encouraged the greater application of what were once industrial forms of construction to areas such as retail and leisure facilities.

However, the biggest market for steel in MMC is in cladding for single-storey structures used for industrial and out-of-town retail type developments. New products for such applications can even go beyond the insulation requirements of Buildings Regulations.

The development of offsite manufacture for all types of steel construction, particularly in modular forms, has led to better quality, increased efficiency and fewer defects. It has therefore contributed to environmental protection by minimising the impact of operations and

Photograph: Alan Conisbee and Associates

Photograph: Corus



products. Steel can also be recycled infinitely without degradation of properties or performance; recovery rates are currently 84% for recycling and 10% for reuse from UK demolition sites[13].

Aluminium

Strength, weight and versatility make this an ideal material for building and cladding. Its resistance to corrosion also helps cut down on maintenance costs.

As well as cladding, typical applications include windows, skylights, weather-proofing, doors, screens, gutters, down spouts, hardware, canopies etc. In addition, solar technologies can also be inserted into aluminium frames providing energy saving potential and, therefore, environmental benefits. Aluminium products also have useful thermal insulation properties and, like steel, can be recycled repeatedly and economically.

Concrete

Concrete is used for a variety of MMC applications including masonry (i.e. precast flat panel systems), paving, insulation and tunnel form (where a structural tunnel is created by pouring concrete into steel formwork to make the floor and walls).

Precast concrete units can provide a safe, cost effective, higher quality and more sustainable alternative to traditional solutions such as in-situ concrete pouring. Although the use of precast technology dates back to Roman times, modern uses include a variety of architectural applications including free-standing walls used for landscaping, soundproofing and security walls. Precast architectural panels are also used to clad all or part of building facades. Modern stormwater drainage, water and sewage pipes and tunnels make use of precast concrete units.

Typically a high strength concrete is used and the process takes place in a purpose-built facility. Ideally this should be as close as possible to the site for maximum convenience and efficiency, and minimal cost and waste.

A controlled factory environment means it should be possible to achieve zero waste, and problems caused by weather/temperature affecting the setting properties of concrete can be completely avoided. In addition, it is possible to use a high proportion of recycled material in precast units.

Where factory production is inappropriate, ready-mixed concrete can be made under near factory controlled conditions offering assured quality, exact quantities and minimal waste.

Integrating materials

One of the main advantages of using off-site manufacturing is the possibility of incorporating numerous materials on the factory floor; this is the case with prefabricated wall, roof and floor cassettes which incorporate electrical wiring, hardware, insulation and more. It is better, therefore, to consider how each material can complement the others and contribute to faster, more efficient and more sustainable construction practices.

Photograph: Concrete Centre

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(Endnotes)

[1] DEFRA 2007, Consultation on Site Waste Management Plans for the Construction Industry, Crown 2007. [Online]. Available: http://www.defra.gov.uk/corporate/consult/construction-sitewaste/consultation.pdf [Accessed: 18/10/2007].

[2] WRAP 2007, Waste Management. [Online]. Available: http://www.wrap.org.uk/construction/construction_waste_minimisation_and_management/waste_management.html [Accessed: 18/10/2007].

[3] Wates Group 2006, Target: Zero. [Online]. Available at: http://www.wates.co.uk/uploads/pdfs/Corporate%20Responsibililty/Target%20Zero%20Landfil%20Report.pdf [Accessed: 26/10/2007].

[4] SITA 2007, Landfill Tax. [Online]. Available at: http://www.sita.co.uk/what-we-do/landfill/landfill-tax [Accessed: 30/10/07]

[5] Concrete Centre 2007, Recycling. [Online]. Available at: http://www.concretecentre.com/main.asp?page=137 [Accessed: 30/10/2007]

[6] Waste Aware Scotland 2005. Scottish Construction Industry Gets an Injection of Colour. [Online]. Available at: http://www.wasteawarescotland.org.uk/html/NewsArticle.asp?NewsID=94&AreaID=&TypeID=&wsa=&Archive=2005&AreaName=&tName=&sWord=&showAll=&PageIndex=5 [Accessed: 10/12/2007]

[7] Envirowise 2007, Site Waste Management Plans. [Online]. Available at: http://www.wasteaware-construction.org.uk/colour.asp [Accessed: 30/10/2007]

[8] English Partnerships 2007, Modern Methods of Construction. [Online]. Available at: http://www.englishpartnerships.co.uk/mmc.htm [Accessed: 30/10/2007]

[9] CABE [no date], Design and Modern Methods of Construction. [Online]. Available at: http://www.housingcorp.gov.uk/upload/pdf/MMC_full_report.pdf [Accessed: 30/10/2007]

[10] Gaze, C (2007), How Big it the Impact of MMC? Presented at: Procuring for Sustainable Construction: An Industry-Wide Perspective, Institute of Structural Engineers, London.

[11] Ibid. [12] Ibid.

[13] The Steel Construction Institute [no date], Sustainable Steel Construction: Building a Better Future.[Online]. Available at: http://www.steel-sci.org/NR/rdonlyres/12A3E33E-C13D-40FB-9B7D-57B93BC7BAAE/2896/SSC.pdf [Accessed: 30/10/2007]

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Plain English Guide to Sustainable Construction

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Section 7 Natural Resources and Conservation

CONSTRUCTING EXCELLENCE
in the built environment

Natural Resources and Conservation

All construction activity has the potential to impact on natural habitats and the established built environment. The related noise, pollution and changes in land use all have the potential to be extremely damaging. Animal and plant species, for example, may be displaced or unable to survive at all as their surroundings change. The appearance and function of existing buildings, and the communities in which they operate, can also be damaged without proper planning considerations. Away from the building sites themselves, the intensive production of resources for the industry also has a huge effect.

The industry therefore has a critical role to play in protecting plants and animals, and the natural systems they live in, as well as our built heritage. Creating, enhancing or at least conserving wildlife habitats and human communities should be a priority on all projects.

Biodiversity and Habitat Loss

Biodiversity is the variation of plant and animal life which occurs in a given area. It includes all the different plant, animal, fungus and micro-organism species, the genes they contain, and the living systems (ecosystems) they are part of. A high level of biodiversity is not only desirable for a pleasant environment, but also essential for the maintenance of living systems. For the construction industry, it also ensures a variety of natural building materials.

The scale of modern construction activities means that they can have major impacts on a range of plants and animals, and therefore biodiversity. This could be due to the scale of projects, the size of machinery used or the transformation of the land. The balance of established natural systems can be upset and they may not be able to continue functioning in the same way.

The result of deforestation

On greenfield sites (previously undeveloped/left to nature and agriculture) construction work can alter natural habitats to such an extent that local species are left homeless. They may be deprived of territory, privacy, food and peace.

Work on brownfield sites (previously developed/occupied by another building or structure) can also have a huge impact on the animals that occupy buildings and grounds, and the plants that have established themselves in the surrounding area.

Construction can even have an impact on biodiversity away from the sites themselves. In the areas nearby, this can include air and water pollution, changes to the flow of rivers and streams, and greater risks of vandalism, fires and fly-tipping. Adjoining building developments and activities can also cause damage.

One example of impacts that may occur far away from construction sites is deforestation which, in many regions, is caused by the demand for wood for construction. It involves the removal of trees without replacing them and has a dramatic effect on biodiversity, not just because of the loss of the trees, but also because of the effects on all the other dependent wildlife. Although an increasing number of UK construction projects now specify wood from sustainable sources, it is still possible to get supplies which come from forests that aren't well managed and may even be illegal (see section eight - Procurement).

The industry's heavy reliance on mining and quarrying can also be particularly damaging. These activities cause direct habitat destruction and changes in landform, as well as noise, dust and other pollution.

Practical Wildlife Conservation

Measures to protect the natural environment should be built in to the construction planning process from the early design and planning stage. Planners and developers should aim to minimise the impacts of their projects on plants and animals. Where possible, they should also improve the habitats within and surrounding their sites.

An increased emphasis on corporate social responsibility means that it is important and beneficial for construction companies to consider their effect on the natural environment on a number of scales, at the local level and beyond.

Whilst some conservation measures are a legal requirement, there are also a number of simple and relatively inexpensive ways that work on and around construction sites can include the preservation and improvement of natural resources. Some of these are as follows:

Providing shelter for animals and birds such as installing bat-boxes.

- Avoiding work during mating or hatching seasons.
- Restoring and enhancing habitats as far as possible when construction is finished or in adjacent areas.
- Relocating plants and animals to similar areas if absolutely necessary.
- Where possible, implementing an ongoing landscape management plan for the site and monitoring any potential problems.
- Implementing a site waste management plan to minimise traffic movements, and potential pollution.
- Protecting established trees and enhancing wooded areas.

However, in certain cases, more complex measures may be necessary as follows:

- Re-routing roads to avoid sensitive habitats.
- Providing tunnels to avoid barriers to movement as well as preventing road kill.

Photograph: Highways Agency

Natural Resources and Conservation

Dealing with Protected Species

Some plants and animals are particularly vulnerable to construction activities because they are sensitive to changes in their environment and/or because there are few of them left.

Bats, for example, have very precise habitat requirements. Some prefer specific types of trees; others like to live inside roofs or loft spaces. A number of UK species are also extremely rare. The removal of trees, or even the simple refurbishment of an existing building, can completely wipe out a local population or, in extreme cases, bring a species close to extinction. The disturbance or destruction of bat habitats is illegal and can carry stiff penalties.

As well as being a rich source of plantlife, hedges and trees are essential in providing habitat and shelter for a variety of animals, birds and insects. It is particularly important to be aware of nesting birds during the spring, when they are legally protected from any form of disturbance.

The presence of vulnerable wildlife on sites is often missed until projects are well underway. This can lead to delays, potential conflict and inconvenience for all involved, not least because of the big increase in legislation on protected species over the last few years. Financial penalties for disturbing, injuring or killing some plants and animals can be very high and in some cases prison sentences are a possibility. Prosecution can also prompt a great deal of damaging publicity.

There a number of extra measures that should be taken to ensure protected species are properly taken into account on or around construction sites:

- Carry out an ecological survey as early as possible, specifically checking for the presence of protected species.
- Commission expert advice if any endangered species are found.
- Modify project plans if any endangered species are likely to be disturbed.
- Provide alternative habitat if appropriate.
- Ensure access and supply of water sources.
- Make sure that access routes are not blocked.
- Avoid the use of heavy machinery close to habitats or breeding areas.
- Store potentially dangerous chemicals in secure locations to avoid leaks or fires.
- Monitor carefully during the project, and even after it is complete.
- Identify sensitive trees and those which provide habitats for other species.

The cost of these measures may well be small compared those of dealing with local pressure groups or paying fines. Killing great crested newts, for example, can lead to fines of up to £5000 per newt and up to six months in prison!

Great Crested Newt

Giant Hogweed Flower. Photograph: Helena Proof

Japanese Knotweed. Photograph: LoopZilla

Moving plants or animals out of the way of developments is generally not a practical or desirable solution; often it is expressly forbidden. Indeed, in extreme cases where protected species could be seriously threatened, it may even be necessary to abandon development plans and find an alternative site.

A full list of European protected species is available on DEFRA's website. The Environment Agency is responsible for enforcing the law on protected species through a variety of measures which can include heavy fines.

Invasive Weeds

As well as protecting habitats and species, some plant life needs to be controlled or destroyed. Species such as Giant Hogweed and Japanese Knotweed can quickly grow out of control, killing off native plants and reducing biodiversity. Knotweed can penetrate walls, roads, foundations and drains, causing serious damage. It is illegal to 'plant or otherwise encourage' the growth of these plants.

Environmental Impact Assessments (also SEA and Sustainability Appraisals)

Environmental Impact Assessment (EIA) involves the organised measurement of how projects are likely to have an effect on natural and man-made environments; they aim to balance the need for development with environmental sustainability.

EIA was brought in as a response to a European Union directive and raises the profile of environmental concerns in both the planning and operational phases of construction projects.

Projects which always require EIA include large scale developments with potentially far-reaching impacts: for example, chemical works and waste disposal installations. However, a variety of projects which could have 'significant environmental effects' must also be assessed. These are selected according to their size, the type of development and whether or not they are located in a 'sensitive' area. They include a range of industrial and infrastructure developments.

More recently, SEA (Strategic Environmental Assessment) directive has been introduced to cover many plans and programmes which are prepared or adopted by national, regional or local authorities or those adopted by parliament or government. The plan or programme should influence the future development consents of projects affected by EIA.

Sustainability Appraisals, which have an even broader focus, aim to promote sustainable development through the incorporation of social, environmental and economic considerations into the preparation of revisions of Regional Spatial Strategies (RSS) and for new or revised Development Plan Documents (DPD) and Supplementary Planning Documents (SPD).

Building Conservation

Whilst it is important to consider the effect of construction activities on the natural environment, conservation measures should also take into account the established built environment.

Royal Crescent, Bath Photograph: Rob Ball

Natural Resources and Conservation

The aims of building conservation and sustainability are often closely linked; the use of natural, renewable, recyclable and breathable products with low embodied energy is common in both.

Why preserve buildings?

Although the consideration of sustainability in existing buildings is often seen as more problematic, the preservation of their fabric and character is desirable and can have environmental, economic and social benefits.

Older buildings were not always designed to fit in with modern ideas of sustainability. However, they often have clear advantages when compared to some modern equivalents and can provide valuable lessons for designers and builders. Some of these advantages are as follows:

Durability:

The age of some of the buildings in the UK is living proof of the durability of many of the materials and construction techniques that were used. Today, such buildings regularly provide valuable examples for designers and builders involved in trying to create modern sustainable buildings.

Local materials:

Traditional buildings were generally built from whatever materials were available locally. Even bricks were made locally. For many construction projects, suitable local materials are still available but may be excluded because of the costs involved. However, where they can be used, this cuts down on vehicle miles and pollution as well as supporting local businesses.

Natural materials:

Materials used in the construction of older buildings generally came from natural sources, avoiding the need for energy-intensive mechanical processes. These lower levels of embodied energy translate directly into lower levels of pollution and carbon emissions.

Gold Hill, Shaftesbury Photograph: John Worsley

Character:

Buildings which are subject to conservation measures are often valued for their 'character'. Although they don't necessarily reflect the living conditions at the time they were built, their modern-day desirability makes them popular as living and working spaces.

Habitat:

Many older buildings provide unique habitats for a variety of wildlife.

Energy efficiency:

Although older buildings can present problems in terms of modern energy use, designing for energy efficiency is not a new idea. Many older buildings were built to be south-facing and north walls were often left with minimal windows to conserve heat. Solid walls also provided good levels of thermal mass (see section 4 on Energy, Pollution and Climate Change) and thatched roofs provided extra insulation.

Whilst there are many ways to improve the energy efficiency and overall sustainability of older buildings in the UK, it is also important to consider this within the context of their durability. Modern materials and techniques may offer much greater efficiency for buildings in use, but their production can involve much greater levels of energy use, pollution and waste. It is worth considering the relative benefits of repairing, reusing, preserving or enhancing what's already there rather than replacing it altogether.

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Front cover photograph: recursion see recursion. Page 1: Catherine Trigg. Page 5: Hedgerow phtograph, Myrrien.

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Section 8
Procurement Solutions

CONSTRUCTING EXCELLENCE
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Procurement Solutions

The procurement of goods, services and buildings has traditionally been based on two overriding considerations: price and quality. However, the choices people make about what they buy and how they buy it can have a huge impact on all aspects of sustainable development. It is also becoming increasingly important for successful private businesses and public organis ations to demonstrate their commitment to sustainable development by buying more sustainable options.

Sustainable procurement isn't just a question of choosing the most environmentally friendly products. It is about achieving the best possible value for money over the long term and should include economic and social, as well as environmental, considerations. As such, decisions on sustainable procurement can have much wider benefits than might be expected. Using recycled materials, for example, reduces the amount of waste which goes to landfill, and therefore methane emissions. It also conserves resources, reduces CO_2 emissions and cuts costs. In addition, there are related social and community benefits (see section nine).

One of the key barriers to more sustainable procurement is the belief that it will always cost more. However, this is certainly not always true. In many cases costs can actually be cut by reducing waste, increasing resource efficiency and promoting innovative new products.

The concept of sustainable procurement has generally been associated with government policy and, as such, many of the developments on the subject have been concerned with government activities. However, most of thinking involved applies equally to the private sector.

In June 2006, the government published 'The National Action Plan: Procuring the Future'. It aims to deliver sustainable procurement, to stimulate innovation through public procurement and to complement and build on existing activity on the subject. It clearly explains how public spending can be used to combat climate change as well as promoting social progress.

Procurement Guides

Procurement guides can help designers, builders and buyers make informed decisions about which products are most suitable for their project. In terms of sustainability, this often involves selecting the 'greenest' options, those which offer the best value for money or those which are widely accepted by consumers.

A number of organisations have produced procurement guides which are specific to their own businesses; these include the NHS, Crown Prosecution Service and Local Authorities. Others provide guidance on specific products; WRAP (Waste and Resources Action Programme), for example, has provided a specific set of guides giving advice and best practice on procuring paper with recycled content.

However, many businesses are still lacking clear, simple, comprehensive guidance. Some of the standard guides which are currently available are outlined below.

The Green Guide

The Green Guide to Specification, which is produced by the Building Research Establishment (BRE), gives environmental rankings to individual products based on Life Cycle Assessment (See section 10 – 'Measuring Sustainability'). It aims to be a quick and easy way for designers and specifiers to assess product options. Materials and components are arranged by type (ie. external walls, internal walls, floors etc) so that it is possible to easily select from comparable products. Environmental performance is indicated by a simple A-B-C rating system and is accompanied by information on costs, replacement intervals and recycling for each material and component.

Greenspec

Greenspec is an alternative construction industry guide to 'green' building design, products, specification and construction. It contains information on how to design more energy and resource efficient buildings, using materials and technologies that minimise damage to people and the environment.

The Greenspec checklist system involves a step-by-step process highlighting areas where sustainable construction best practice can be applied.

WRAP Recycle Content Guide

WRAP (Waste Resource Action Programme) has developed an online, downloadable recycled content guide which helps source construction products with recycled content. It provides details of a range of products and materials commonly used in new build and refurbishment projects and helps identify how to increase recycled content. The guide is aimed at a range of construction professionals.

Government Procurement Guides

The government has produced various procurement guides which are aimed broadly at the public sector. However, much of what they have to say applies to projects in all sectors. They can therefore be useful in helping project managers to consider the most sustainable options.

'Quick Wins'

A government sustainable procurement group was established in 2001 and identified certain product areas in which immediate environmental benefits could be achieved. Known as 'Quick Wins', products include office supplies, lighting and refrigeration systems, boilers and white goods. It also covers consumables such as tissue paper, light bulbs, detergents, paints and varnishes.

Achieving Excellence in Construction Procurement Guide – No. 11: Sustainability (Office of Government Commerce)

The Achieving Excellence procurement guides reflect developments in construction procurement over recent years. Number 11 highlights the importance of sustainable development. It sets out the ways in which the public sector can procure and deliver construction projects that promote sustainable development as well as delivering value for money.

The guide covers issues which should be considered at all key decision making stages, from preparing the business to operating and decommissioning buildings. The main focus is on the key social, economic and environmental factors that should be addressed throughout the procurement lifecycle. Tables in each section set out the major issues that need to be considered at each stage and give links to further information.

Certification and Labelling Systems

Environmental labelling can be particularly helpful in raising awareness of key issues as well as creating a market for environmentally friendly products and buildings. It is the simplest way of getting information across to consumers. Although most schemes are voluntary at present, their proven track record in Europe, particularly in Germany, shows that widespread adoption is valuable.

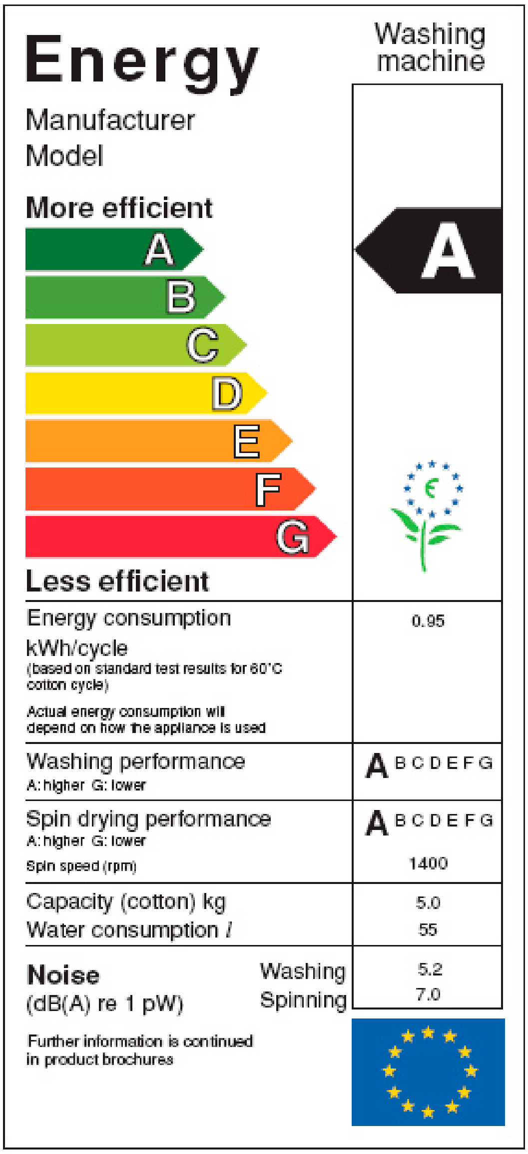
There are now green labelling schemes for a huge number of products and different types of environmental impacts. Good schemes provide an effective way for companies to show that their products have achieved demanding environmental standards. There are also schemes which focus on ethical, social or agricultural themes, but also have implications for the environment.

Many schemes focus on a logo or symbol which consumers can easily identify. One example is the European Ecolabel which uses a flower logo to indicate that products meet the standards of the scheme (See section 4 – 'Energy, Pollution and Climate Change'). Others set out more detailed data which allows consumers to make easy comparisons between the products they are buying.

Procurement Solutions

However, the recent increase in the number of schemes and duplication of the areas they cover can cause confusion and consumers don't necessarily know which of them can be trusted. In addition, it isn't always easy to trace the source of many 'certified products'. This seems to suggest a pressing need for a more standardised approach.

DEFRA provides a list of labelling schemes, and what they cover, at: http://www.defra.gov.uk/environment/consumerprod/glc/pdf/greenlabels-index.pdf



An example of an energy efficiency label including the European Ecolabel logo.

Sustainable timber supplies

An increasing global concern about the destruction of rainforests has been a key driver in the move towards more sustainable timber sourcing. Trees from sustainable sources are constantly replaced to maintain their numbers at the same levels or greater. In other words, there is a balance between the demands for forest products and the preservation of forest health and diversity.

The heavy use of timber in construction means that the industry has a clear role to play in promoting this balance. For government and modern businesses, it is particularly important to be seen to be using only the most sustainable timber sources. Otherwise, there can be unwanted attention from pressure groups and damaging negative publicity.

The Forestry Stewardship Council (FSC) is one of the best-known international networks for promoting responsible management of the world's forests and providing certification of sustainable forest products. It sets international standards for forest management and provides a label for products which is recognised worldwide.

It also runs marketing programmes and information services to promote responsible forestry. Over the past 13 years the FSC has certified over 90 million hectares in more than 82 countries.

The Programme for the Endorsement of Forest Certification Schemes (PEFC) is an alternative to the FSC. It helps the standardisation process by acting as an umbrella organisation for the assessment and recognition of national forest certification schemes. According to their website they have assessed 22 independent schemes which account for 196 million hectares of certified forests worldwide.

However, the growing number of certification systems can cause confusion. Those involved with timber procurement should always ensure that they can track products from the point of sale back to the forest they came from; in other words, they should have a reliable 'chain of custody'.

Increasing the Sustainability of Concrete

Of all construction materials, concrete is one of the largest consumers of energy and materials. However, there are now a number of ways of making concrete 'more sustainable' and reducing its environmental impact. Some examples are given below.

Environmental damage can also be minimised in cement manufacturing through the use of waste from other industries. This might include slag from steel manufacturing, fly ash from coal burning, and silica fume from silicon manufacturing.

The recycling of concrete after demolition work is also becoming increasingly common, with much less being sent to landfill. Pieces of concrete can be crushed along with asphalt, bricks and rocks to produce gravel for new construction or aggregate for the foundations of roads. The purest crushed concrete can even be used in new concrete products, but only if it is completely free of contaminants.

The use of precast concrete, which is manufactured under factory conditions before being transported to site and lifted into place, cuts down significantly on waste. It is also of higher quality and cheaper than standard options. Roman builders used precast concrete in moulds for different parts of their complex infrastructure network. Modern uses include ready-made walls for all parts of buildings, panels for building façades, drainage systems and tunnels.

Some concrete alternatives utilise dried plant material as an ingredient. 'Industrial Hemp' for example can be combined with a lime based binder which can even have a negative carbon footprint[1]. The plant material absorbs carbon in its growing phase and the carbon emissions from the lime binder are minimal. There is much less embodied energy in products of this type and the carbon is 'locked up' for the lifetime of the building they form a part of.

Photograph: Concrete Centre

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in the built environment

Plain English Guide to Sustainable Construction

1 - The Need for Plain English

2 - Construction and Sustainable Development

3 – Who is responsible for sustainable construction?

4 – Energy, Pollution and Climate Change

5 -Water

6 - Waste and Materials (Including Modern Methods of Construction)

7 - Natural Resources and Conservation

8 – Procurement Solutions

9 – Social Aspects of Sustainable Construction

10 – Measuring Sustainability in the Construction Industry

Endnotes

[1]Tradical 2007, [Online]. Available at: http://www.lhoist.co.uk/tradical/hemp-lime.html [Accessed: 30/10/2007]

Front cover photograph: Thingemejig. Page 1: Thingemejig. Page 4: Claire L. Evans.

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Section 9 Social Aspects of Sustainable Construction

CONSTRUCTING EXCELLENCE in the built environment

Social Aspects of Sustainable Construction


Grange Primary School, Newham Photograph: PRP Architects

Social aspects are often missed out of the construction industry's considerations of sustainability despite the important effect that they have on long-term value for money and the well-being of building occupants.

Planning, design, population levels and layout all have an influence on how communities function and their overall success. For new developments, these factors should be carefully considered at the earliest possible stage to ensure a well managed and maintained infrastructure, healthy social networks and good overall community organisation.

At the level of individual buildings, well thought out internal building plans offer clear advantages. In offices, for example, the well planned use of space including wide open corridors, open plan work areas, calming colour schemes and thoughtful use of natural light can promote a sense of well being and raise productivity. However, all this has to be achieved within a commercial context.

The background to social sustainability in the UK

UK Sustainable Development Strategy

The government's Sustainable Development Strategy identifies a 'strong, healthy and just society' as one of the five sustainable development goals. The strategy talks about 'meeting the diverse needs of people in existing and future communities promoting personal wellbeing, social cohesion and inclusion, providing employment, and creating equal opportunity for all'.


Artist's Impression: Cross Street South, Birmingham. Photograph: Bromford Housing Group

Sustainable Communities Plan

The Sustainable Communities Plan, launched in 2003, explains that communities will only be sustainable if they are fully inclusive and if basic minimum standards of public services are delivered.

> *"Sustainable communities require good quality local public services, including good public and private transport links, education and training opportunities, healthcare, sports and community facilities. Communities need easy access to a varied range of these services, and these need to be provided holistically and, in the case of a new development, at the same time as the housing is being built."*

- 'Building Houses or Creating Communities' – Sustainable Development Commission

Section 106 Planning Obligations

Planning obligations created under section 106 of the Town and Country Planning Act (1990) include the essential principle that developments should pay for supporting social and physical infrastructure[2]. In other words, developers are expected to contribute to limiting the social impact of their own projects on the local area or balancing those impacts by providing new facilities. Requirements vary according to the size, impact and nature of proposed developments.

Some of the schemes on which contributions may be spent include community meeting spaces, open spaces, play areas and leisure facilities.

Social Impacts of Construction

In addition to the environmental and economic impacts of construction, there can also be major social impacts. The built environment has an enormous effect on the quality of life of the communities that use it.

Some of the tower blocks which were rapidly built in the 1960's, together with poor building/estate management, are now widely seen as the root of serious social problems. Community issues have included low levels of well-being, increased depression and high levels of crime. Developments like these didn't properly consider the requirements of the communities involved.

New developments should be able to learn the lessons of the past to improve the quality of life of their future residents but this is not always the case. Unfortunately, financial considerations mean that design quality is still compromised by some developers, even though the case for good design has been made over and over again.

The social impacts of construction start early in the construction phase and continue for as long as the structures remain standing. Some of the most common potential problems are outlined below.

The Construction Process

Even relatively small-scale construction work can have a dramatic impact on surrounding communities. Disruption caused during the construction process can include the following:

Noise pollution

This is largely caused by construction vehicles and a variety of onsite machinery. Noise can have a major impact on the stress levels of surrounding residents, and knock-on effects for health and well-being.

Increased vehicle movements

Construction activity may involve increases in the number and size of vehicles near to sites. This can cause serious congestion problems, particularly where access roads are unsuitable for construction vehicles. It is also likely to increase local delays, inconvenience and stress.

The Bristol Accord

In December 2005, during the UK presidency of the EU, ministers from member states met in Bristol to discuss and agree the benefits of creating sustainable communities across Europe. The 'Bristol Accord', which they were asked to endorse, included eight characteristics of a sustainable community and a commitment to sharing good practice on case studies[1].

The eight characteristics are as follows:

1. Well Run: With effective and inclusive participation, representation and leadership.
2. Well Connected: With good transport services and communication linking people to jobs, schools, health and other services.
3. Well Served: With public, private, community and voluntary services that are appropriate to people's needs and accessible to all.
4. Environmentally Sensitive: Providing places for people that are considerate of the environment.
5. Thriving: With a flourishing and diverse local community.
6. Well designed and built: Featuring quality built and natural environment.
7. Fair for everyone: Including those in other communities, now and in the future.
8. Active, inclusive and safe: Fair, tolerant and cohesive with a strong local culture and other shared community activities.

Ministers agreed the importance of fostering skills for successful place making and the value of cooperative activity on this theme across member states.

Dust and local air pollution

Construction work, particularly demolition, generates dust which can spread well beyond construction sites. There is also increased local air pollution from exhaust emissions. In some cases, these types of pollution have the potential to cause a variety of respiratory problems.

Social Aspects of Sustainable Construction

Cardinal Place, London. Photograph: Concrete Centre

Visual 'eyesores'

Building work often has a negative visual impact on the communities in which it takes place because of the waste, dirt, scaffolding, hoardings and heavy machinery involved. This can have a knock-on effect of reducing levels of well-being and community pride; it may also encourage anti-social behaviour.

Health and safety

Construction projects have major health and safety implications, not only for onsite workers, but also for surrounding residents. However, simple measures can be taken to secure sites, dangerous materials and machinery.

Buildings in use

Once buildings and other structures have been completed, they continue to have an impact on occupants and surrounding communities throughout their lifetime. Poor planning, design and maintenance can be the source of a number of related problems:

Crime levels

If developments are badly planned, they can divide communities, rather than uniting them. Anti-social behaviour, such as vandalism, may become deep-rooted. In the worst cases urban ghettos may develop, where drugs and violent crime are commonplace.

Photograph: HBG UK Ltd

Depression

The effects of living and working environments on levels of well-being should not be underestimated. Unattractive and unwelcoming buildings and developments can have a significant impact on the mental health of those who live and work in them.

Illnesses and low levels of productivity

Occupants of poorly designed or maintained buildings are much more likely to suffer from illnesses than those who live and work in more pleasant environments. Poor workplaces have effects on both physical and mental health, potentially leading to aggression, hypertension and stress; in turn, these can lead to a number of more serious problems.

On the other hand, buildings which are planned to provide a better working environment are much more likely to have higher levels of staff productivity and lower levels of absenteeism.

Good internal air quality is particularly important; improvements in the air tightness of buildings have had a dramatic effect in reducing heat loss but these need to be carefully balanced with appropriate ventilation strategies to avoid increases in condensation and, therefore, asthma and allergies.

The choice of materials can also have direct health consequences: choosing hard flooring and blinds rather than carpets and curtains, for example, will help to reduce problems for allergy sufferers.

Secured by Design

Secured by Design is an initiative by the UK police supporting the principles of 'designing out crime' through the use of effective crime prevention and security standards. Architectural liaison officers are responsible for dealing with crime risk and offering advice on the relationship between crime and the built environment.

The Secured by Design Developer's Award is given to developments which can demonstrate that they have been built with the reduction of crime in mind.

Education, training and skills

It is essential that all those involved in the creation and maintenance of sustainable communities have the right skills. The current shortfall in skilled construction professionals needs to be urgently addressed, perhaps by linking planning agreements to the provision of relevant training.

A lack of skills is one of the most commonly mentioned barriers to the establishment of truly sustainable communities. Local construction professionals, in particular, need to have the understanding and skills necessary to create and maintain places in which people are comfortable, happy and safe. Initiatives should explore the current skills gaps and aim towards the generation of a common set of sustainable construction skills. Opportunities need to be created for relevant training and apprenticeships; they should ideally target the local people who have an interest in the community involved.

There needs to be a greater commitment to research and innovation, from both government and the construction industry, to inform future decision-making for sustainable communities. There is no catch all solution for creating an ideal sustainable community so local decision-makers need to know how their local area can be developed to maximise its advantages.

There is also value in creating awareness of the sustainability benefits of communities from within. In existing businesses, environmental awareness training is becoming more common but emphasis on the social aspects of sustainability is often lacking.

Photograph: Lovell Partnerships

It is also vital that residents understand how to make the most of their living environment. One way of enhancing such awareness is through the strengthening the relationships between constructors and occupiers.

Transport and Infrastructure

Well planned transport networks are, arguably, the most important consideration for the sustainability of any community. Proximity to reliable, public and private transport links is vital for an acceptable standard of living. It is also important for minimising the environmental impacts of our mobility and maximising economic prosperity.

Without decisive action, the Sustainable Development Commission estimates that traffic congestion could cost the UK £30bn/year by 2010[3].

Public Transport

An affordable, efficient and reliable public transport service is widely regarded as the most important way of increasing sustainability in any community. Where people can be persuaded to abandon their cars in favour of buses and trains, there is the potential to reduce pollution, congestion and ill health. Good public transport is also seen as a valuable community asset and can increase social cohesion and house prices.

Walking and Cycling

There has been an increase in initiatives to design communities that encourage and enable walking and cycling. These can have huge benefits for all aspects of sustainability.

Switching to walking or cycling reduces environmental impacts by lowering emissions and congestion; this promotes cleaner air, improved health and higher productivity.

Social Aspects of Sustainable Construction

Cars and Roads

A reliance on cars can have major effects on health and wellbeing, not least where developments are built in areas with limited access to public transport. Local communities in such areas are likely to have a much greater carbon footprint and may well suffer from higher levels of air pollution. Road accidents may also be more common.

However, in more isolated communities, public transport is still not always a viable option. Although future service improvements would provide great benefits for the sustainability in these areas, well maintained roads may be the best option for the moment.

Where car use can't be avoided, car sharing schemes can reduce environmental impacts and congestion, as well as contributing to social cohesion.

Local Schools and Services

For health and well-being to be maximised, all residents of a community must have access to public services such as schools, shops, sports centres, parks, healthcare, and social facilities.

Local schools are particularly important because they are often the focal point of a community. They provide opportunities for young people, as well as influencing wellbeing for all. Where local schools fail or close, this can signal the decay of whole communities. On the other hand, successful schools in the right location can prompt the development of other services and provide widespread benefits. Outside teaching hours, for example, classrooms and school halls can provide the base for a variety of community activities.

Photograph: HBG UK Ltd

Lifetime Homes

Dwellings which achieve Lifetime Homes standards are designed to be flexible and adaptable so that they can accommodate changes in the lifestyles of their occupants quickly, cost-effectively and without upheaval. Such changes might include changes in family size or the mobility of individuals.

The standards apply to both the interior and exterior of a home and include considerations of accessibility, layout, controls, fixtures and fittings.

Developers should plan for local facilities and services in their master planning of larger developments and these should be delivered alongside any housing provision, as outlined in Section 3, Section 106 Planning Obligations (see above). Without such considerations, it is much more difficult for healthy communities to become established.

Modifying User Behaviour

The whole construction process must be constantly reviewed in order to take into account new demands from occupiers, new techniques available and new materials which are accessible. However, once buildings are occupied, it is facilities managers and building users who must make sure they are run efficiently and effectively.

Unless users are aware of how to make the most of their buildings, the benefits of sustainable design can be quickly lost. This represents one of the biggest challenges for the success of sustainable buildings. Education, media coverage, regulation and environmental taxes will all help to raise overall awareness; however there will also need to be significant cultural change if people are really going to modify the way they live.

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[1] Communities and Local Government 2006, UK Presidency: EU Ministerial Informal on Sustainable Communities. [Online]. Available at: http://www.communities.gov.uk/documents/citiesandregions/pdf/143108 [Accessed: 10/12/2007]

[2] Communities and Local Government 2006, Model Planning Obligation (Section 106) Agreement. [Online]. Available at: http://www.communities.gov.uk/planningandbuilding/planning/planningpolicyimplementation/planningobligations/modelplanningobligation/ [Accessed: 31/10/2007]

[3] Sustainable Development Commissions 2007, Building Houses or Creating Communities? [Online]. Available at: http://www.sd-commission.org.uk/publications/downloads/SDC_SCP_report_2007.pdf [Accessed: 31/10/2007]

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Section 10
Measuring Sustainability in the Construction Industry

CONSTRUCTING EXCELLENCE
in the built environment

Measuring Sustainability in the Construction Industry

York St.John University, courtesy Alumasc

In order to remain competitive, construction companies increasingly have to demonstrate their environmental record by providing reliable performance information. A number of tools and methodologies are now available to allow companies and organisations to measure their progress; however, it is not always clear which ones are the most appropriate. This final section of the Plain English Guide outlines some of the most commonly used techniques.

Considering long-term costs and value

Traditionally, the costs of construction have only been considered up to the point that building work is completed; maintenance and operational costs have commonly been overlooked by designers, developers and contractors.

However, an increased interest in environmental issues, together with rising energy costs, means that building operators and occupants are becoming more concerned about the long-term operational costs and related values of their buildings. This has been reinforced by increase in legislation and initiatives which encourage the consideration of broad sustainability issues – environmental, economic and social.

Life Cycle Analysis

Life cycle analysis looks at the environmental impact of a product throughout its life from 'cradle to grave' by carefully considering all its material and energy inputs, and environmental burdens. All of the processes from the extraction of raw materials through production, use, reuse and recycling until eventual disposal within the environment must be accounted for. For the construction industry, this specifically includes the whole design life of products from the earliest feasibility stage, right through design and construction phases to maintenance and eventual disposal/replacement.

Life cycle analysis is particularly useful for construction projects which generally have very high materials requirements. It helps architects, designers and other specifiers to compare the environmental impacts of a variety of construction products, materials and services. They can then make informed decisions to maximise sustainability.

Life cycle analysis procedures now form part of the **ISO 14000** standards.

Whole life costing

Whole life costing (WLC) for construction projects specifically considers all the economic implications from the design stage through to disposal, including environmental and social costs. The use of WLC techniques aims to deliver improved value for money in the long term. However, it can be difficult to take all the long term operating and maintenance considerations of a building into account; this is because many of the major environmental costs only become apparent when a building is operational. As such, it is easy to place too much emphasis on up-front, capital costs in WLC techniques. Social costs and benefits are particularly difficult to quantify and are often left out.

Environmental Assessment Methodologies for Construction

Carbon Footprints

Carbon footprinting is used to calculate the amount of environmental damage caused by an individual, household, institution or business through harmful carbon dioxide emissions. For businesses it measures the amount of carbon dioxide or CO_2 emitted through the combustion of fossil fuels as part of their everyday operations. Carbon footprints are generally measured in grams of CO_2 equivalents; this accounts for the different global warming effects of a variety of greenhouse gases.

If we are to effectively manage carbon emissions in the UK, it is vital that the construction industry, as the biggest source of CO_2 emissions, is aware of its carbon footprint and how to reduce it. Demonstrating this is increasingly seen as good business practice as well as being part of Corporate Social Responsibility.

The new offices of East Thames Group which has been designed to achieve a BREEAM Excellent rating.

BRE Methodologies

With the support of the UK government, the ***Building Research Establishment*** (BRE) has developed numerous tools to assess the sustainability of various types of buildings. These are intended to help architects, specifiers and clients make informed decisions about construction materials and components, by providing independent information about the environmental impacts of different design options. They also enable materials producers to develop 'environmental profiles' for their products.

The ***BREEAM*** (Building Research Establishment Environmental Assessment Methods) family of assessment methodologies aims to help construction professionals understand and reduce the environmental impacts of the developments they design and build. There are different tools for the various stages of the construction process as well as for different scales of construction activity.

Specific versions of BREEAM cover a number of different building types; these include schools, prisons, courts, offices, retail and industrial developments. In addition 'Bespoke BREEAM' can cover a variety of buildings which fall outside the standard categories.

BREEAM Ecohomes has been used to assess new homes and those undergoing major refurbishment; however, since April 2007 this has been replaced by the Code for Sustainable Homes (see below).

The different versions of BREEAM are supplemented by tools including LCA (certified system for life cycle analysis), ENVEST (web-based tool for designing buildings with a low environmental impact), Smartwaste (waste minimisation) and BREEAM: Developments (targeting and benchmarking)

BRE also produces the 'Green Guide to Specification', which outlines the relative environmental impacts of a variety of products and specifications (see section eight – Procurement).

Measuring Sustainability in the Construction Industry

The Kingspan Lighthouse which achieved level six of the Code for Sustainable Homes.

The Code for Sustainable Homes

The ***Code for Sustainable Homes***, which was launched in December 2006, aims to be a single national standard to measure the environmental impacts of our homes and encourage the incorporation of increasingly tough performance standards. It gives a star rating, from 1 to 6, to indicate the overall sustainability performance of a home and is expected to be a guide to development and a basis for improving on Building Regulations, particularly with regard to energy use, emissions, water and waste management.

Publicly funded housing already has to achieve Code level 3 and this will increase to level 6 by 2016. Although the Code is currently voluntary for the private sector, it is likely that that the standards involved will gradually be adopted as part of Building Regulations.

The requirement for zero net carbon production at level 6 means that any carbon produced from energy use must be balanced by carbon savings elsewhere (i.e. over the course of a year, energy taken from the grid when demand is high is balanced by energy which is returned to the grid when demand is lower; this means that onsite generation of renewable energy is generally necessary).

Carbon offsetting

Carbon offsetting involves balancing CO_2 emissions with measures to cancel out those emissions elsewhere. It is the principle behind carbon trading schemes as described in section four of the Guide. It allows companies to continue to burn fossil fuels while contributing to an overall reduction in carbon emissions by investing in initiatives that reduce emissions elsewhere. For example, where a business in the UK emits more CO_2 than is permitted, it could invest in efficiency measures for a business in another part of the world. The idea is that this 'neutralises' any extra emissions which are produced.

Benchmarking and Key Performance Indicators

Benchmarking is a process whereby organisations evaluate various aspects of their processes in relation to best practice with a view to advancing overall performance. The process can be a one off event but is much more effective when used continuously to improve working practices.

As we build up more and more comparable examples of the performance of different buildings against individual indicators, formal benchmarking techniques will become increasingly workable and informative, and should become effective aids for monitoring progress. However, despite widespread monitoring of the environment in recent years, there is still a lack of standardised, comparable data for effective benchmarking; one of the main complications in the UK is the huge variety of building types in existence.

Key Performance Indicators (KPIs) are measures of factors critical to success that are used by organisations to evaluate performance. The information provided by an organisation's KPIs is used to monitor and improve performance and can be used for benchmarking as a means of moving towards best practice. The current construction industry KPIs are managed by Constructing Excellence.

Environmental Management Systems (EMSs)

EMSs are designed to help businesses and organisations to put in place processes that will reduce their environmental impacts. They are important for achieving competitiveness and access to markets. Current pressures from regulation and increased competition, as well as growing public awareness of environmental issues, means that adopting such systems can be seen as offering clear, competitive advantages for individual businesses.

In the construction industry these standards are important in addressing the following:

- The growth of environmental concerns
- Public intolerance of unsound business practices

- The increase in international, EU and national legislation
- The need for organisations to demonstrate that their activities meet guidelines.

However, the costs of gaining accreditation are substantial and may be beyond the reach of some smaller businesses. Nonetheless, where this is the case, it is possible to gradually incorporate the various requirements and accreditation can be sought at a later date.

ISO 14000 Standards

ISO, the International Organisation for Standardisation, is able to set standards that often become law, either through treaties or nationally based initiatives.

The United Nations Rio Earth Summit of 1992 first prompted the introduction of the ***ISO 14000*** standards which aim to help organisations minimize their negative effect on the environment. They also make it easier to comply with laws and regulations and improve on them. The standards were designed to be used by any type of organisation, public or private, and have since been adopted on a world-wide scale.

Like ISO 9000, certification is carried out by third party organisations; it is not awarded by ISO directly.

EMAS – Eco-Management and Audit Scheme

EMAS http://emas.org.uk is an alternative, voluntary scheme which is also designed to improve an organisation's environmental performance. Its aim is to recognise and reward initiatives which go beyond minimum legal compliance and continuously improve environmental performance. Participating organisations must produce public environmental statements that report on their environmental performance; accuracy and reliability is checked independently.

EMAS is strongly backed by Government and environmental regulators. It has been further strengthened by the integration of ISO 14001 as the required environmental management system.

Participation extends to public and private organisations which operate within the EU and the European Economic Area (EEA). Some other countries are have also begun to implement the scheme as part of the process of accession to the EU.

Post-occupancy evaluation (POE)

One of the main criticisms of environmental assessment methods is that they often fail to measure the performance of buildings **in use**. Too much emphasis is usually placed on the design and constructionprocesses and, while some methods are able to predict how a building might perform in the best possible conditions, in many cases the reality doesn't live up to this.

It is important, therefore, that future development of assessment methods includes detailed follow-ups once buildings are fully completed and operational and maintenance procedures are established.

Post-occupancy evaluation involves the organised assessment of buildings in use, from the point of view of their occupants. It looks into how well buildings suit their users' needs, as well as suggesting possible improvements in design, performance and general fitness for purpose. It is very useful for ironing out problems in new buildings, developing new facilities in existing buildings and managing buildings which pose particular difficulties.

Businesses and other organisations can also use POE to establish company policies on maintenance, replacement, purchasing and supply.

POE can lead to sustainability improvements by prompting more efficient use of buildings and equipment, as well as ensuring that their lifetime is maximised. This also allows cost savings and improvements in working environments.

Typical POE involves three phases:

- Preparation: identifying users and potential participants.
- Interviews: the comments and observations of small groups of similar users are noted. Written questionnaires can also be used.
- Analysis and Reporting: Findings are brought together and recommendations are made. The final result is usually a written report accompanied by presentation(s).

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4 – Energy, Pollution and Climate Change

5 -Water

6 - Waste and Materials (Including Modern Methods of Construction)

7 - Natural Resources and Conservation

8 – Procurement Solutions

9 – Social Aspects of Sustainable Construction

10 – Measuring Sustainability in the Construction Industry

Photograph on page 2: Lee Jordan

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