REPORT 13

SUSTAINABLE CONSTRUCTION
THE UNITED KINGDOM VIEWPOINT

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NATIONAL REPORT

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1. INTRODUCTION

This research project is part of an international research initiative investigating and reporting on sustainable construction and on efforts towards achieving sustainability in high and low consuming countries. The work is being carried out in collaboration with experts from around the world through the Conseil International du Bâtiment Working Commission 82 (CIB-W82), with contributions coming also from the following countries:

- Australia
- Austria
- Belgium
- Finland
- France
- Hungary
- Italy
- Ireland
- Japan
- Netherlands
- Romania
- Spain
- United States

1.1 Definitions

For the purposes of this study:

'***Sustainable development***' is defined as

'*development which meets the needs of the present without compromising the ability of future generations to meet their own needs*'[1]

The UK Government issued the first comprehensive British White Paper on the environment in 1990, entitled 'This Common Inheritance'. This stresses that 'Sustainable development means living on the earth's income rather than eroding it's capital. It means keeping the consumption of renewable natural resources within the limits of replenishment. It means handing down to successive generations not only man-made wealth... but also natural wealth...'

'***Sustainable construction***' is defined as

'*the creation and responsible management of a healthy built environment based on resource efficient and ecological principles*'[2]

1.2 Methodology

Based on the definitions outlined above, and the assumption that 'the UK construction industry will whole-heartedly embrace the concepts of sustainable construction', this report presents the responses to 6 fundamental questions in the light of a variety of four possible future scenarios that would lead to varying degrees of success in moving towards sustainable construction in the UK:

1. **What kind of buildings need to be built by 2010 and how could we adapt existing buildings?**
2. **How should we design and construct them?**
3. **What kinds of materials, services and components should be used?**
4. **What kinds of skills and standards would be required?**
5. **What kind of cities and settlements would we have?**
6. **What are the perceived barriers to the implementation of sustainable construction?**

The first five of these questions were discussed at length at an international CIB-W82 conference held at Ascot in October 1995. Each participating country is now compiling a report, following a standard format, using the same assumptions, scenarios and questions. CIB-W82 will then correlate and compare the response from each country. The sixth question follows on naturally as part of the requirements for this research project. A seventh question naturally follows on from this:

7. **How do we overcome these barriers?**

This question was considered at a second UK workshop held in Birmingham on 28 October 1996 and will be the subject of future workshops and international conferences. Some preliminary responses to this question have been included in this report, but they will feature prominently in future reports.

1.3 Commentary on scenarios for the UK

It became clear during the discussions that took place at the UK workshops on 18 September 1996 and 28 October 1996, and from reading the replies to the questionnaires, that of the four scenarios, Scenario 1 (Strong Together) is highly unlikely in the time scale envisaged. Scenario 2 (Strong Alone) is unlikely for the UK by 2010. Scenario 3 (Partial Sustainability) is most likely for the UK by 2010, and Scenario 4 (Weak Sustainability) is where the UK is now, and may still be by 2010. These are the pragmatic consensus views, and it was generally thought that for the UK to progress beyond Scenario 3 by 2010 would require a radical change of government, commercial and industrial policy, together with considerable shifts in public opinions and attitudes. It was thought that a few individual countries may have already reached Scenario 2, at least partially.

However, whichever scenario is chosen, the opinions of what the future vision of the construction industry and the type and style of future settlements may be are remarkably similar. Transport, energy and water use are the key factors in deciding the shape of our future. Education at all levels is vital to overcome the lack of knowledge and indifference to the high consumption, high waste society in which we currently live.

There are, however, some underlying doubts and difficulties with all of the scenarios and assumptions. It has been suggested that it is pointless trying to forecast the future without some futures framework which goes beyond the four given scenarios. The most obvious starting point would be the effects of the global economic shift, which will have profound consequences for the European construction industry, let alone for the UK. Other topics for serious consideration include the effects of an energy crisis in 2020/2030; potential mass migration northwards into Europe; more rapid climate change than previously predicted. In the context of such fundamentally important issues, examining sustainability a mere 15 years into the future is surely short sighted. If these issues are to be taken into account, then we are almost certainly not using the most appropriate definition of sustainability, and we should be endeavouring to define more realistically what it is that we are trying to sustain, and why.

1.4 Sustainable Development in the UK

Following the 1992 Earth Summit in Rio, the UK Government developed a Sustainable Development Strategy[3]. This included four broad aims for sustainable development:

1. a healthy economy should be maintained to promote the quality of life while at the same time protecting human health and the environment, in the UK and overseas, with all the participants in all sectors paying the full social and environmental costs of their decisions;
2. non-renewable resources should be used optimally;
3. renewable resources should be used sustainably;
4. damage to the carrying capacity of the environment and the risk to human health and bio-diversity from the effects of economic activity should be minimised.

The UK Strategy also contained a commitment to develop a set of indicators which could help assess whether our development was becoming more sustainable and whether the Government was meeting the objectives set out in the Strategy. As a result of this, a preliminary set of general indicators were published in 1996[4]. There are 118 indicators, grouped as follows:

A healthy economy should be maintained to promote quality of life while at the same time protecting human life and the environment, in the UK and overseas, with all participants in all sectors paying the full social and environmental costs of their decisions.	*Non renewable resources should be used optimally.*
• The economy. • Transport use. • Leisure and tourism. • Overseas trade.	• Energy. • Land use.
Renewable resources should be used sustainably.	*Damage to the carrying capacity of the environment and the risk to human health and biodiversity from the effects of human activity should be minimised.*
• Water resources. • Forestry. • Fish resources.	• Climate change. • Ozone layer depletion. • Acid deposition. • Air. • Freshwater quality. • Marine. • Wildlife and habitats. • Land cover and landscape. • Soil. • Minerals extraction. • Waste. • Radioactivity.

The carrying capacity of the environment for our effluent and emissions is recognised to be an important concept, but ascertaining what that capacity might be is difficult to determine. Equally, the cumulative effect and the interactions between the various components of our effluent and emissions on the environment is as yet unknown. Knowing which components are likely to have an effect on which part of the ecosystem is a key factor in the equation.

The construction industry accounts for a large share of environmental impacts including: demand for about 50% of UK primary energy supply (combined with building occupation); use of vast quantities of construction materials; and significant generation of pollution to land, air and water[5]. It is essential to determine the implications of sustainability for construction, both to reduce risks and identify opportunities. Following on from the original set of indicators for sustainable development, the UK Construction Foresight Panel has launched a project in 1997 to develop a framework and a set of sustainability indicators specifically for the construction industry. These are being developed through a series of workshops organised by the panel through BRE.

When the Sustainable Development Strategy was launched, the Government also appointed a Panel on Sustainable Development. This was set up to provide advice to Government on strategic issues relating to sustainability and other environmental issues. They have so far produced three annual reports, which cover many recommendations which affect construction and the construction industry in the UK. Comments from the latest report[6] recommend the Government to[7]:

- pursue a more proactive policy of greening its supplies and purchasing, e.g. by encouraging certification of environmental management standards;
- define a comprehensive set of principles and practices for the use of subsidies based upon the concept of sustainable development;
- develop new regulatory and fiscal measures to make it more difficult to develop greenfield sites and to encourage reuse of brownfield land.

A separate, non-government group, the UK Round Table on Sustainable Development, was also established in 1995. This brings together people from a wide range of backgrounds and responsibilities, and aims to produce agreement on major sustainable development issues. The group have also produced reports on topics identified as priorities for sustainable development, many of which are relevant to construction.

A key driver on the UK construction industry will be any framework introduced by Government to encourage more sustainable production and consumption, including regulatory controls and incentives for companies to improve environmental performance. The response to demands for sustainability in the construction industry will be crucial, and companies are likely to come under increasing political, public and economic pressures to become more sustainable. Organisations which do not adapt are likely to loose income.

Many UK organisations have investigated sustainable development, particularly from a planning viewpoint. The new government planning regulations also encompass the delivery of a set of sustainable development objectives. The draft document of Planning Policy Guidance Note (PPG) 7 supports sustainable development as a main objective. However, as no boundaries have been set, it is still difficult to determine what is a ‘sustainable’ development compared to an ‘unsustainable’ development.

There are many other non-governmental organisations in the UK who are involved with the issues of sustainable construction, and are actively working within the frameworks which have been set. The main sustainability initiatives in the UK have been detailed in the following Section of the report.

2. SUSTAINABLE CONSTRUCTION IN THE UK: ISSUES, VIEWS AND RECOMMENDATIONS

This Chapter summarises the responses received by BSRIA from the questionnaire survey and workshops. These have been discussed in relation to the five phases of

construction specified by CIB: *development and planning, design, construction, operation and deconstruction.*

In each phase a number of issues relating to the UK construction community's approach to sustainability are identified. Recommendations for government, educational organisations and institutions, and research and development are indicated, alongside a list of selected initiatives relating primarily to each phase. More detailed descriptions of each initiative can be found in Appendix A3.

The discussion and recommendations contained within the following Sections are based entirely on opinions reported to BSRIA through questionnaires and workshops. Although BSRIA personnel participated in both the questionnaire survey and the workshops, the views expressed are not necessarily those held by BSRIA.

2.1 Development and planning

There are two primary sustainability concerns falling into this phase of construction. Arguably the most fundamental of these relates to the question of whether a new construction is required at all, and whether re-use of an existing structure (refurbishment) or area of land would satisfy the requirements of the client. The construction industry itself has little influence over the need for a new building, something which is most often decided by the industry's clients on the basis of financial or commercial considerations. However, the need to rely much more on refurbishment and use of brownfield sites is recognised as essential to make construction more sustainable, and incentives from government in the form of fiscal measures and proactive planning policies are cited as means of achieving this. A total requirement of 4.4 million new homes is forecast for England between the years 1991 and 2016.

Similarly, there are calls for more resources to be fed into structured and planned refurbishment and maintenance of the existing building stock, in order to both maximise its useful life and reduce its environmental impact. This type of policy has recently been enacted as legislation within the UK through the Home Energy Conservation Act 1995[8], which obliges Local Authorities to survey all dwellings within their area, of all tenures, and develop and implement a strategy to reduce energy consumption by an average of 30% by the year 2006. In view of the current concerns over water resources in the UK a similar regulatory mechanism to enforce greater water conservation may be of use.

The second key area of concern regarding the planning and development of a sustainable built environment is that of transport. Improved public transport systems, relying on a range of transport mechanisms, and developments which not only encourage use of these systems but also discourage use of the car and commuting in general are seen to be important. The increased use of information and communications technology is seen as consistent with this objective, and while it is recognised that social interaction is essential for any sustainable society, it is felt that home-

working, and combining office and living space, should be increased. Again, a role for government is envisaged, with calls for incentives to reduce car use and subsidise public transport, to the point perhaps where public transport is free to the user, at least at the point of use.

2.1.1 Recommendations

2.1.1.1 Government

- Enable the planning system to promote sustainable development.
- Introduce fiscal measures to encourage sustainable construction, particularly the redevelopment of brownfield sites.
- Fund a refurbishment programme to implement HECA and water conservation improvements within existing dwellings.

2.1.1.2 Research and development

- Improve contaminated land clean-up procedures in order to minimise developers' perceived liabilities.

2.1.2 Relevant existing initiatives

- The Urban Villages Forum.
- The Home Energy Conservation Act 1995.
- Zero car housing estates.
- The Sustainable Urban Neighbourhood (SUN) initiative.
- European Housing Ecology Network (EHEN).
- Green Futures Network.
- Groundwork.
- Sustainable Cities Network.

RESOURCE	ISSUES	CONSEQUENCES
Land	• Is a new building really needed? • Brownfield/greenfield sites.	• Greater use of existing buildings and land for new developments. • Refurbishment should address changing social requirements.
Energy	• Structured refurbishment to increase efficiency.	• HECA implementation is essential, but more funding is required.
Water	• Structured refurbishment to increase efficiency.	• A home water conservation act?
Materials	• Refurbishment vs. new build.	• Much greater emphasis on planned refurbishment and management of existing stock.
Other/All	• Transport requirements. • Public involvement in development.	• New developments should give rise to minimal transport needs and should improve public transport provision. • Greater density of development along public transport routes. • Citizens' juries to preside over development applications.

Table 1: Development and Planning

2.2 Design

Again, a number of key generic issues can be identified. Possibly the most prominent of these relates to the longevity of buildings, and means of ensuring that buildings have the necessary flexibility and quality to enable them to remain useful, throughout several phases of refurbishment and under whatever social conditions we may experience in the future. Greater numbers of more durable buildings will undoubtedly lead to reduced premature demolitions and materials demands for new buildings, but will also result in fewer construction starts, having potentially adverse consequences for the construction industry in the UK (although this may be somewhat offset by increased refurbishment projects). Multi-use and communal buildings will also be important, and mixed age co-housing projects, groups of dwellings with communal facilities, and combined offices/dwellings will be required.

In all cases, the ability of buildings to be repeatedly altered to meet the changing needs of society will be essential, and technical means of facilitating this have been suggested, focusing primarily on the use of standardised building 'modules', manufactured centrally to enable efficient on-site installation. Such modules could be services packages, structures or entire elements of a building. Also important, however, is construction which is locally focused, making use of local labour and craft, using local style and aesthetics, and minimising the transport requirements and other adverse environmental consequences of large manufacturing industry. There is of course no need why these two approaches should not appear together, but work is required to indicate which is more appropriate for different areas of the country, different building types, and different social groups.

The use of timber framed construction for housing, and of more innovative construction techniques such as dynamic insulation[9], breathing walls and natural ventilation must become more widespread and acceptable to clients and users. 'Environmentally friendly' construction materials and services are also widely deemed to be important. In consideration of services, a greater level of independence from centralised mains services (energy, water and sewerage/drainage) is a viable option, alongside a significant increase in the general level of resource efficiency of the building stock. However, there is far less agreement on what constitutes an environmentally friendly construction material, with a range of specifications (such as a minimum of 20% recycled material) and means of reducing adverse impacts relating to materials (including measuring 'ecological footprints') being suggested. The use of environmental labelling to inform designers was also suggested, although there is a need for reliability of labelling to increase the confidence of the users. With reference to both services and building fabric, avoidance of over specification and waste is essential to moving towards sustainability.

The process of design itself also presents a target for reform. The nature of construction in the UK is seen as too adversarial and risky, discouraging technological and design innovation, and strengthening differences between the professions. While

it is recognised that each design profession has specific skills which are valuable to the process of design, higher quality, better suited and more sustainable buildings will result from a more co-operative approach. Not only this, but a significantly greater level of client participation in the design process is essential, and experiences of the early stages of occupation of a building should be used to provide feedback to the designers. The range of environmental guides to building design should be promoted more widely, perhaps with statutory obligations to adopt particular codes of environmental design or performance measures (such as the BREEAM scheme).

2.2.1 Recommendations

2.2.1.1 Government

- Incentives to encourage the use of more environmentally friendly materials.
- Adopt measures to reduce the adversarial nature of building design.
- Increase building standards in general, with standards for longevity being introduced.
- Impose a minimum recycled material content for all building materials.
- Support the introduction of reliable labelling schemes for building materials and components.

2.2.1.2 Education

- Feedback mechanisms for building designers.
- Provide better information to building designers on how to interpret environmental labelling.
- Educate designers to adopt a more integrated approach to design, and to appreciate the
- fundamentals of sustainable building design.

2.2.1.3 Research and development

- Durable, long-lasting buildings vs. temporary buildings? Both have been cited as ‘more sustainable’, but this clearly depends on a range of factors, including the type of building involved. In which circumstances should one or the other be preferred?
- In which cases are standardisation, rather than local specialisation of building component production more sustainable?
- What is an environmentally friendly material?
- Total energy (water and other resources) assessment models to combine embodied and operational consumption.
- Per capita resource indices for construction projects.
- Develop usable environmental accounting tools for construction projects.

2.2.2 Relevant existing initiatives

- BREEAM
- Energy Design Advisory Service (EDAS).
- The Technical Aid Network (ACTAC).

- Action for Sustainable Rural Communities (ASRC).
- Association for Environment Conscious Building (AECB).
- Built Environment Evaluation for Sustainability Through Time (BEQUEST).
- Construction Industry Environment Forum (CIEF).
- The Green Building of the Year Award.
- HVCA (Heating and Ventilation Contractors' Association) Green Product Initiative.
- Sustainable Homes.
- Lifetime homes.
- Construction Industry Trading Electronically (CITE).

RESOURCE	ISSUES	CONSEQUENCES
Land	• Longevity of buildings. • Multiple use of buildings. • Communal buildings.	• Flexible design, both in terms of future use and current use requirements. • Standardisation of materials and components. • Increased co-occupancy of buildings.
Energy	• Independence from mains sources. • Passive ventilation (also cooling and heating) and lighting.	• Greater use of renewable energy sources. • Increased uptake of passive design solutions, shallow plan buildings and landscape techniques. • Super-insulation, sophisticated energy management systems, air-tight buildings.
Water	• Independence from mains water supply and sewerage.	• Greater recycling of water and interception of rainwater for direct use. This may be on single buildings or communally.
Materials	• Longevity of buildings. • Environmentally friendly materials.	• Flexibility of buildings, and standardisation of materials and components. • Promotion of and greater uptake of environmentally friendly materials, along with better guidelines on what they are.
Other/All	• The nature of design and its products. • Transport demands resulting from the design. • Critical assessment of new designs. • Avoidance of over-designing.	• More co-operative/integrated design and more client participation. • New buildings (and refurbishment projects) should address demographic changes. • Post completion design assessment leading to feedback mechanisms for designers. • Greater (statutory) use of assessment methodologies such as BREEAM.

Table 2: Design

2.3 Construction

There were very few responses to the questionnaire which related specifically to the construction phase. This possibly reflects a feeling amongst respondents that the

construction process itself has little to contribute to making a building more sustainable, and that planning, design and operation are far more important. While much of the specification of building materials and components takes place during the construction phase of building, this is design work, and so comments relating to this have been included in the Section above. However, one theme specific to this phase can be identified in the responses received, and is described below.

The importance of making more use of human labour, in particular traditional craft skills, is widely emphasised. The self-build movement in the UK is particularly strong, and many individuals are interested in taking a more active part in the design and construction of their homes. However, it does represent a tiny part of the construction market and will remain so for a considerable period of time. There is a heavy social sustainability element to this phase of the construction process, and the increasing use of mechanical labour, both on site and in factories, is seen as moving away from sustainability. In addition, greater human labour is seen as consistent with improved construction quality, and thus longevity of the building. A converse argument is that increased 'low-tech' prefabrication of building modules with installation of 'high-tech' control systems is necessary. This may have the advantage of enabling more stringent quality control, but may also have adverse aesthetic consequences. It is likely that one approach will be more appropriate for certain building types than the other, and some research work will be necessary to determine the best solution in all cases.

2.3.1 Recommendations

2.3.1.1 Government

- Impose strict built quality standards for all building types to cover new build and refurbishment projects.

2.3.1.2 Education

- Greater information on effective and efficient building design, production, materials and techniques.

2.3.1.3 Research and development

- Investigate the social sustainability issues surrounding self-build, and determine the most appropriate circumstances for its promotion.

2.3.2 Relevant existing initiatives

- Greater use of reused and recycled materials in construction handbook: CIRIA/Scott Wilson Kirkpatrick.

RESOURCE	ISSUES	CONSEQUENCES
Land		
Energy	• Use of mechanical labour vs. use of human labour.	• Using more human labour and traditional skills could bring about both environmental and social benefits. • More self-build. • More robotic construction to increase safety and productivity.
Water		
Materials	• Environmentally friendly materials. • Modular, standardised construction vs. local construction.	• See 'Design'. • Building 'modules' make recycling of buildings easier and reduce wastage on site, but can have adverse aesthetic and social consequences.
Other/All	• Build quality. • Environmental labelling and standards.	• Standards must be imposed to ensure that build quality is maximised. • The existence and use of rigorous and believable labelling systems.

Table 3: Construction

2.4 Operation

The operation of buildings clearly has a significant impact on their overall environmental performance and sustainability. Although this can be influenced to some extent by good planning, design and construction, these early phases can only be regarded as providing the building user the means of minimising the building's overall environmental impact. The benefits of excellent sustainable design can rapidly be outweighed by the adverse impacts of poor building management.

A key to ensuring that operation does not become the weak link in sustainable construction is thus to invest heavily in education of building and estates managers, and other building users (including of course the general public) to ensure that they fully appreciate the concept and implications of sustainability. A wide change in personal and professional ethics is required.

In conjunction with this, however, there are tools and guidance which can be developed to make efficient operation of buildings simpler for the users. Many buildings, when handed over to the operators, are not accompanied by any instructions on how to operate the building in the most effective and sustainable way, and provision of 'Building Handbooks' provided for the users by the designers, is essential. Standards of resource use within buildings, to include energy, water and materials, would further encourage more sustainable operation, and excess noise also presents a major problem which should be addressed by the imposition of maximum noise standards. As well as concentrating on minimal resource consumption, building operators should also aim to maximise the useful lifetime of the building and its components by undertaking planned, strategic maintenance and refurbishment.

The operations carried out within buildings (as distinct from building operation), can of course have significant environmental impacts, but are outside the scope of sustainable construction.

2.4.1 Recommendations

2.4.1.1 Government

- Impose noise insulation and maximum noise level standards.

2.4.1.2 Education

- A wider appreciation of sustainability and its implications for personal and professional activities will lead to more efficient operation of buildings.
- Building handbooks, specific to each building, to be available to building operators.

2.4.1.3 Research and development

- Rapid development of usable environmental accounting tools, or accounting regimes may be imposed on the construction industry.

2.4.2 Relevant existing initiatives

- Advisory Committee on Business and the Environment (ACBE).

RESOURCE	ISSUES	CONSEQUENCES
Land	• Operations within buildings should minimise non-public transport requirements. • Environmental externalities.	• A wider change in personal and professional ethics towards greater sustainability. • Environmental accounting
Energy	• Minimisation of energy demands.	• Education, feedback and standards.
Water	• Minimisation of water demands.	• Education, feedback and standards.
Materials	• Planned maintenance and refurbishment programmes. • Minimisation of materials demands	• More emphasis on maintenance and refurbishment to ensure longevity. • Education, feedback and standards.
Other/All	• Minimisation of noise pollution.	• Education, feedback and standards.

Table 4: Operation

2.5 Deconstruction

Sustainable construction requires buildings to be either durable, lasting hundreds rather than tens of years, or temporary, movable and almost entirely recyclable. In either circumstances, deconstruction will be a significantly less important phase of a building's lifecycle, and the problem of disposing of, as well as the availability of, construction waste will be diminished.

However, we currently face a situation where demolition, rather than deconstruction of buildings is an important phase of the lifecycle, and significant when considering sustainability. Means of encouraging reuse and recycling of building materials and

components, as well as much greater levels of land redevelopment are essential, and respondents recognise that improved reuse/recycling infrastructure is required. This could take the form of a brokering service which operates to match construction material needs with supplies of waste materials. Concerns over quality of reused/recycled materials would also need to be addressed by introducing suitable standards.

2.5.1 Recommendations

2.5.1.1 Government

- (with industry) Establish a brokering service for waste construction materials.
- Introduce quality standards for reused/recycled materials which minimise concerns over their use, but do not place undue barriers to their sale.

RESOURCE	ISSUES	CONSEQUENCES
Land	• Redevelopment of land.	• Fiscal measures will be introduced to promote redevelopment. • Sustainable redevelopment.
Energy		
Water		
Materials	• Reuse/recycling/redevelopment of buildings and materials.	• New 'brokering' services for waste building materials.
Other/All		

Table 5 : Deconstruction

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4. APPENDIX 1 : RESPONSES RECEIVED BY 20 DECEMBER 1996

Question 1

What kind of buildings need to be built by 2010, and how could we adapt existing buildings?

In order to adapt existing buildings in the UK sustainably, we should:

- Develop a properly funded refurbishment programme, with funding to implement Home Energy Conservation Act plans. Insulation improvement is simple to do, relatively cheap and has a realistic financial pay back period. A simple grants policy would help considerably. This is likely to achieve the biggest single impact by 2010.
- Develop a systematic, prioritised refurbishment programme for all building types which addresses insulation, ventilation, heating, water conservation and other needs. Ideally refurbishment needs to be simple, and flexible, without requiring major surgery to buildings, e.g. dry lining to cut heating costs. Building services should be regarded as a major target for refurbishment.
- Refurbish using environmentally friendly materials.
- Subject all buildings to pre-design procurement assessment, i.e. ‘why move or build at all?’ and if building or moving is considered necessary, assess new-build against refurbishment. The quality of existing buildings should be valued - we should promote the understanding that a good old building is better than a good new one. We should not adapt buildings unless refurbishment was going to take place anyway (economics must prevail).
- Use refurbishment as a means of changing the internal design to reflect changes in the population composition, working attitudes and current housing needs. Changes in working requirements might include dedicated working spaces for working from home. Multi-use areas could become more common.
- Adapt existing buildings of any type to provide greater residential capacity.
- Improve existing settlements by connecting groups of buildings and inserting living plants and water wherever possible. The important issue is how to avoid the creation of ‘ghettos’.

New buildings or settlements should:

- Be made to last 1000 years rather than 20 or 30.
- Be well researched to fully understand the effect of the building process and end products on the environment. Running costs and life cycle impacts in terms of resource utilisation and emissions for new and existing buildings are not yet fully documented and they need to be.

- Follow patterns set by simple, elegant, balanced, non-extreme, single issue and composite solutions that have been developed and promoted for both the public and private sector as ‘best practice exemplars’.
- Be as autonomous as is environmentally beneficial, including techniques such as on-site water collection, re-use, waste water and sewage treatment, electricity production by PV or other renewable source, solar heating to reduce the environmental impact of the buildings.
- Be long life, loose fit, low energy.
- Be flexible and adaptable. Office space will be designed into the majority of homes.
- Where appropriate, be designed for natural ventilation.
- Be constructed of local materials wherever possible. Over specification should be avoided.
- Be critically assessed for their environmental impact by using a scheme such as BREEAM or similar.
- Have a ‘sense of drama and discovery’ with inner courtyards, gardens, galleries and usable roofs, with ‘designed-in’ meditation spaces for mental renewal, and physical recreation spaces for bodily renewal.
- Have ‘complex edges’, that make, not destroy the spaces between them. Buildings should be connected to their environments.
- Have all rooms with natural light on two sides. The corollary of this is that new buildings would be smaller, and not deep plan.
- Be low rise (no more than 4 stories high has been suggested by one respondent), except in exceptional circumstances, and no new residential tower blocks should be built.
- Buildings should not be merely functional but glorious, charming or quaint depending on the function.
- Be community buildings, supporting local initiatives, and providing opportunities for intelligent recreation, fitness and social interaction. People may not wish to live together, but there could well be a need to rebuild communities, so the term ‘community building centre’, or something similar, could well replace ‘social centres’.
- As the population ages, more accommodation will be needed for the retired and elderly. The corollary of this is that the workforce will be proportionately smaller, thus imposing a increasingly higher workload on a constantly reducing workforce.
- Be built to cater for changes in lifestyles. More smaller dwellings will be needed to complement and balance urban developments and changes in lifestyle due to the continued fragmentation of families.
- Be built involving the users to prevent short-term dissatisfaction, rejection and discarding, leading to unnecessarily early replacement.

Question 2:

How should we design and construct them?

We should design and build:

- Using a 'team' approach, involving the customer, architect, contractor, engineer, and also other non-construction professionals as appropriate, possibly human scientists and ecologists. There needs to be more trust between the various parties involved, with partnerships replacing the existing traditional combative approach. There needs to be more client participation.
- With commitment and a unified vision and holistic approach to the implications of sustainable construction. The team should attend specialist 'green' courses in order to assist their understanding of the issues involved. Clients, contractors, designers and planners need to use a common check list.
- With more statutory rights of consultation, access rights and tougher planning restrictions to ensure buildings are adaptable, appropriately sized, and have sufficiently high energy performance.
- Always vastly over-design.
- Using designs relevant to the local context.
- With less emphasis or provision for cars.
- To make buildings more cost effective and affordable.
- To encourage flexibility of use of the structure and/or the interior of a building. This would include designing for accessibility for the less mobile, and lifetime use, particularly in the case of homes. Include provisions for wheelchairs, pushchairs, and stair lifts. Design for regular use and maintenance by the less mobile should be encouraged, to allow for the changes in population age.
- Including super-insulation, good daylighting, passive solar design, active solar heating, PV, computerised energy management systems, and with close attention to every detail. Attention to thermal capacity and passive solar design will become the norm. Buildings will need to be as air tight as possible, reducing heat loss through excessive air change rates.
- Using correctly sized components, particularly HVAC. So-called 'safety factors' lead to inefficiencies and waste of resources.
- For correct and comprehensive commissioning, which should be carried out before occupation, and either certified or witnessed.
- Using matrix wiring systems to accommodate easy layout changes.
- Using the climate modifying properties of the structure and surrounding landscape to minimise service inputs.
- As energy autonomous as is environmentally beneficial. Operational energy is much more significant over the life of the building than embodied energy, therefore operational energy efficiency is the important factor. The possibility of using alternative energy sources in the future should be kept in mind.
- Including performance monitoring capabilities or features as a standard part of the services, and the results of the information gained should be freely and widely available.

- To allow the built space ‘service’, not the product, to be purchased, or leased (such as serviced apartments or offices).
- In such a way that each new design is environmentally better than the previous one.
- To promote culture and depth in human relations. Buildings with character and individuality will be required. We need to get away from the ‘little boxes’ syndrome.
- Use materials which weather pleasingly rather than deteriorate.
- For a small ecological footprint, (either with or without reference to Life Cycle Analysis (LCA), Life Cycle Impact (LCI), or usage conditions). To do this, we need a better understanding of the sources and processes involved in material supply. We need a better understanding of the effects on the environment of buildings in use.
- Assessing the environmental impact of the building as an integral part of the design process by choosing materials for minimum environmental impact (either benign low embodied energy materials which can be reused and/or returned to the natural cycles, or small amounts of materials which can be ‘endlessly’ recycled such as copper). Design for a ‘reduced’ material content is one way of achieving this.
- Using at least 10 % reclaimed components/materials. A specific example is the use of recycled crushed concrete as aggregate in construction.
- Using materials which are not over-specified for the intended use. Tight specifications often lead to high reject rates at source. Sensibly specified materials allow a higher raw material usage rate.
- Identify cost effective low resource use materials and designs. Develop and publish methodology to do this.
- Using LCI as a major factor in design and construction.
- To BREEAM standards as the minimum required.
- If the current trends in global warming continue, the threat of increasingly violent storms must not be overlooked. Stronger construction will be needed, particularly for roofs. As the ozone layer continues to deteriorate, UV protection in the form of increased shading either from buildings or increased planting of trees will be needed.
- Construction methods should use lots of people rather than non-renewable energy.
- For demolition/disassembly, possibly using reversible fixings. One suggestion is that we should aim for at least 20 % of the building to be reused/reclaimed. ‘Take back’ schemes for recycling or refurbishment will be more common.
- Using or encouraging self build where appropriate, to allow people to have more control of their environment. However, larger integrated companies are likely to develop, with more capital backing.
- Using maximum labour, minimum capital. Traditional construction methods will become more highly valued.
- Using building ‘blocks’ in a variety of long life forms. Buildings can then be kept for ever by periodic replacement of the modules.
- Using modular construction utilising prefabricated factory made units (possibly imported), reducing wastage on site. Past attempts at prefabrication have resulted in complex assembly methods due to excessive bureaucratic control. We need to aim for ‘low-tech’ prefabrication whilst maintaining quality. Robotic construction could become more widely used, eliminating or at least reducing repetitive or dangerous tasks. Both customisation and standardisation will become more widely accepted.

- To ensure buildings are more visually attractive and appealing.
- Using much better (more efficient/effective) use of available land. Landscaping will be more popular.
- With regard to the 'spiritual' dimension of a building.
- Using simple, robust technology, to enable people to understand and relate to a building's form and design more easily. Simple technology, intelligently applied, can yield complex living and working spaces. Technology should be subservient to the users, not dominate or intimidate them.
- To encourage social intercourse and interconnections, not exclude them behind sheet glass and concrete. Individuals' needs for privacy must also be respected.
- Incorporating local shops and services to reduce travel needs, increasing the density of local developments along public transport routes.
- Acknowledging that new types of family groups may emerge, entailing a more diverse range of both uses and locations for dwellings.
- With communal facilities. Design factors should encourage multiple use to create a shared 'family resource centre'.
- For multi-generational occupation, such as mixed age co-housing projects.

Question 3:

What kinds of materials, services and components should be used?

We should use:

- The modular construction concept, with factory built washrooms, bathrooms, and kitchens. These would have advantages of commonality, standardisation and economies of scale.
- Materials which are identifiable, and traceable, with more liabilities on suppliers.
- Materials which are not harmful to people or the environment. This will be brought about by both popular and client demand, due to the problems caused by materials such as asbestos, or CFCs.
- Avoid anything plated, spray coated, laminated etc. Use solid 'all-the-way-through-to-the-back' materials such as stone, wood, thick metal, and even thick plastic.
- Materials and components which will be more easily recyclable, and will be designed for re-use and recycling. Existing redundant buildings should be regarded as a source of materials provided that suitable deconstruction methods are used.
- Building materials which are locally sourced and renewable, such as wood, (untreated is preferable), or alternatively plentiful non-renewable materials. like local stone, minimum metals and plastics. Locally supplied minerals should be adequately specified for the intended purpose, without excessively stringent requirements. Fossil fuels or their derivatives are not intended to be considered in this connection. Many materials will be conspicuous by their absence, especially tropical timbers, HCFCs, PVCu.
- Durable materials. Materials which do not require regular refinishing during their lifetime reduce maintenance costs and long term resource consumption.

- The materials content of services reclaimed during refurbishment, for re-use. Old style, inefficient kit should not be perpetuated.
- Timber construction where appropriate, and the necessary investments in appropriate research should be made. Timber should only be used from certified sustainable sources.
- 'High-tech' materials, but in small, carefully controlled quantities. Current advanced materials technologies should be researched for their contribution to construction. Whatever high performance materials are used should be designed to be reusable or easily recyclable.
- Strong price incentives to use services as sparingly as possible.
- De-centralised service supplies, such as waste disposal, water treatment, energy supply.
- PV, together with wind and solar (active and passive) power, and local hydroelectric supplies. Local climate changes could be a factor in the increased use of solar power.
- Local, simple on/off controls for lighting, heating, and fresh air supply.
- Maximum use of natural ventilation and light.
- Design for reuse/recycling of water and heat.
- Pulsed services systems, such as intermittent heat, fresh air and cooling to offset boredom and discomfort.
- Built in flexible infrastructure for IT communications so that if there is a move away from large conurbations, work can be done elsewhere. The possibility of a 'centralised service control network' built into the building has been suggested, which would use standardised interface analogous to the UK three pin plug, to control a range of systems such as windows, lighting, heating, ventilation, computers, communications and entertainment systems.
- Standardised services packs for water, electricity, gas, IT. These could conceivably consist of modules or plug-in packs for quick, easy installation or modification.
- Landscaping to incorporate natural shade and/or shelter wherever possible.
- Roofs suitable for the installation of gardens or landscape features.
- Energy and/or eco-labelled products. This should rely on a rigorous and believable labelling system which is in force to inform the consumer, not just provide more marketing material for the manufacturer.
- EMAS/7750 or a similar, rigorously applied Quality Assessment procedure in the construction industry for materials, services and components.
- Components (doors, furniture, windows) should be solid, built to last and not screwed to chipboard.
- Small scale services and specialist components such as high efficiency boilers or heat pipes, chosen with an emphasis on the environmental cost of manufacture, including raw materials extraction, transportation, processing, and post fabrication distribution.
- Standard kits of parts for refurbishment of standard types of installation. (for example Victorian plumbing, change sealed, fully A/C to natural ventilation).
- Visual energy consumption indicators for users.
- Minimum mechanical devices to minimise maintenance requirements.
- Weather/climate control adaptable facades; awnings for shade or rain protection.

Question 4:

What kinds of skills and standards would be required?

We will require:

- Changes in planning procedures and associated legislation to encourage sustainable construction. Legislation and professional standards will be pulled along in the wake of 'popular' approval. Health and Safety legislation could be extended to cover people generally, and not just those at work.
- Design and construction standards for durability.
- Design standards for low ultra low energy usage in operation (at the cost of possible high energy component production processes).
- A constant push towards tougher limits, higher targets, minimum environmental impact levels.
- Performance standards and third party guarantees are likely to be used to restrict the use of low quality products and installations.
- Materials specifications, particularly for natural products, to be lowered, consistent with safety and longevity of the finished product.
- A 'Home Water Conservation Act'?
- Better standards of construction.
- Design for low water consumption and waste output.
- Environmental issues to be linked to Health and Safety issues in building design.
- Mass produced, high technology buildings, with first class quality control, high reliability and high performance.
- Standard sizings and fixings for new component design (such as radiators, windows).
- Citizens juries (as already in use in Germany and Canada) with Local Agenda 21 remit.
- Considerably better environmental education at all levels from children to practising professionals (both supply and demand oriented).
- BREEAM and other assessment skills and systems for all building types to be developed and used. These systems should be continuously updated and improved. Whatever methodology is used for quantifying environmental impacts must be coherent.
- To develop new total energy assessment methods to combine embodied and operational energy.
- Design skills for building disassembly and reuse of all component parts.
- A change towards a much more multi-disciplinary and cross disciplinary approach in the construction industry.
- A greater holistic awareness and understanding of both the scale and rank of environmental effects.
- Architects who are not driven by ego.
- Designers who are prepared to 'go it alone' in setting the highest standards, finding allies in the client body.

- Designers with a wider breadth of knowledge of environmental concerns specialisation will no longer be sufficient.
- A more labour intensive construction industry, both physically and intellectually. Better design takes time, and natural materials often are not regularly shaped.
- A return to the traditional skills of carpentry, metal work, thatching, lead work, brick laying, water engineering, together with more modern skills such as reed bed technology, energy systems management, solar and wind technology. This would be combined with more use of a local work force. Workers are likely to be multi-skilled.
- High grade skills for increasing factory production; low grade skills for site preparation and installation/assembly.
- A flexible application of technical skills at all levels for refurbishment programmes, which can conflict with a drive for system building. However, design for disassembly can assist in a later refurbishment program.
- Increased levels of maintenance, security, space management and traffic management as a result of changes in city structure.
- Less reliance on centralised large scale plant, with a much greater level of local human knowledge and skills.
- Better product information in respect of environmental parameters such as embodied energy, CO_2 data, environmental impact assessment.
- Per capita resource use indices to assess projects.
- Components broking services for reclamation.
- 'Rules for the environment' for building operators in order to minimise the environmental harm caused by buildings.
- Building handbooks, as issued with cars, explaining operating principles, as well as the details.

Question 5:

What kind of cities and settlements would we have?

It is likely that:

- Most cities will spread further in to the countryside, continuing the present tendency towards urban sprawl.
- Dependent on demographic changes and local working practices, some cities may actually shrink, becoming more dense.
- The trend towards 'them and us' will become much stronger. Those with wealth and/or knowledge will separate or isolate themselves from the rest; private quality will restricted to the few, whilst the majority will remain in need of the basics, with minimum resources.
- Better use should be made of existing urban space, including the use of derelict land and buildings before the use of green field sites is even contemplated. Infill sites should be used in preference to green field sites, with the proviso that some infill sites should be used to create open green spaces instead of buildings.

- Brown field development might become a more preferred option, particularly if suitable encouragement is given in the form of tax breaks or concessions. The natural reluctance of investors to become involved in brown field sites due to the possibility of consequential damages and liability as a result of contaminated land or ground water needs to be overcome. Better clean up and risk liability procedures would help.
- As communications technology improves, there could be a move away from the present large city centre clustering. This would result in a trend towards a more mixed industrial/services base in most settlements.
- New developments are likely to be 'compact' (greater density, mixed use developments, with more co-housing projects).
- High rise buildings would be demolished instead of being refurbished, and the materials recycled for reuse.
- There are likely to be examples of sustainable *re*-development.
- The NIMBY (Not In My Back Yard) attitude will strengthen considerably, with the result that direct action from lobby groups will increase.
- Underground buildings may become more popular.
- There could be a change towards shared facilities in new housing developments, such as waste disposal, cooking, washing facilities, water collection and treatment.
- The existing UK tendency (and preference) towards ownership, particularly in the domestic market, could change towards renting, or lease/hire agreements.
- There will be increased use of teleshopping and teleworking. This is likely to be forced as an economic necessity rather than as a desire or wish to do so. Transport difficulties could be the driver.
- Permanent need for cleaner air which doesn't corrode and dissolve buildings.
- Citywide water recycling and waste minimisation/recycling.
- Need to rethink zoning and promote mixed development.
- Cleaner production facilities.
- There will be reduced noise levels, both internally and externally.
- The use of renewable energy sources will increase, including wind, solar, PV, biofuel powered CHP, and there are likely to be more community based energy generation systems.
- There will be more self-build, car free zones, low impact settlements in open country, with a significant increase in the acreage under woodland.
- Transport will remain a major environmental issue, and any transport changes will therefore have a significant impact on our development style. Specialised settlements may develop ('cycletown', 'pedestriantown').
- Low energy, low pollution mobility systems.
- City centres will still be a focus of business, so transport infrastructure will need to be improved. It is likely that city centres will become increasingly pedestrianised, with very limited/restricted vehicular access.
- The most significant single improvement to the quality of life in the majority of areas could be gained by subsidising free public transport. Companies which provide free car parking are in effect discouraging the use of public transport by subsidising

and encouraging car use. The true cost of car use (including road construction costs, parking, pollution, CO_2) should be passed on to the users.
- The regular use of bicycles will become more common, heavily influencing settlement designs.
- Light, low cost, tramway systems will be introduced.
- Flexible public transport systems will be combined with cars being banned from city centres. Monorails and luggage links could be introduced.
- By connecting the living place and the work place, either by teleworking, or some other means, commuting, as we know it now, could become an anachronism, greatly reducing non-renewable fossil fuel consumption, and improving quality of life.
- Increased and improved local facilities should reduce local road journeys by car.
- A reduction in commuting could mean that social interaction within local communities could begin to re-establish itself. It is possible that special interest communities or trading groups may establish themselves as transport changes occur.
- It is likely that travel for leisure activities will increase.

Question 6:

What are the perceived barriers to the implementation of sustainable construction?

The barriers to the implementation of sustainable construction in the UK are:
- Construction is demonstrably not sustainable, so all that can be done is to make it less unsustainable.
- The initial assumption that the construction industry will adopt sustainability is questionable.
- The construction industry can/will only provide what clients demand.
- It is unclear what constitutes ‘the construction industry’. Additionally, the participants in the life cycle of a building are many, varied, and may change many times.
- Short-termism. Economic evaluation favours cheap, short-lived solutions.
- The service life of building materials is typically very long, which means that a significant part of the environmental burden from building components occurs for many years after the production and construction process.
- Virtually every commercial building (with the possible exception of modern out-of-town supermarket buildings) is a prototype.
- The residual organisational patterns and habits deriving from the easy availability of fossil fuels will hinder the adoption of appropriate energy strategies at a local level.
- Central government departments are dominated by energy intensive economic interests.
- There is little public information available on the state of the UK sustainability indicators.
- Materialism. We live in a heavily consumer oriented society. People perceive themselves as ‘poor’, and therefore the struggle for an ‘improved’ lifestyle,

involving increased consumption, overshadows the long term care for the environment.
    - Modern day values promoting individual survival result in reactions of
    - 'Why should I tighten my belt?'
    - 'Why should my standard of living reduce?'
    - 'It's someone else's way of life that is at fault and causes all the problems, not mine!'
- The impact on the environment of human lifestyles and attitudes is not properly understood.
- Many existing products are not 'green' labelled, and those that are labelled are labelled for marketing rather than environmental reasons.
- We have a market driven economy. The definition and meaning of 'economic growth' needs to be re-interpreted.
- Insufficient evidence of the benefits of sustainable construction.
- Lack of high quality, robust, demonstration projects.
- Inadequate measurement techniques to quantify environmental impacts.
- Conflict of system boundaries between clients, designers and Local Agenda 21.
- There is a public perception that environmentally friendly buildings are somehow 'odd', or 'strange'. The association with 'hippie communes' still exists.
- There is a perception that sustainability is elitist, and that only the rich can afford it. The difficulty is raising sustainability standards for all, at minimum 'real' cost. A suggestion is massive investment in technological 'fixes' which would then become available to all.
- Undervalued/cheap resources and energy, particularly non-renewables.
- Priorities are as yet unidentified. Which is most important, water or energy, global or local? This tends to confuse the issues and makes decision making difficult. All decisions are context dependent.
- Demographic shifts taking place in the UK may hinder the effectiveness of sustainable development:
- Some predictions indicate that the UK population will increase to some 65-70 million by 2030.
- There is a population shift towards the South of the UK.
- The average age of the population is increasing. The result is that the proportion of the population working is decreasing, and the financial burden of supporting the non-working population is increasing.
- Household size is reducing, leading to an 'unnecessary' demand for more individual dwellings.
- We live in a 'Technofix' culture.
- We have adversarial construction industry contract law.
- Sustainable development will not happen; people do not want it, because it costs, and people who need to pay for it cannot afford it.
- It has taken 25 years for the simple concept of energy efficiency to begin to be taken seriously in the UK. Even now, many houses in the UK are poorly insulated. How long will it take for the relatively complex issues involved in sustainable construction to be accepted and then implemented?

- Lack of awareness that there is a problem and an urgency to address it. This is probably due to ignorance. There is a lack of awareness of sustainable construction, and a lack of answers. Poor education and training may be blamed for this. There is a lack of serious interest in sustainability in schools of architecture.
- The environmental perceptions of the general public, and probably most of the construction industry contains virtually no sustainability element at present.
- Lack of a democratic/populist mandate for sustainable construction. Whilst people may be concerned in some way about the issues in general terms, there is a general perception that 'Nothing can be (or should be) done. There are other priorities'.
- Short termism. Indifference to today's actions causing environmental problems 'in the future'.
- Lack of conviction. Individuals do not believe that their own individual actions can make a difference.
- Nobody feels particularly responsible. However, one respondent has suggested that when a client/design team does feel responsible, a sustainable development can be achieved.
- Lack of 'ownership' or responsibility for environmental impact. However, 'take back' schemes are gradually being introduced in the car, electronics and white goods industries. Similar schemes could be adopted in the construction industry.
- Conservatism. Unwillingness to accept new or what is perceived to be 'controversial' knowledge. The construction industry is conservative, tending to use traditional methods and designs.
- Resistance to change attitudes and perceptions.
- Environmental problems are seen as insurmountable problems rather than opportunities.
- Lack of a sustainability culture.
- Lack of demand from the general public and construction clients.
- Adverse publicity associated with extreme fringe groups activities. Environmental pressure groups tend to cloud the issues and distort the true environmental picture. Whilst a result may be achieved, is it the best one?
- Cynicism in politics, business and hence in the general population discourages any moves towards sustainability.
- The environment is not seen to provide a marketing advantage.
- Sustainable construction is perceived as 'risky'.
- The perception that environmental aspects of construction are expensive. Sustainable construction is considered to be too expensive.
- Lack of financial incentives to achieve sustainable construction. Financial institutions minimise their risk. Capital costs are still too important. Intangible future environmental benefits are not costed against immediate financial costs.
- Environmental externalities are not accounted for in conventional accounting systems.
- Professional indemnity insurance encourages 'safe' designs which are over specified to ensure minimum risk to the designer.
- Building procurement methods are dominated by large developers and building companies motivated by profit at all costs.

- Lack of ‘drivers’, incentives, enforcement, legislation.
- Insufficient public involvement in Local Agenda 21.
- Lack of sufficient public participation in sustainability initiatives or the sustainability debate.
- Unimaginative Local Plans which discourage sustainable settlements.
- Existing planning laws, technical standards and attitudes conspire against experimentation, alternative approaches and low technology solutions.
- Insufficient use of existing guidance.
- Policies led by forecasts. For example, predictions of increased road traffic have been used to justify more and bigger roads, which then encourage more road traffic.
- More respect and support by Government for moves by Local Authorities to adopt sustainable policies is required.
- Modern democratic government is a block to sustainability, because once it has accepted re-election as its overriding determinant, it will only implement short term measures.
- A cultural shift is needed by government and individuals.
- Lack of ‘internal’ construction industry consensus on what sustainable construction is, or means.
- Lack of public consensus on what sustainable construction is, or means.
- Achievement of consensus by Trade Associations and the public is likely to be an unachievable goal.
- Long time lags are needed for changes in attitudes towards and understanding of sustainability.

5. APPENDIX 2 : SUSTAINABLE CONSTRUCTION INITIATIVES AND RELEVANT ORGANISATIONS IN THE UK

UK GOVERNMENT COMMITTEES

ADVISORY COMMITTEE ON BUSINESS AND THE ENVIRONMENT (ACBE)
This forum was established in 1991 to promote dialogue between businesses on environmental issues. Membership is made up of business leaders from across a wide range of sectors and the Committee reports regularly to Government on sustainability related issues.
Contact:
Gavin Costigan
Department of Trade and Industry
151 Buckingham Palace Road
LONDON
SW1W 9SS
Tel: 0171 215 1882, Fax: 0171 215 1621

GOVERNMENT PANEL ON SUSTAINABLE DEVELOPMENT
The panel comprises a small group of individual experts, appointed by the Prime Minister in January 1994, to give authoritative and independent advice on areas of priority relating to sustainable development to the Government.
Contact:
Mrs K V Cavill, Secretary
Floor 23, Portland House, Stag Place, London, SW1E 5DF
Tel: 0171 890 4962/4963, Fax: 0171 890 4959
Email: 106174.2501@compuserve.com

LOCAL GOVERNMENT MANAGEMENT BOARD (LGMB)
Local Agenda 21 involves a process of consultation and consensus between local authorities, citizens, local organisations and business enterprises. Although not a statutory requirement, the majority of UK local authorities are now establishing Local Agenda 21 programmes. The initiative is being co-ordinated by a steering group supported by the Local Government Management Board (LGMB), based in Luton.
Contact:
Arndale House, The Arndale Centre, Luton, Bedfordshire, LU1 2TS
Tel: 01582 451166, Fax: 01582 412525

UK ROUND TABLE ON SUSTAINABLE DEVELOPMENT
The Round Table brings together representatives from central and local government, business, environmental organisations and other groups in society. It began work in

January 1995 and aims to identify the agenda and priorities for sustainable development, as well as to develop consensus on difficult issues.

Contact:
Round Table Secretariat,
Floor 23, Portland House, Stag Place, London, SW1E 5DF
Tel: 0171 890 4966, Fax: 0171 890 4959
Email: 106174.2501@compuserve.com

UK NETWORKS & ORGANISATIONS

ACTAC - THE TECHNICAL AID NETWORK

The Technical Aid Network is a national network of centres, groups and individuals who provide a range of professional and technical skills in support of community improvement to land and buildings.

Contact:
Ray Georgeson - Director
64 Mount Pleasant, Liverpool, L3 5SD
Tel: 0151 708 7607, Fax: 0151 708 7606

ACTION FOR SUSTAINABLE RURAL COMMUNITIES (ASRC)

The aim of this organisation is to generate sustainable rural communities through community-led partnership development based on ecological principles. A national network of individuals, agencies, and organisations with a commitment to the above is one of the ways in which the organisation seeks to operate an information network and a technical project group in order to achieve this aim.

Contact:
Rod Hughes
Lowe Rae Architects, Three Crowns Lane, Penrith, Cumbria, CA11 7PH
Tel: 01768 863812
E-mail: nal@dial.pipex.com

ASSOCIATION FOR ENVIRONMENT CONSCIOUS BUILDING (AECB)

AECB acts as an information centre within the construction industry, persuading the trade and suppliers to give more consideration to environmental matters. It promotes awareness through publications, audio-visual talks, displays and exhibitions to both the trade and the general public. Members are encouraged to develop green policies and to work together. AECB liaises closely with Friends of the Earth, Greenpeace and other conservation groups.

Contact:
Keith Hall
Windlake House, The Pump Field, Coaley, Gloucestershire, GL11 5DX
Tel: 01453 890757, Fax: 01453 890757

BEQUEST (BUILT ENVIRONMENT EVALUATION FOR SUSTAINABILITY THROUGH TIME)

This network was set up as a result of the first International Workshop on Environmental Impact Evaluation of Buildings and Cities for Sustainability, held in September 1995 in Florence, Italy. An E-mail network has been set up as a discussion forum on the title topics, mainly involving the delegates from the original workshop. A new topic for discussion is presented each week.

Contact:

Prof. P S Brandon
Research and Graduate College, University of Salford, Salford, MS 4WT
Tel: +44(0)161 745 5164, Fax: +44(0)161 745 5553
E-mail: P.S.Brandon@surveying.salford.ac.uk

BUILDING RESEARCH ESTABLISHMENT (BRE)

The BRE carries out research, provides technical consultancy on construction problems for the public and private sector, and disseminates results via publications and seminars. Current projects on sustainable development include the identification of key issues concerning sustainable development, recycling and reuse of building materials.

Contact:

Technical Consultant - Advisory Service
Garston, Watford, WD2 7JR
Tel: 01923 664000

BREEAM

The Building Research Establishment Environmental Assessment Method (BREEAM) has been developed by BRE to provide an independent and comprehensive assessment of the environmental performance of a new building. It is now a tried and tested scheme and currently covers offices, superstores, industrial units and homes. BREEAM covers issues ranging form global atmospheric pollution, the local environment of the building through to the comfort and health of occupants. A BREEAM assessment will give the building a 'rating' of its environmental performance which can then be used for comparisons or improvements.

Contact:

The BREEAM Office at BRE (see above)

BUILDING SERVICES RESEARCH AND INFORMATION ASSOCIATION (BSRIA)

BSRIA is a co-operative and collaborative centre for research, technical information and advice for the building services industry. The Centre for Construction Ecology within BSRIA provides services and undertakes research into all environmental issues relating to buildings and construction.

Contact:

Dr Stephen Mustow
Old Bracknell Lane West, Bracknell Berkshire, RG12 7AH
Tel: 01344 426511, Fax: 01344 487575
Email: stephen.mustow@bsria.co.uk

CONSTRUCTION INDUSTRY RESEARCH AND INFORMATION ASSOCIATION (CIRIA)

CIRIA is the independent private sector research association, carrying out research and disseminating information relating to all areas of construction. CIRIA focuses on providing best practice guidance to professionals, covering construction practice, building design and materials, management and productivity, ground engineering, water engineering, and environmental issues. This guidance is disseminated widely through networks, publications, newsletters, and events.

Contact:

6 Storey's Gate, Westminster, London, SW1P 3AU, England
Tel: 0171 222 8891, Fax: 0171 222 1708.

CONSTRUCTION INDUSTRY ENVIRONMENTAL FORUM (CIEF)

CIEF is managed by CIRIA in partnership with BRE and BSRIA. The objectives of the Forum are:

1. to promote awareness and understanding of environmental issues relating to construction through fortnightly discussion meetings throughout the UK;
2. to identify available guidance for practitioners;
3. to identify barriers to good environmental practice, particularly in respect of information shortfalls;
4. to promote collaborative studies to produce guidance information.

The Forum has been developed to act as a focus on environmental matters for all those involved with construction including developers, material producers, design and other consultants, builders and contractors, property owners and managers, lending institutions and insurers.

Contact:

Jon Bootland at CIRIA (see above)

CONSTRUCTION INDUSTRY TRADING ELECTRONICALLY (CITE)

This is an initiative set up in 1995 by some of the leading contractors in the UK to develop and encourage the use of electronic trading in the UK construction industry. The tools and standards have been developed to enable member companies to transfer data in common electronic interchange formats. The membership, comprising contractors, major suppliers of building products and quantity surveyors, creates a community that allows trade to be carried out extremely efficiently, using the latest communications technology. Contractors are able to deal with their suppliers using ‘paperless communications’, and quantity surveyors can now tender for new contracts electronically. This initiative illustrates the industry’s increasing acceptance of and uptake of electronic communication mechanisms.

Contact:

PO Box 5432, Redditch, Worcestershire, B96 6JN
Tel: 01386 763300, Fax: 01386 793306

ENERGY DESIGN ADVICE SCHEME (EDAS)

The Energy Design Advice Scheme is a discretionary initiative sponsored by the Department of Trade and Industry. It provides access to advice on energy conscious

design of buildings by regionally based experts for those professionals commissioning or executing the design of new-build or refurbishment projects. Subject to the availability of funds, the Scheme will consider helping any project which meets the criteria for support.

Contact:

Tadj Oreszczyn, Regional Director
Energy Design Advice Scheme, The Bartlett Graduate School, University College London, Gower Street, London, WC1E 6BT
Tel: 0171 916 3891, Fax: 0171 916 3892

ENVIRONMENT AGENCY

The Environment Agency is one of the world's largest environmental regulatory organisations. Its overall aim of protecting and enhancing the environment contributes to the world-wide environmental goal of sustainable development. The Agency is required to place its activities within the context of sustainable development, based on government guidance.

Contact:

Head Office, Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol, BS12 4UD
Tel: 01454 624400, Fax: 01454 624409
Email: enquiries@environment-agency.gov.uk

EUROPEAN HOUSING ECOLOGY NETWORK (EHEN)

A European network of housing bodies and consultants established in order to develop partnerships for THERMIE funding. A number of such awards have been made.

Contact:

Ken Walker, Secretary
Chart Cottage, Graftham Nr Petworth, West Sussex, GU28 0PX
Tel: 01798 867609, Fax: 01798 867413

FRIENDS OF THE EARTH

The Sustainable Development Research Unit (SDRU) is part of Friend's of the Earth campaign department. It supports Friend's of the Earth campaigners through research and information provision and deals with issues like trade and aid; employment and environmental policy; health impacts of environmental degradation; environmental taxes and regulation. It commissions and manages consultancy research and undertakes it own projects. It produces between ten and fifteen reports, briefings, journal and conference papers each year.

Contact:

26-28 Underwood Street, London, N1 7JQ
Tel: 0171 490 1555, Fax: 0171 490 0881
Email: webmaster@foe.co.uk

GAP - GLOBAL ACTION PLAN

Global Action Plan was founded in 1989 to develop structured support for people wishing to adopt sustainable lifestyles. A worldwide organisation, GAP has focused its

work on the most affluent countries of the North because of the high levels of consumption. It runs 'EcoTeams' encouraging local people to optimise their lifestyles and reduce the amount of resources consumed.

Contact:

Trewin Restorick
Global Action Plan UK, 3rd Floor, 42 Kingsway, London, WC2B 6EX
Tel: 0171 404 0837/405 5633, Fax: 0171 831 6244
Email: trewin@gapuk.demon.co.uk

GREATER USE OF REUSED AND RECYCLED MATERIALS IN CONSTRUCTION

Through recent research, CIRIA (see above) have identified that there are several barriers to reuse and recycling in the construction industry. In collaboration with Scott Wilson Kirkpatrick, they are producing a handbook that provides guidance on the use of reused and recycled materials in construction. This work will include a literature review of existing knowledge and guidance in the UK, and also consultation with clients, designers, material manufacturers and a wide range of other people in the field. This consultation is being carried out through a series of workshops.

Contact:

Claire Woolveridge
Scott House, Basing View, Basingstoke, Hampshire, RG21 4JG
Tel: 01256 461161, Fax: 01256 460582

GREEN BUILDING OF THE YEAR AWARD

This is an annual award for which any new or refurbished building in the UK can be entered for, with the exception of residential properties, as long as it has been operational for a whole year. The award aims to encourage all concerned with the built environment to think 'green', from the original concept, through construction to future maintenance needs. Nominations may come from architects, developers, building owners/operators or contractors. The judges consider the overall environmental impact of entries, taking into account design, materials, transport and planning implications, etc. The awards are usually given in the autumn of every year.

Contact:

Caroline Horne
HVCA, ESCA House, 34 Palace Court, London, W2 4JG
Tel: 0171 229 2488, Fax: 0171 727 9268

GREEN FUTURES NETWORK

A unique initiative for the co-ordination of academic research, design, business development and housing construction in the midlands.

Contact:

Richard Baines, Project Co-ordinator
Black Country Housing Association
Tel: 0121 561 1969

GREEN INITIATIVE PRODUCT AWARDS

This award is open to any manufacturer or supplier exhibits at one of a number of trade shows, and who believes that they have a building services related product or service which makes a positive contribution to the environment. The judges consider innovation, overall design quality and contribution to a healthy, safe and sustainable environment.

Contact:

EMAP Business Communications, (organisers of the National HVAC Show)
Maclaren House, 19 Scarbrook Road, Croydon, Surrey, CR9 1QH
Tel: 0181 688 7788, Fax: 0181 686 7224

GROUNDWORK

Groundwork is a national network of local initiatives committed to working with others to tackle the problems of dereliction, to restore landscapes and wildlife habitats and to make positive use of wasteland in and around Britain's towns and cities. Established in 1981, Groundwork is the leading UK environmental partnership organisation active in 120 towns and cities throughout the country, operating through an expanding network of local trusts. Groundwork delivers high quality cost effective programmes which help people improve the environment and economic prospects of their area.

Contact:

Ken Davies - External Relations Director
85/87 Cornwall Street, Birmingham, B3 3BY
Tel: 0121 236 8565, Fax: 0121 236 7356

INTERNATIONAL SUSTAINABLE DEVELOPMENT RESEARCH NETWORK

An interdisciplinary non-profit making network organised in association with the Centre for Corporate Environmental Management (University of Huddersfield), ERP Environment and the journal Sustainable Development. The aim is to promote research into and the practice of sustainable development. Dissemination of information on research and best practice is by e-mail.

Contact:

International Sustainable Development Research Network
c/o Centre for Corporate Environmental Management
School of Business, University of Huddersfield, Queensgate, Huddersfield, HS1 3DH
Tel: +44(0)1484 472262, Fax: +44(0)1484 472852,
E-mail: isdrn@hud.ac.uk

LIFETIME HOMES GROUP

The idea of lifetime homes is to design all housing so that those who become moderately disabled can continue to live in their existing homes. Also those homes can be more readily and cheaply converted if disability does become more severe, say for wheelchair use. Implementation comes through adopting a set of 16 house design standards.

Contact:

The Joseph Rowntree Foundation

SUSTAINABLE CITIES NETWORK

This network is intended to allow the interchange of ideas and experience with regard to urban sustainability. Aims of the network include the establishment of a database of academics, practitioners and policy makers in the field of urban sustainability, in order to promote best practice in this area.

A database of network members and interests is to be constructed and made available. The network is funded by two UK Research Councils and will also be used to disseminate the findings of certain similarly funded research programmes.

Contact:

Dr David Gibbs

School of Geography & Earth Resources, University of Hull, Hull, HU6 7RX

SUSTAINABLE HOMES

Sustainable Homes works to promote environmental policies in housing, and is supported by an Innovation and Good Practice Grant from the Housing Corporation. The group will shortly produce a Sustainable Homes Directory (due in autumn 1997), which will contain case studies of recent projects, as well as details of relevant publications and useful contacts.

Contact:

Wendy Shaw

7 High Street, Teddington, Middlesex, TW11 8EL

Tel: 0181 943 4433, Fax: 0181 943 2163

SUSTAINABLE URBAN NEIGHBOURHOOD INITIATIVE (SUN)

The aim of the Sun initiative is to develop a broadly based network of organisations and individuals interested in sustainable urban development. The initiative is managed by URBED from its Manchester office.

Contact:

David Rudlin

41 Old Birley Street, Hulme, Manchester, M15 5RF

Tel: 0161 226 5078, Fax: 0161 226 7307

Website: http://www.urbed.co.uk/sun/

SUSTRANS LTD

Sustrans plans, builds and maintains safe non-motor routes, primarily for walkers and cyclists but also often for horse riders and less able people. It lobbies on behalf of those who prefer to use sustainable forms of transport, and for whom heavily trafficked roads represent a very hostile and dangerous environment. As the Sustrans route network grows, the possibility of safe, low-pollution travel is extended to more and more people.

Contact:

John Grimshaw

35 King Street, Bristol, Avon, BS1 4DZ

Tel: 0117 926 8893, Fax: 0117 926 4173

TWEED HORIZONS: INTERNATIONAL CENTRE FOR SUSTAINABLE TECHNOLOGY

This international Centre for Sustainable Technology is based in Scotland. Within the Centre there are 18 individual companies all having sustainability central to their business philosophy. The aims of the Centre are to:

- raise awareness of sustainable technology and provide international exchange of information and ideas;
- support companies working with sustainable technologies; and
- demonstrate sustainable technologies and their relevance to economic development.

Contact:

Website: http: www.scotborders.co.uk/horizons

UNITED NATIONS ASSOCIATION SUSTAINABLE DEVELOPMENT UNIT (UNA SDU)

The unit was set up prior to the Earth Summit in Rio in order to popularise the work of the UN in the area of sustainable development. It co-ordinates the work of non-governmental organisations on a UK National Sustainable Development Commission. The unit produces regular briefings and organises conferences and seminars on the implementation of Agenda 21 and the UN conventions. It advises local councils on the production of Local Agenda 21 and sustainability indicators.

Contact:

Felix Dodds
3 Whitehall Court, London, SW1A 2EL
Tel: 0171 930 8169, Fax: 0171 930 5893

URBAN VILLAGES FORUM

The Urban Villages Forum aims to investigate and promote the concept of planned mixed-use, mixed-tenure developments which would provide a more civilised and sustainable environment for the people living and working in them. Members of the Group include leading developers, housebuilders and representatives of financial institutions, as well as architects, planners and environmentalists.

Contact:

David Lunts
70-77 Cowcross Street, London, EC1M 6BP
Tel: 0717 490 2702

WALTER SEGAL SELF-BUILD TRUST

A national charity which helps people to build their own homes, promoting and facilitating self-building.

Contact:

Martin Field, Development Worker
57 Charlton Street, London, NW1 1HU
Tel: 0171 388 9582

6. APPENDIX 3 : UK CASE STUDIES

1. Eco Centre - Groundwork South Tyneside

Designed to lead by example, this building (completed in 1996) was originally intended to be totally self-sufficient, creating the UK's first truly autonomous office. Cost considerations have prevented this vision being wholly fulfilled, but the combination of low energy design, water conservation and on-site electricity generation means that the Eco Centre places only a small burden on the local utility supplies. The building obtains its heating and cooling via a ground source heat pump, recycles human waste via composting toilets, recovers rainwater for fire sprinklers and toilets, and uses greywater for site irrigation.

The £800,000 two storey, naturally ventilated building contains 1400 m^2 of usable floor area, arranged as large cellular offices around a triangular lightwell. Its site was a plot of derelict, contaminated land, chosen after a rigorous study of local wind regimes. It was also a good location for the 60m borehole which supplies water for the ground source heat pump and various non-potable water needs. The building is a net exporter of electricity to the National Grid via an 80kW wind turbine which is expected to generate 100,000 kWh/year for a capital investment of £76,000.

The construction materials were obtained where possible from renewable sources and recycled materials were used. The building is timber framed, with timber supporting the roof structure and internal brickwork supporting the intermediate floor slab. The reclaimed bricks came ready cleaned and palleted. The building is 30% double glazed, with the timber window frames from a sustainable timber source.

Other materials in the building were also chosen for their environmental qualities. Linoleum floor coverings are used, and acrylic (almost totally recyclable) is used for kick plates and door handles. The plasterboard is made from a gypsum residue which is a by-product of the flue gas desulphurisation process of a power station.

The basement contains the borehole, heat pump and three Clivus composting toilet chambers. Each toilet is flushed by a single pint of recycled rainwater. The liquid effluent is siphoned off and mixed in a holding tank with the building's greywater, which dilutes the effluent and then supplies an irrigation system to improve the condition of the soil around the site. Domestic hot water is generated by solar panels on the glazed roof, with storage temperatures being maintained or raised by a calorifier powered by the wind turbine.

2. Straw Bale Farmhouse, Wales

This straw farmhouse, costing in the region of £15,000, is situated in a small village in mid Wales. It is built with large bales of tightly compacted straw, and sits on a concrete foundation. The bales are held in position by wooden stakes, which reinforce the rigidity of the building. Once the walls were built, the whole building was tied by wire wrapped horizontally around it and then fixed into the foundations. These wires are regularly tightened during the months following construction.

The exterior of the building has been treated with a coat of lime-based rendering plaster. This was used instead of the usual sand and cement mix as it allows the straw to breathe, and will also act as fire protection. The final coat will be a lime and pea gravel mix.

The house will be centrally heated by a solid fuel stove attached to a boiler, but as the straw bales are estimated to provide ten times more insulation than manufactured blocks, the house is very energy efficient. The building's roof will be insulated with wool, supplied by the farm's own sheep, and is built from wood cut from a nearby forest and machined by a local supplier. The owner hopes to finish the roof with timber shingles, again made out of the local wood. All of the windows and most of the other timbers used in construction were reclaimed.

3. Car Free Housing Development - Edinburgh

This scheme is being developed on disused rail land in Edinburgh, and is due to be ready for a mixture of rented, bought and social housing by 2000.

It will consist of 121 flats which will provide energy efficient homes in a car free environment. People wanting to buy or rent flats will have to sign an agreement not to own a car and have no plans to buy one. Edinburgh City Council plans to extend its 'car club' to the development, allowing residents to hire vehicles preferentially. Two new bus routes and a possible new suburban railway station, will provide sufficient public transport services for the residents.

The land that would have normally been allocated for parking will be used for terraced gardens, allotments and reed beds. The site is to be developed to a density of around 50 units to the acre, a high density compared to typical developments.

The Canmore Housing Association has secured funding from Scottish Homes and the private sector, and has already received enquiries from many interested people who insist that they do not own a car. The architect was trying to design something that would not look out of place in Edinburgh but included technology for the next century. Houses will come complete with solar power and water recycling, and other features include:

- ◊ breathing wall timber frame construction using Warmcel recycled newsprint insulation;

- reed beds to treat greywater;
- an agreement in principle with the neighbouring North British Distillery to use excess industrial heat to provide cheap hot water for every flat;
- solar cells to provide electricity for stair lighting.

4. Holy Island Retreat Centre

This project, yet to be started, is intended to be a truly sustainable development on an island off the west coast of Scotland. It will house a Buddhist community, who desired to be part of a sustainable environment and a wholly self-sustaining community. Thus, the design had to take account of agricultural needs, integration of water and crops, waste management and disposal, and rigorous energy efficiency strategies. The overall objectives of the project were:

- to be energy self-sufficient
- to be water self-sufficient
- for all waste to be processed on site or recycled

Holy Island was bought by the Rokpa Trust in 1992, and has limited sunshine and severe exposure to Atlantic storms. In the subsequent winning design the overall complex is built into the hillside, in layers close to the ground. It has been developed in the following ways:

- orientated to face south for maximum solar gain;
- glazing sloped to maximise winter solar gain;
- buried in earth and well insulated to minimise heat loss;
- thermal shutters to reduce heat loss at night;
- trombe wall and thermal mass to provide 24 hour heating;
- sunk in ground and shaped to reduce wind exposure and heat loss whilst maintaining views and solar exposure.

The majority of the project's floorspace consists of 108 individual retreat rooms. The rooms are designed to ensure that views can be enjoyed if the occupant is standing, but are restricted at lower levels to prevent distractions while the retreatants are meditating. This is done by using the roof of the room in front as a barrier to the outside world.

The retreat also has a sustainable strategy for water use. Rainwater for washing and cleaning is to be collected along a gully at the upper perimeter, and stored at the highest point of each individual retreat. Fresh water for drinking or for food preparation is to be taken from natural springs. Most wastewater will be filtered through reed beds and fed into a pool lower down the slope.

Energy conservation is a key part of the Holy Island project's sustainability aims. As the buildings are covered in earth, energy losses will be minimised and internal temperatures will remain relatively stable. Energy use will be comparatively low so that heat absorbed from passive solar gain can provide almost half of the space heating requirements. Overall predictions for the energy consumption of the retreat are

expected to be in the region of about a third of the consumption for an equivalent conventional hotel design.

The community plans to self-build a part of the project on site soon. Although for some parts of the construction precise finishes are required (such as for the back walls, roof and facades), other less critical areas present the possibility of self-build for the community.

5. The Oxford Photovoltaic House

The house was designed by Dr. Sue Roaf of Oxford Brookes University and has the only UK example of a domestic photovoltaic roof. The aim of the project was to demonstrate that by creating a superinsulated low energy house a photovoltaic array is a technically feasible method of supplying a significant proportion of the energy required.

Several features of the design have contributed to ensure the usefulness of the PV system, including the following:

- the roof upon which the PV array is mounted faces south and is not obscured by trees, allowing the 4kW array and thermal collectors for the heating of water to operate using peak sunlight exposure;
- gas is used for cooking and instant heating of hot water for the washing machine and dishwasher (hot water for direct use comes from the active solar water heating system), and the majority of heat is provided by warm air circulating by convection to the rest of the house from the south facing double height conservatory. Energy efficient appliances are used throughout the house;
- the house is highly insulated, with 150mm of cavity insulation and an internal concrete block wall. There is 350mm insulation in the roof and a further 150mm under the ground floor. The windows are triple glazed with evacuated cavities ('U' value approximately 1.8 W/m^2K). Doors in the south side are buffered by the conservatory and in the north side by a porch.

These energy saving measures lead to a reduced electricity demand, so that the PV array is able to produce a greater percentage of the energy needs of the occupants than would be possible in a typical situation. During the winter approximately 44% of the total average 24 hour load is met by the array. The area in which the house is situated receives approximately 4 hours of sun per day in the summer, but only 0.6 in the winter. A major problem of domestic rather than commercial building PV systems is that the times of peak energy production (daytime) are times of minimum load. Maximum loads occur in the evening and in winter, when production is low. In this case, a system of battery storage of the excess production was rejected in favour of a importing and exporting energy to the National Grid.

The electricity consumption has been calculated as 2131 kWh/yr. During the summer, the PV array supports the daytime load, producing a daily surplus of typically 12kWh, which is exported to the utility supply through an import/export meter. In the evening

this can be reclaimed, with typically 2kWh being reimported. The surplus that is exported to the grid is greater than the deficit created in winter.

The photovoltaic arrangement was based on 24v dc in order to be high enough for good inverter conversion energy (approximately 90%) whilst avoiding hazards during installation and maintenance. The wires from the array pass in series parallel arrangement to a distributor box which is in turn wired to a 4kW inverter, converting dc to ac.

The PV modules are sited low upon the roof with an air gap behind to avoid overheating of the modules and the roof lining. The placing of the modules was designed to allow easy access for cleaning and to incorporate two skylight windows in addition to the forty evacuated tubes thermal collectors which provide hot water for the house.

The proportion of electricity demand met by the PV array would be considerably reduced had the house not been designed to minimise it's electricity load. In fact it is unlikely that the PV array would have had the effect of producing enough electricity to meet all demands had this not been the case. This is an excellent example of demand side management effectively reducing the capital requirements of the autonomous system.

The total cost of the PV system is estimated at £22,000 including the cost of installation, grid supply connection (including import/export meter), the inverter and VAT. However, the PV cells were supplied by BP Solar at a price of £3/Wp, around half what would normally be charged.

An array surplus of 1000 kWh/a is produced, which is exported to the grid. Therefore if the cost of installing the system is set against the cost of each unit of electricity generated by solar energy a payback period can be calculated. For example, if the unit cost is set at a minimum of 10 pence/ kWh then the system will have a payback time of 66 years. However, it is reasonable to assume that the cost of PV equipment will continue to fall in the future. In addition to this, possible increases in the price of grid electricity could make the system cost effective.

The current cost per year of running the solar array based on a consumption of 2131 kWh/a is calculated as £375. This is approximately double the cost of the conventional utility supply, but this can be expected to decrease considerably as the price of electricity increases.

6. Autonomous House, Southwell

This house, designed and occupied by Brenda and Robert Vale, is the only example in the UK of a fully occupied urban autonomous dwelling. It is of a conventional appearance, located in a medium density country town. It is extremely energy and

water efficient, and uses a range of autonomous technologies. External wall U values are 0.14 W/m^{2}K, and that of the windows is 1.1 W/m^{2}K.

Energy needs for the Southwell autonomous house are met entirely by solar gains, heat production from inhabitants, a wood-burning stove, and a 20 m^2 bank of photovoltaic panels. This generates around 1800 kWh of electricity per year, which passes directly through an inverter when being used within the house. Surplus electricity is sold to the grid, which also provides extra power to the house when needed. For the first year's occupation, electricity was generated on all but three days of the year[1], and the PV panels generate more power than is required. Battery storage of power is required for the water pumping system in the house, as rainwater is collected and stored in tanks in the cellar. An electric immersion heater is also used to provide hot water, although this is supplemented by active solar collectors.

The cost of the PV panels was approximately £20,000. They save around £175 per year, giving a simple payback of over 100 years. As an isolated element, the PV panels are therefore not cost effective. However, the £20,000 costs were included in the overall building price of £500/m^2, typical for a house of this size (there are no architect's fees). The PV panels need cleaning very occasionally, but this is normally adequately performed by the rain.

The demand for water use within the house is reduced by the inclusion of a chambered composting toilet connected to two ground floor toilets. All of the water for the house comes from rainwater collection. The water is stored in 20 recovered orange juice containers which together hold enough water for 300 days supply. The capacity of each container is 1,500 litres. In the summer of 1995, only one third of the available water was used, and this was quickly replenished by rains in early September. When required to top up the header tank located in the roof, the water is screened and passed through a slow sand filter. If the water is required for drinking, it is passed through a charcoal filter located under the sink. This filter needs cleaning occasionally (approximately every three weeks) when it gets blocked. The ceramic filter needs to be replaced every year (maximum) and costs approximately £25.

The house requires very little extra maintenance than a conventional, utility served house. The composting toilet needs no cleaning, but has to be stirred every six weeks. Most problems which do occur can be sorted out as normal, by an electrician or plumber.

7. Ebworth

The Ebworth Centre is a National Trust property consisting of woodland and six farm buildings. When the property was donated to the National Trust in 1989, the buildings

were very neglected and in need of extensive renovation. They are now in the process of conversion into an Education Centre, offices and countryside workshops, with the inclusion of several environmental features.

As the buildings are listed, the local planning authority has been closely involved with the conversion to date, and rigorous conditions have been associated with the planning permissions granted so far. The visual aspect of the estate has also been of great consideration, which has limited the technologies appropriate on the site, as has the need to restore the buildings in a vernacular style.

There is no mains water connection to the buildings and fresh water is sourced from a nearby stream by means of a hydraulic ram pump.

Water conservation on the site is maximised by use of composting toilets which serve the main visitor area. The model used has three toilet cubicles whose waste pipes all connect to one main chamber. The chamber has a capacity based on 60 - 80 solid uses per day. The toilets have proved easy to maintain, wood shavings are added weekly and the waste is raked every couple of weeks. Liquid waste is removed from the base of the chamber every month and transferred to the reed bed. No compost has yet been removed. The cost of the toilet amounted to approximately £7000, the majority of which involved the import of the system from the USA. Feedback from members of the public has generally been very favourable.

Greywater from the hand basins in toilets, the kitchen sink and the workshops is discharged into a soakaway via a grease trap. Several problems have been experienced with this system due to the clogging of the perforated pipes with grease and other substances, however these have been rectified by slight structural changes and the careful consideration of the type of substances disposed of in the sinks.

The on-site warden's house has conventional plumbing, however all the waste from the house is treated in a system of bark rings and reed beds. The steeply sloping nature of the site is ideally suited to a gravity fed system of this nature. Waste water leaves the site and enters one of two concrete rings filled with bark, which is contained within a netting bag for easy removal. The bark acts as a filter, trapping most of the solid waste. Water is discharged from the rings into the first of two vertical flow reed beds and from there into a horizontal flow reed bed. Finally the treated effluent enters a manmade pond before final discharge to land.

The cost of this system was approximately £7000, but would have been greater had not much of the work been carried out by National Trust staff. It is designed for continuous use by eight people, with occasional use by up to fifteen. Maintenance involves the emptying of the bark from the rings, which is required around once a year. As only one of the rings is in use at any one time, this allows one ring to be used whilst the other composts prior to removal. The maintenance of the reed beds is minimal.

Future modifications are planned, including the direct linking of the liquid effluent from the composting toilets with the reedbeds. The greywater from the kitchen and workshop may also be connected to the reedbeds, eliminating the problems which have occurred with the soakaway.

8. Allerton Park, Leeds

This development is a terrace of three self built houses in Leeds. One of the priorities of the self-builders was to attain total autonomy from water and sewage mains systems. This is enabled by the use of a composting toilet in each house, which means that there is no sewage effluent to be disposed of.

Grey water from all remaining discharge sources is passed through a grease trap and collected communally in an underground storage tank. The water is then discharged to a vertical flow reed bed and from there to a pond via a submersible pump. The pond water is also supplemented by rainwater draining from the surrounding land. The reedbed and pond system overflow directly to a soakaway. The water is finally pumped to a storage tank through a mesh filter and then a 12.5 micron filter (which has an automatic backwash facility).

Additional treatment is required before the water is pumped to each of the houses for use in bathing and washing and for the heating systems. A 40W UV steriliser has been connected to the tank such that incoming water is treated and a timed circulatory motion provides further treatment.

The grey water equipment is stored in an insulated pump house under the houses. The heat generated by the pumping and treatment equipment should prevent freezing of the system, and a 100W light connected to a frost-stat provides a fail safe back-up.

Rain water is collected from the roof of each house and is stored separately (rather than communally) to avoid disputes as to use in periods of drought. The water is treated before being used for drinking and cooking.

As rain water drains from the roof it is collected in wooden gutters, backfilled around plastic land drain piping with gravel. Water drains via downpipes through a double filter and into a storage cistern of food grade plastic under the house. Water is pumped from the cistern through a 25 micron pre filter and then a 0.5 micron carbon/ceramic filter. Both filters are direct in line to the drinking water supply. Voluntary water quality tests are being carried out by the Environment Agency, and this system is not being used until these are complete. It may be necessary to install a UV treatment system in addition to the carbon/ceramic filter.

A maintenance schedule and servicing routine has been drawn up by the residents and will be written into the freehold deeds of the properties to ensure correct care and maintenance of the systems.