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House for the Future

Museum of Welsh Life St Fagans

AMGUEDDFEYDD AC ORIELAU CENEDLAETHOL CYMRU
NATIONAL MUSEUMS & GALLERIES OF WALES

Foreword

The House for the Future at the Museum of Welsh Life St Fagans has been conceived from the broadest of visions. As the following pages will show, this remarkable project brings together heritage and business interests in Wales in an innovative building which is quite exceptional in its scope and ambition.

The success of the House is that it marries the multidisciplinary expertise of the National Museums & Galleries of Wales with the generosity of sponsors whose areas of interest showcase a whole spectrum of our country's riches, from innate talent to natural resources. Using the very best of Welsh technology and artefacts – from grand conception to tiny details – it has been designed and built to the most stringent of briefs to be sustainable yet realistic, and flexible enough to rise to the challenge of forthcoming change.

Its physical situation is perfect. The Museum of Welsh Life is a very special site, where the skills of staff combine a deep and detailed knowledge of social history with a wide-ranging awareness of the relationship between buildings and their context, both historical and environmental. What better place then, to explore the very idea of home? Or to show how the future grows out of the past?

As its name proclaims, this house is indeed a blueprint for our possible future. Yet, better still, it is also a dialogue, an idea shaped from slate and clay, wood and stone, to invite debate and discussion on how we might live in times to come. Like the National Assembly for Wales itself, this is a space where we can engage with our ideas of tomorrow, add our ideals to a vision for life, and join together in creating our common aim – a better Wales.

Jenny Randerson

Jenny Randerson, Assembly Member
Minister for Culture, sport and the Welsh language

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Introduction

Introduction

In the Spring of 1999 the Museum of Welsh Life at St Fagans, together with BBC Wales, announced a major competition to design 'The House for the Future,' giving architects an opportunity to portray their vision of the way housing in Wales could evolve over the next fifty years. The challenge which faced them was to provide a realistic contribution to on-going debates about the way housing and society might develop, addressing socio-economic issues such as changing family structures, new patterns of work and leisure as well as more obvious building-related issues such as energy efficiency, sustainability and accessibility.

The competition attracted 49 entries, which were eventually reduced to a shortlist of six. The winning design, by Jestico + Whiles with ECD Energy & Environment and Barton Engineers, was felt by the judges to most closely meet all requirements set out in the brief.

Whilst the final selection of the winning architect was taking place, the Museum sent a letter to fifteen established house builders who were active in Wales in order to gauge their interest in getting involved with the construction aspect of the project. Redrow Homes was chosen in September 1999 because the Museum felt its profile and attitude best met the criteria.

For Redrow, the House for the Future provided an opportunity for strengthening relationships and cultivating new contacts, developing skills and examining new working practices whilst tackling new technology.

Detailed design took place late in 1999, and construction began in November 1999. The completed House was taken for a 'test-drive' by the Powell family from Bridgend late in 2000. BBC Wales captured the entire process on film, and the results were broadcast in three programmes beginning at the end of February 2001.

The innovative partnerships developed in the House for the Future project attracted further support from New Partners, an investment programme developed by Arts & Business. New Partners, launched in April 2000, promotes sustainable, mutually beneficial and multi-faceted partnerships between businesses and cultural organisations. Rachel Jones, Director Arts & Business, explains: "We are delighted to support the House for the Future through New Partners. This project is an excellent example of business and the arts working together creatively."

This book explains the background to the Museum and the role the House for the Future will play. Sustainability was a key design issue in the competition brief and the guiding principles of the design process and methods undertaken in order to achieve this are described in detail. Explanations of the solutions offered by the House, from concepts to design, through to construction are given. Interior design and garden design are explored, and finally the verdict of the family who lived in the House is delivered.

Whilst this book aims to provide the story of this particular house, the authors hope to encourage the reader to embrace the principles of sustainability. Our aim as designers was to demonstrate that sustainability principles can be elegantly incorporated in a beautiful and exciting home. We hope that the House for the Future will encourage visitors to take a step, however large or small, towards a more sustainable way of life.

1

Why a House for the Future?

"It is a widely held belief that museums, especially social history museums like the Museum of Welsh Life, deal exclusively with the past. This is not the case and one of the primary aims of all museums is to use their knowledge of the past to inspire informed discussion of the future. This truth is dramatically demonstrated in the latest project at the Museum of Welsh Life, which uses the Museum collection and knowledge of historical buildings as the basis for a forward-looking and innovative development."

National Museums & Galleries of Wales

The Museum of Welsh Life

Since it opened in 1948, the Museum of Welsh Life at St Fagans, near Cardiff, has become one of Europe's most outstanding open-air museums and Wales' most popular heritage attraction. The Museum illustrates the way the people of Wales lived, worked and spent their leisure time over the past five hundred years. The Museum stands in beautiful countryside, in the grounds of the magnificent St Fagans Castle, a late sixteenth century manor house donated to the people of Wales in 1946 by the Earl of Plymouth. Over the past 50 years it has inspired generations of visitors with an appreciation of Welsh history and tradition.

The open-air section of the Museum has an internationally significant collection of almost forty historical buildings. These buildings, which have been carefully moved to the site from various parts of Wales, are each typical of a particular area, period or function and their acceptance is based on rigorous research into Welsh vernacular architecture. In many ways these buildings could be seen as an historical databank which had the potential to inform the architects in their deliberation.

The vision

The National Museums & Galleries of Wales and BBC Wales commissioned a competition to design a new house to stand alongside the collection of domestic Welsh buildings which comprise the Museum of Welsh Life. The house is intended to be a serious contribution to the debate about our society and housing at the turn of the new century, responding to issues about sustainability, changing family and working life, new technologies and their many impacts, as well as to the aesthetics of houses to come.

© Jestico + Whiles

The challenge

The competition brief was to build a house that combined challenge and innovation with realism. The brief made it clear that the house should be small to medium in size and represent the type of home which might be expected to be built in numbers in the first century of the new millennium. In order to reflect this realistic brief, the construction cost of the house was limited to a maximum of £120,000.

Sustainability was a significant concern of the judging panel, reflecting the importance of environmental issues such as energy and water use, waste disposal and the use of environmentally positive materials in house building.

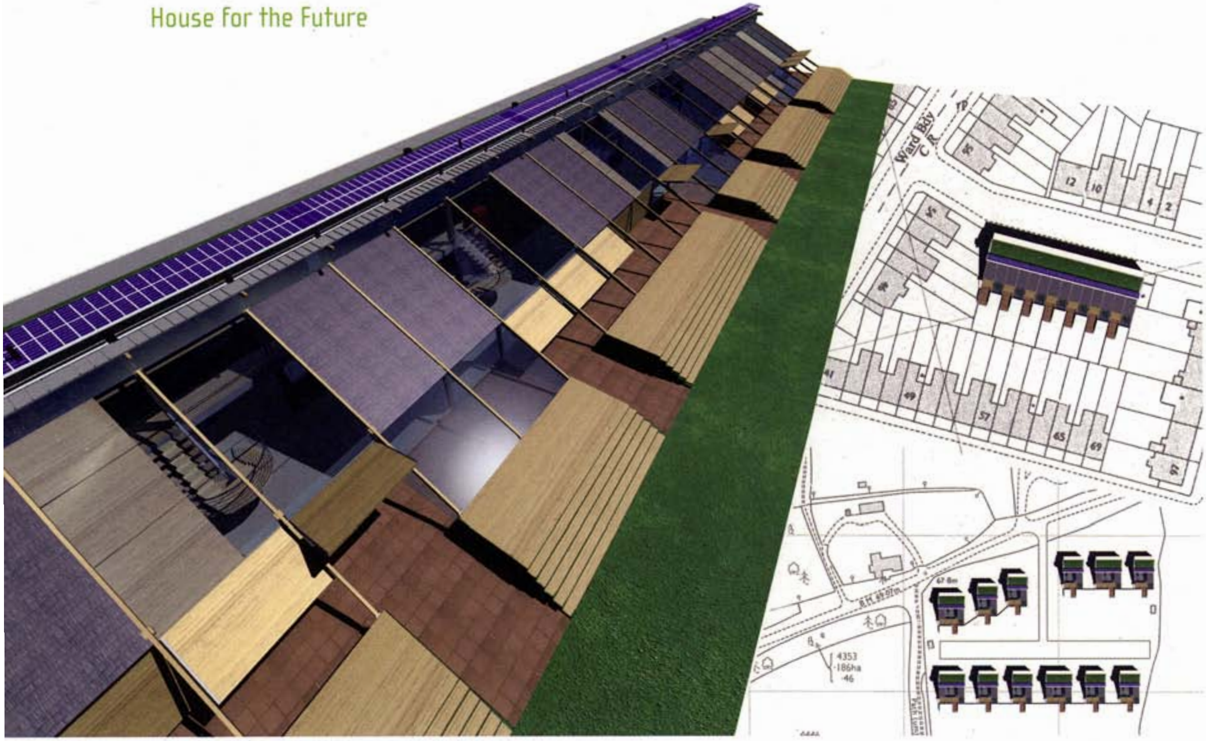
Another key element of the brief was to consider changing patterns of family and working life and to demonstrate how new technologies might support and sustain these new living patterns. The aim was to respond to Welsh culture and climate, but to avoid nostalgia.

The House had to incorporate the traditional functions of a home – relaxation, entertainment, cooking, eating and sleeping, with possible changes in functions such as working, shopping and communication as new technologies emerge.

The brief required a flexible design, so that although initially it should house a family of four or five people, it might address the changing needs, for example, of a couple or family with elderly relatives.

Underlying these considerations was a concern that the house should be resonant for visitors from a wide variety of backgrounds who will look around the house. The house should avoid being so large or packed with devices that it becomes a 'dream house' in which most people could not aspire to live.

The competition brief stressed that all solutions must allow for a steady flow of visitors as a museum piece. Successful designs would maintain the sense of this as a 'real' home whilst allowing for a through-flow of visitors. Disabled visitors must be able to access the whole house. The House was expected to have surpassed the updated building regulations in respect of access for disabled people to new-build residential properties.



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The House design, although it would be built at St Fagans, had to address the way housing should be sensitively created in the urban fringe, in rural housing areas or on brownfield or urban sites. The brief stressed that the winning design would also make a suitable response to the site and be capable of being built singly, or in clusters or large groups.

Winning design

The award-winning design was by architects Jestico + Whiles with ECD Energy and Environment providing energy and environmental advice. Structural design was by Barton Engineers.

In the winning scheme, the judges felt that they had an entry which directly answered all the elements of the competition brief. It offered the most convincing vision of an adaptable design, configurable in terraces, clusters or alone; in urban, suburban or rural situations and at varying densities. In its internal form the house also offered a flexible solution - space and features being changeable and reconfigurable whilst retaining a quality of execution. In this respect the house illustrated responses to different family forms and ways of life.

The design and construction of the house made reference to the built forms already present at St Fagans, using traditional and established techniques and materials in an integrated and natural way. This respect for material and method was integrated into a highly innovative and forward-looking design, which, in the opinion of the judges, would excite the interest of visitors to the Museum in housing for the future whist remaining true to the kinds of houses we will most probably live in.

The level of detailed consideration which the team had invested in their scheme surpassed the expectations of the judges and meant that one could really envisage not only the building of the house, but living in it. Nowhere was this care and consideration more evident than in the sustainability strategies which the team had employed. All elements of the house (design, appliances, use) were considered from a sustainable living point of view. Yet the house was substantially free of expensive or complex technology or control systems. Sustainability systems were designed for practical and common-sense use by the occupants.

© Jestico + Whiles

The scheme made a positive and integrated approach to the needs of disabled people, rising to the challenge of tackling this important competition requirement within the context of a modest house and budget.

The judges felt that the scheme offered intelligent solutions to all the questions that the brief raised. The presentation of the design and its context were of the highest quality, combining a wealth of technical support and analysis with an interpretation which was highly intelligible and communicated complex ideas vividly and clearly to a wide audience. The judges were convinced that this interpretation would extend to the house itself as a highly communicative exhibit as well as a 'real house'.

2

A sustainable agenda for the future

"The House for the Future addresses the increasing need for sustainable design in all areas – from building design and interiors through to garden design. Our hope is that the House will inspire visitors to embrace these principles in their own homes and lives."

Hannah Routh and Amy Garrod, ECD Energy and Environment

Introduction

Sustainability has become a buzzword in architecture, but it is often ill-defined and misunderstood. For the designers of the House for the Future, sustainability does not stop with the design of the House; it involves enabling people to lead more sustainable lives. To this end, a person living in the House would find it easy to reduce their transport needs by working from home, using the internet for shopping and growing their own food in the garden. Provision has been made for bicycles for the whole family. Local materials have been used in order to provide jobs in the area and to reduce embodied energy. The flexible nature of the space enables people to stay in the house throughout their lives. It is accessible to all, including the elderly and those in a wheelchair.

A predominant aspect of the design is realism. This is not a high-tech palace, it is a real home that combines the best low-tech solutions with more sophisticated ideas to give a user-friendly and enjoyable place to live. The House provides a showcase for a number of sustainable technologies, which may be taken together or individually by those wishing to move gradually towards a more sustainable way of life.

The features that have been briefly mentioned above form the basis for this whole section on sustainability within the House for the Future. Most of the specific features discussed in this section have been incorporated in the design of the House. The aim is to provide the reader with a holistic view of the methods, applications and attitudes that can work together towards a more sustainable future.

Energy

In the year 2000, as the House for the Future was being built, England and Wales experienced the wettest autumn since records began in 1766. Total rainfall during the period September to November 2000 was nearly 500mm, surpassing the previous record of 456mm set in 1852. Although this in itself is not evidence of global climate change, even cautious scientists now admit this type of extreme weather is likely to recur unless urgent action is taken to reverse the effects of man-made greenhouse gas emissions.

At the same time, in November 2000, the UK Government launched the new UK Climate Change programme. This focuses on the challenge of reducing carbon dioxide emissions by ensuring a fundamental shift in the way we generate and use energy over the coming century. The UK is obliged by the internationally agreed Kyoto protocol to cut greenhouse gas emissions by 12.5% over 1990 levels by 2010. The UK's strategy aims for reductions of 23%, whilst acknowledging that 60% reductions globally may be necessary to avert international disaster.

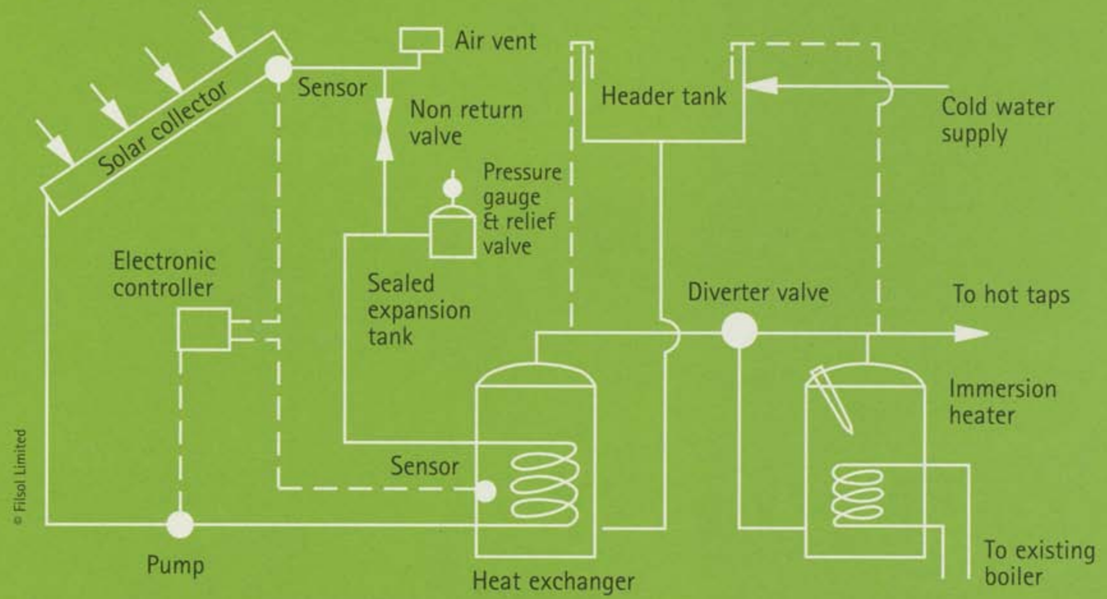
The National Assembly for Wales is committed to playing its part in achieving these reductions, indeed it is the only Government in Europe with a constitutional duty to promote sustainable development.

How will the Welsh climate change?

A detailed and sophisticated model run for the UK Climate Impacts Programme predicts that by 2080 (i.e. within the lifetime of our children) Wales will experience:

- increases in average temperature of around 2°C
- more rain in winter
- less rain in summer
- a rise of sea level of 18-79 cm
- increased windspeeds
- more extreme weather events and very severe gales
- 10% more drought years

Typical active solar installation



Where does energy come from?

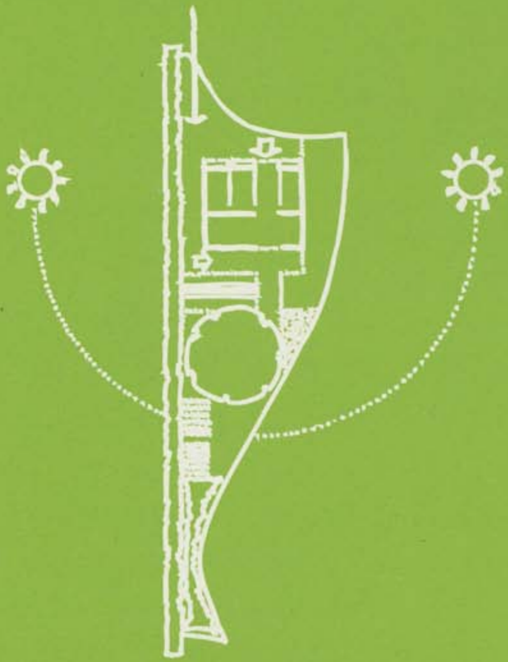
In most homes electricity and gas are supplied via national electricity and gas networks. From a sustainability perspective, the use of natural gas, either as direct supply to the house or as a fuel source to generate electricity, depletes the earth's natural resources. Similarly electricity generation uses irreplaceable supplies of gas, coal and oil. Other than these finite resources, renewable resources can be used to produce energy. Various technologies allow us to harness the earth's natural resources such as the sun, wind and water to generate electricity. These renewable energies help to conserve the natural resources, produce fewer emissions than conventional energy sources and once established, tap into a free energy source. In particular the emissions of carbon dioxide and other greenhouse gases produced from the combustion of fossil fuels are virtually eliminated.

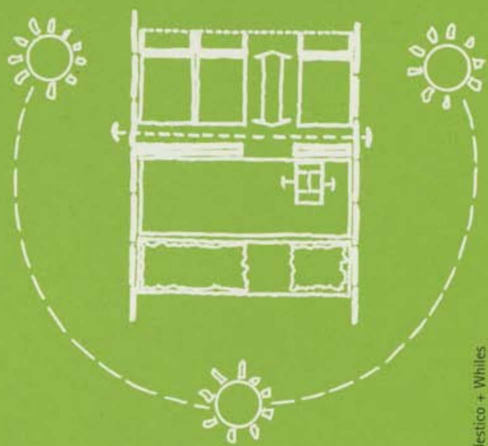
The shift towards a more sustainable fuel supply is happening gradually. The Renewables Review was published by the UK Government in 1998, and sets out how they intend to increase the amount of electricity from renewable sources to 10% by 2010. Petroleum companies are realising that their traditional commercial product is running out and are moving into renewable energy markets. At the other end of the scale, individuals are realising that technologies such as solar panels can save them money on fuel bills as well as contributing to sustainable energy supply.

Using energy from the sun

Passive solar design aims to maximise the useful contribution that the sun can make to the energy demands of buildings. It uses the building design and orientation to increase sunshine and daylight in buildings so that energy economy, environmental comfort and amenity are improved. The House for the Future is designed to maximise the use of passive solar energy for heating and daylighting. The House faces south, and the large area of glazing on the south-facing roof allows daylight and warmth to penetrate deep into the house. This is outlined in more detail in the following section.

Solar water heating is widely used across Europe, and is considered by the European Commission to be cost-competitive with electric water heating. The principles involved are not complex or new. A black surface placed directly in the sun, provided it is insulated, will heat to 200-250 degrees centigrade in a short time. When air or water is passed over this black surface heat energy is





© Jestico + Whiles

exchanged from the black surface to the fluid. This heated fluid can be stored until it is needed in a tank or water cylinder.

The chief component of any solar water-heating system is the collector. Solar collectors absorb the radiant energy of the sun and change it into heat energy. Both direct sunlight and diffuse daylight are captured by the collector, which is why these systems work even in cloudy climates. The storage tank is the second major component in the active solar hot water system. Generally solar thermal systems for water heating either use a single hot water cylinder which has 2 coils or two separate cylinders.

Photovoltaics (PVs) are solar panels that convert sunlight directly into electricity. The basic element of a PV system is the solar cell, made of a semiconductor material, typically silicon. When sunlight falls on the semiconductor it causes a current to flow. This current can then be passed through an inverter to convert it from DC (direct current) to the AC (alternating current) used by household equipment, then used in the house in the normal way. In the UK most PV systems are 'grid connected' (i.e. connected to the National Electricity Grid) so that they can sell excess electricity to the grid and draw from the grid when there is no sunlight.

Traditionally PV cells have been made using expensive monocrystalline silicon, which has meant high initial costs and consequently long payback times. As technologies improve, cheaper materials such as amorphous silicon are becoming viable. Increased efficiencies and decreased production costs mean that PV technologies are becoming increasingly competitive.

Green Electricity is electricity from renewable sources that can be purchased in the usual way via the National Grid. Many electricity suppliers are now offering domestic customers the opportunity to purchase electricity from renewable resources such as wind power, energy crops, hydropower and solar energy. Although the electricity is typically 10% more expensive, it guarantees the provision of electricity from renewable sources, as well as providing a positive indicator to the Energy Company that such a demand is required. So-called Supply Tariffs require that the amount of electricity a person buys each year is matched by the electricity supplier's purchases from renewable resources. Fund tariffs mean that the electricity supplier invests the extra charge paid by the customer in a special fund to stimulate the market in renewable energy technologies.

© Ecotricity

Future Energy is an accreditation scheme for green electricity tariffs which is designed to verify the environmental claims made by the electricity suppliers. It is administered by the Energy Saving Trust which is an independent, Government-backed organisation. They can supply a list of accredited suppliers, along with the type of tariff offered and the renewable technologies that they invest in (see Useful Addresses).

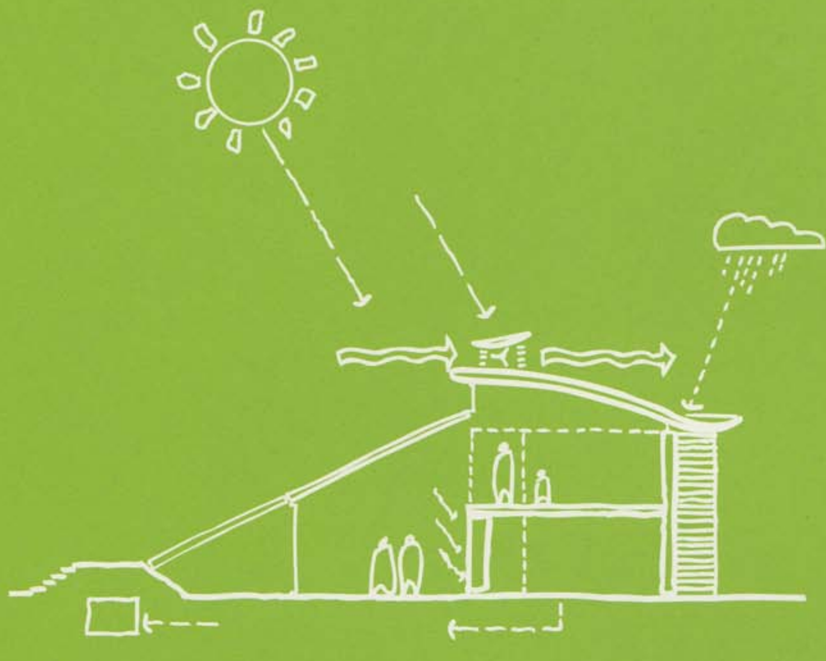
Using energy from the wind

Wind power involves harnessing the power in the wind in order to generate electricity. Wind turbines are available with a range of power outputs from watts to megawatts. Depending on the size, they can be grouped together to form wind farms to supply whole towns, or can be incorporated in a single building.

The UK has an extremely large wind resource, by far the largest in Europe, with the capacity to meet approximately 20% of all UK electricity use. According to the British Wind Energy Association, there are currently about 60 wind farms in the UK, providing less than 1% of the UK's electricity demand. It is anticipated that the contribution from wind energy will have to increase, especially if the UK is to meet its own government target of providing 10% of electricity from renewable sources by 2010. A well-sited wind farm of about twenty turbines has an average output sufficient to meet the electricity needs of about 15,000 homes. One such windfarm would reduce the amount of carbon dioxide (the main greenhouse gas) emitted by power stations in the UK by 45,000 tonnes per year.

An example of a successful wind turbine can be found in Swaffham, Norfolk, East Anglia (left). Here a single 1.5 megawatt turbine provides 3.9 GWh of electricity per year, which is enough to power half the village of Swaffham (population 3000). This project has been so successful that the town council has asked the distributors, Next Generation Ltd, the wind energy company responsible for building the Ecotricity wind turbine, to build a second turbine.

Wind power is not without its critics – many argue that the turbines are unsightly and noisy. Many windfarm developments in the UK have failed to get off the ground due to 'nimbyism'.



© Jestico + Whiles

© BP Solar

A solution to this perceived problem is to locate the wind farms offshore. This concept is still very much in its infancy, although an offshore wind development has recently come on line in Blyth, Northumberland. Two turbines are located half a mile from the shore and can provide enough energy to power 1,500 homes.

Another alternative is to include wind power in the design of buildings. Again this idea is in its infancy, with only a handful of prototypes up and running. Systems are being developed by the University of Strathclyde and Altechnica. The orientation and shape of the buildings and the overall site layout can impact on the available wind resource, and need to be considered carefully.

Doing more with less – energy efficiency

Electricity and gas can be used more efficiently to provide the required services to a home.

Combined Heat and Power (CHP), also known as co-generation, simultaneously generates heat and electricity. It is a much more efficient way to produce electricity than conventional electricity generation with a 65-85% efficiency overall compared to 35% from conventional electricity generation. With a greater efficiency comes lower overall emissions, as the aim of CHP systems is to make best use of the waste heat which would otherwise be rejected. CHP is suitable for small-scale schemes for buildings such as hotels, hospitals and office buildings as well as community schemes where the heat is distributed via a district-heating scheme. Micro CHP boilers for individual houses are currently under development.

Most existing CHP plants are powered by gas. There are many other fuels that are suitable as a fuel source, some of which are well-established, such as using domestic waste as the fuel, while others are still in their infancy. Biomass CHP, which uses wood as a fuel, is an environmentally preferred option as the carbon dioxide released through combustion has previously been absorbed by the tree during the growth phase.

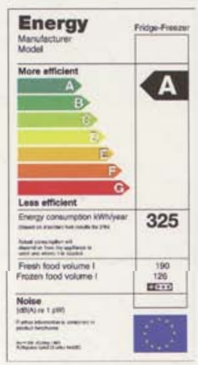
Heat Pumps use electricity to move energy, as heat, from one place to another. In the same way that a conventional refrigerator takes unwanted heat from food and releases it from cooling fins, so the heat pump takes heat from the ground outside or from the air and releases it as useful warmth in the building.

Ground source heat pumps (GSHPs) work by transferring heat from the earth to the building. The earth is an enormous solar collector, storing almost half the radiation received from the sun in rocks, soil and water. GSHPs consist of three main parts. Firstly the copper collector coil, which is effectively a long loop of pipe filled with water or a refrigerant, is buried vertically or horizontally in the earth. The heat pump itself is powered by electricity and turns low-grade heat from the ground to high-grade heat for the house. Finally the distribution system can be an underfloor system or a more traditional radiator system.

Heat pumps are commonly used for heating or cooling commercial buildings, but their use in houses is quite new. Ground source heat pumps are commonly used for heating Scandinavian homes, and the search for energy-efficient heating in the UK has led to an increase in their use.

The use of a heat pump can be a highly effective way of reducing the carbon dioxide emissions associated with a house, as shown below:

Heat Source	Kilograms of carbon dioxide per unit of heat energy
Gas	0.19
Electricity	0.44
Heat Pump	0.146



© Energy Savings Trust

Reducing demand in housing

The demand for energy is continually increasing and domestic energy consumption alone rose by a fifth between 1970 and 1997. This is largely due to the increase in the number of households, and increased use of lights and appliances such as televisions, videos and microwaves. Energy use for appliances has more than doubled in the period 1970 to 1997.

Energy Efficient White Goods can therefore make a considerable difference to domestic energy consumption. The EU-wide Ecolabel establishes a range of criteria which aim to assess the overall efficiency of an appliance with regard to water, energy and detergent consumption, or washing performance. The efficiency of a product is given an overall rating between 'A' (most efficient) and 'G' (least efficient).

Superinsulation of walls, roofs and windows reduces the heating demand of houses. Hot water cylinders should also be highly insulated.

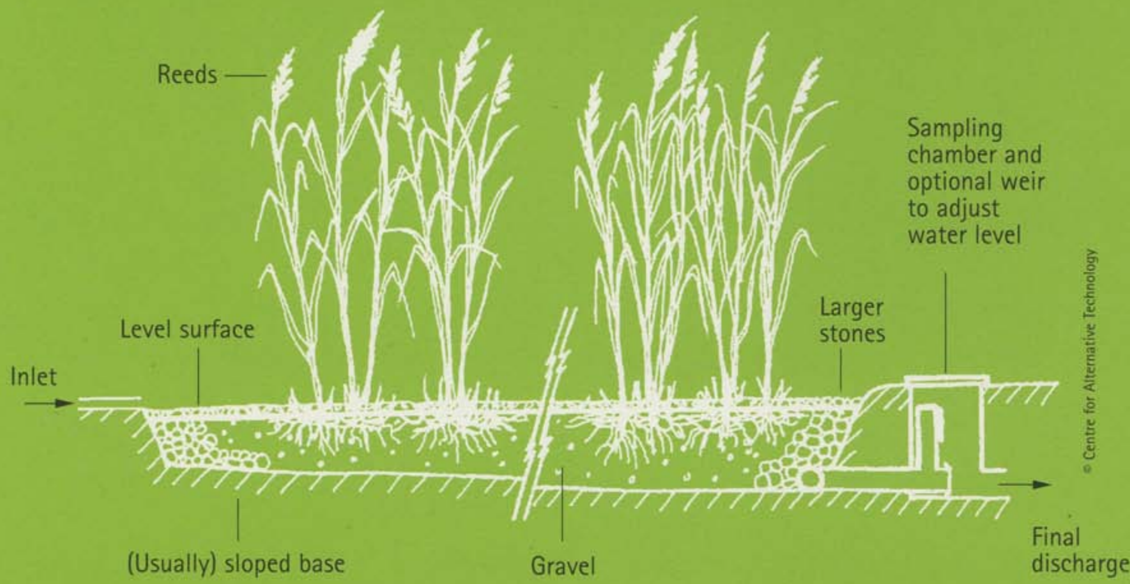
Water

Water is an increasingly scarce resource. Whilst it might appear particularly abundant in Wales, water conservation is an essential constituent of any strategy for sustainability. Worldwide water use has more than trebled since 1950, and in the UK, water consumption in households has nearly doubled over the last 40 years. Water shortages are increasing and hosepipe bans have almost become an annual occurrence in most parts of Wales. Indeed, the World Resources Institute has classified Wales as having 'low' water availability (1000-5000m^3/person/year), a classification more commonly applied to areas of Africa. Of course, more dams can be built to collect and store water, but there is an increasing resistance to this solution because of the cost and effect on the countryside.

Reducing demand

Reducing water use cuts down on the energy required to treat water and transport it, as well the environmental effects of water abstraction. Continuing developments in the water industry mean that there are many services and products to help reduce the water demand of a home. Low flush WCs, spray taps, low water appliances such as dishwashers and washing machines can all contribute. Some water companies give out free 'Hippos' to put in the cistern to save 1 litre per flush.

Cross-section of a horizontal flow reed bed



Rainwater Collection – All water supplied to houses by the water service companies is of drinking water quality, and yet less than 8% of this is actually used for drinking and cooking.

Collecting rainwater creates an opportunity for it to be used before being discharged to sewers or watercourses. Rainwater can be treated and used for all domestic water requirements, but is generally limited to irrigation, flushing WCs and non-contact washing such as washing vehicles, washing machines etc. There are two sustainability benefits of such a system. Firstly, it reduces the amount of drinking quality water used in the house. Secondly, it reduces the amount of rainwater transferred to the municipal network thereby reducing storm water loadings of combined sewers and wastewater treatment plants. Using a rainwater collection system also helps to reduce any unnecessary treatment of rainwater.

WCs are the largest single use of water in the home, with one third of the average family's water use flushed down the toilet. Using rainwater for WCs alone can reduce water bills by a third.

Waste water treatment

Treatment of wastewater in municipal treatment works requires energy to move the water from the point of use to the treatment works. Treatment on site can be the environmentally preferable option, particularly where the site is a long way from the treatment works.

Reed beds are based on the fact that vegetation can adapt to extract waste materials from water. In reed bed systems, the roots of the reeds provide a medium within which bacteria can grow. These bacteria break down organic components in the waste water. The reeds are planted in gravel and the wastewater flows through the bed of reeds. Reed beds have been used for secondary treatment of sewage since the 1960s.

Any water treated by a reed bed system can then be recycled much in the same way as rainwater recycling. This can be used for flushing WCs or irrigating the garden or surrounding land. Another benefit of reed beds is that they can be made an aesthetically pleasing feature of the garden by attracting wildlife.

Waste

Waste in the UK, whether from the construction industry or from our homes, is traditionally buried in landfill sites. Space is running out however, and in some parts of the country suitable landfill space will have run out within fifteen years. This means that waste will have to be transported over longer distances, with the associated environmental impacts. This is not a sustainable option in the long term. Landfill sites have several environmental effects. They are generally located on land that has low financial value, which unfortunately is often land with high ecological value. The demand for landfill means that safeguards such as statutory protection (e.g. Sites of Special Scientific Interest, SSSIs) are overridden. Landfill sites also carry a pollution risk. Leachate is a highly polluting liquid produced by landfill. It is often highly acidic and contains a mix of heavy metals, organic solvents, chlorinated compounds, ammonia and a mix of other substances. Although all modern landfills have an impermeable layer at their base, some leachate may escape and potentially enter groundwater, contaminating drinking water supplies. Methane gas is produced by rotting waste in landfill sites. It is highly explosive, and can be a particular problem if it migrates through the soil and accumulates in nearby houses – where it can ignite, with potentially fatal results.

Reducing waste is the most efficient way to reduce its environmental impact. Waste is produced by inefficiencies in the system – an ecological system, in contrast, produces no waste that is not returned to the system. It means resources are not being used effectively and money is being wasted. To take a holistic view, the most practical and effective way to deal with waste is to consider it right from the specification or purchase stage. If materials are specified which save waste or are easy to reuse or recycle, then this will avoid difficulties with waste which can only be disposed of to landfill.

Construction in the UK accounts for 17% of all waste. This equates to six tonnes of waste building materials for each and every member of the population, every year. 30% of this waste is disposed of to landfill – about four times the rate of household waste production. The rest is recycled mostly for low-grade applications such as road sub-base construction or landfill engineering. Only 4% of the total waste is used in higher-grade applications. Minimisation of construction waste is therefore crucial in reducing the problems associated with waste disposal methods.

Recycling at Home – Only 7.5% of UK household waste is recycled. A change in attitudes and habits is required to increase this figure and reduce the amount of domestic waste going to landfill. It is not impossible – in Sweden 91% of aluminium cans are recycled, three times as many as in the UK. Since the introduction of the landfill tax (a charge for every tonne of waste going to landfill) many local authorities have introduced home collection schemes for recyclables. Designers can make recycling easier for the eventual user of the home by providing storage areas for recyclable materials.

Materials

The millions of new building and refurbishment projects worldwide each year are significant consumers of the earth's natural resources. Many of these resources are non-renewable and reserves are running out fast. Certain materials consume significant amounts of energy during their manufacture – depleting fossil fuels and emitting pollutants and greenhouse gases. Others require transport over possibly huge distances for raw materials or delivery of the finished product.

Pollution – Some materials use hazardous or toxic chemicals during their manufacture, which may be emitted into the environment, causing environmental damage and ill health. Accidents and leakages may cause even more severe effects.

Some materials are potentially hazardous when in use in the building – perhaps emitting harmful gases, or allowing liquids to seep into the earth to contaminate land and groundwater. Paints, for example, have been associated with a variety of health problems from lead poisoning to asthma. Recent studies have shown a threefold increase in the number of children suffering from asthma in the ten years to 1992, and this has led many people to question the chemicals present in their houses.

No virgin material is without some environmental impact. Although some chemicals and energy are used in the recycling process, reuse and recycling are always environmentally preferable to raw materials.

Embodied Energy is the energy needed for procuring raw materials, manufacturing them into useful goods, transporting these to the site and then using them in the construction process. The total amount of energy needed to procure, manufacture and use materials can be high, typically causing 20% of the building's energy use during a 50 year life cycle. In other words, the embodied energy of a building can be ten times higher than the annual energy use. So the low energy strategies described in earlier sections are almost futile if the embodied energy of the building is high. Reducing embodied energy can reduce the overall environmental burden of a building, and provide pointers to reducing construction costs.

The embodied energy of materials used can be calculated, but such calculations are often complex. Difficulties arise because the source and distribution route of a material is not always known, nor the amount that has been recycled. There are some general rules however. For example, timber has low embodied energy as it requires very little processing. It is generally held to be the preferred choice for many construction elements. Aluminium generally has very high embodied energy due to the energy required to smelt the metal. However it is easily recycled and very durable, so aluminium from recycled sources could be a preferred choice, although this is hard to specify. Embodied energy research is on-going, and in the future we may see the embodied energy of materials listed on an 'Embodied Energy ' label, similar to the Energy Label discussed above. Various methods exist to calculate the embodied energy of buildings, for example BE_2AM and Envest. The former incorporates four different assessments of building performance:

- Energy in use – The energy consumed during the life of the building;
- Embodied energy – Energy contained in the materials used to construct the building;
- Environmental preference of materials – the environmental impact of the materials used to construct the building;
- Environmental design opportunities – The level of consideration of environmental impact in the building.

Biodiversity

Biodiversity is a simple contraction of 'biological diversity' and the term encompasses the entire spectrum of life on land and in water, ranging from bacteria, fungi, lower plants and flowering plants to insects, amphibians and reptiles, fish, birds and mammals.

The UK Government published its Biodiversity Action Plan in 1994 in response to the Rio Earth Summit in 1992. Since then, preliminary action plans have been produced for 116 priority species and 14 key habitats, of which 54 and 12 respectively occur in Wales.

Any building or development will inevitably have an impact on the biodiversity of a site. Improving biodiversity on sites involves two main priorities: identifying the natural features or valuable areas already present on the site, and then conserving or enhancing the ecology already present.

Green roofs effectively 'lift' the layer of ecology that was previously on the site to the roof of the building. They involve planting on the building roof itself above a waterproofing layer. They are generally divided into two types, extensive and intensive. So-called extensive roofs have little substrate, are lightweight and are not intended to be used as an amenity area. Intensive roofs on the other hand are usually used as an amenity by the occupants. They require greater substrate as planting is often substantial and may include water features or recreational facilities. These will be significantly heavier than an extensive green or traditional roof, which must be taken into account in the building design. Due to the considerable structural support required they are not applicable to all situations.

Green roofs can help limit the visual intrusion of the building, benefit wildlife, absorb pollutants and reduce storm water runoff. They can also provide further protection to the roof surface from deterioration due to ultraviolet light and exposure, as well as providing additional thermal and acoustic insulation.

Transport and communications

After buildings, transport is the second largest source of carbon dioxide emissions, the main greenhouse gas. It is inextricably linked to buildings in that a building's location will affect the amount of car use required to get to it. Indeed, movement between buildings consumes the largest part of transportation energy. The trend for urban dispersal exacerbates this problem and an integrated transport strategy is just as important as tackling the burden of our buildings on the environment.

Transport is also the fastest growing pollution sector. It is estimated that over the next 20 years car traffic could grow by more than a third. Between 1982 and 1992 the average power of new cars rose by 35% and weight by up to 10%. As a result, despite improvements in engine performance, the average fuel efficiency of new vehicles has worsened since 1988.

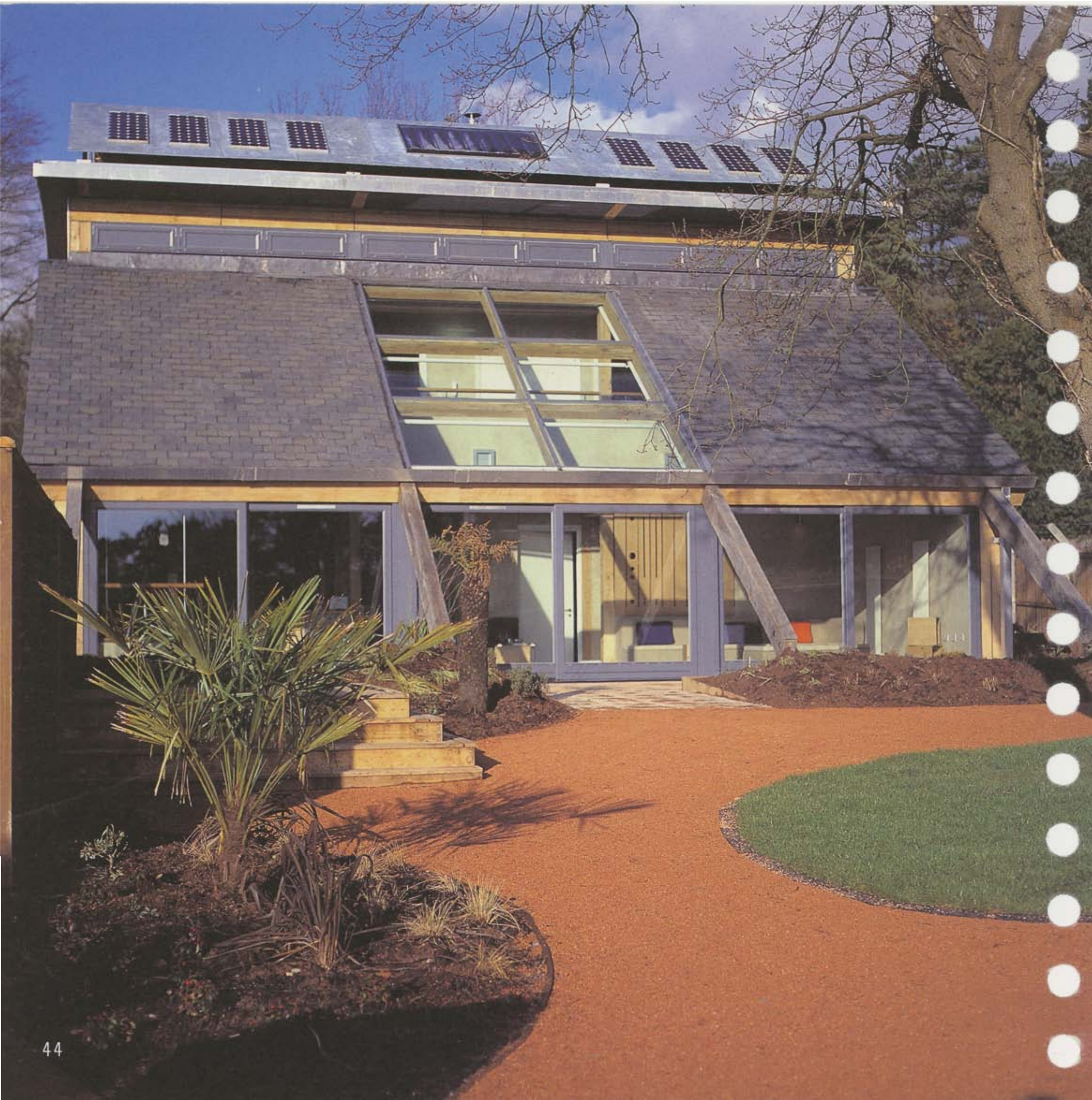
Designers can reduce transport needs in two main ways. Firstly they can tackle the number of trips that need to be made by providing the facilities to work, shop and entertain at home rather than going out. The Internet, email and home shopping are increasing the opportunities for communication at practically no energy cost. Building design can also encourage building users to walk, cycle or use public transport in preference to the private car. Cycle storage spaces can easily be incorporated in any building, and in larger buildings clear routes to public transport should be provided.

3

A description of the House for the Future

"The house takes its place in history as a natural evolution of traditional Welsh housing, responding to local conditions, the climate of Wales and the availability of materials."

Heinz Richardson and Jude Harris, Jestico + Whiles Architects



Energy

Architects have been making proposals for low energy buildings since the 1970s, when the oil crises demanded a critical assessment of building energy consumption. The desire to reduce the profligate consumption of energy that can be exacerbated by poor building design has been further highlighted by recent agendas for sustainability and attempts to minimise the production of greenhouse gases, to which buildings are major contributors.

The briefing information available for the site at St Fagans advised that natural gas would not be available. Whilst gas is often the preferred fuel source for domestic heating installations, it is not regarded as a sustainable fuel in the long term as it depletes finite resources. The team was forced to make an assessment of the greenest fuel sources in our attempts to strive for zero carbon dioxide emissions.

At present electricity is a significant contributor to the country's carbon dioxide emissions, largely through its use of fossil-based fuels for generation. The obvious preference is for the increased generation of electricity from renewable sources such as wind and water, although in the UK we are woefully deficient in this respect, with only 2% of our electricity generation attributable to renewable sources.

In speculating about the future the objective for zero carbon dioxide emissions was best secured through the specification of a green electricity tariff to demonstrate that electricity from renewable sources can be bought via the National Grid. A small premium is charged for green electricity, and SWALEC estimate that the average customer would pay only 50 pence extra per week for this simple form of renewable energy.

The House for the Future has been constructed with thermal U-values that exceed the current Building Regulations by almost a factor of three, to superinsulation levels (less then $0.20W/m^2K$). The timber frame is wrapped with an insulated 'overcoat' of wool and cellulose fibre to limit fabric heat loss.

All the windows installed in the House for the Future have been glazed with some of the highest performance glazing currently available on the market, boasting U-values as low as 1.1W/m²K. These units are double glazed and use an inert gas in the glazing cavity to further reduce glazing heat loss.

Passive solar design

Even on a cloudy, overcast day the sky emits up to 50 Watts of solar radiation per square metre. The House for the Future taps into this free source of heating through the south-facing glazed areas. The glazing exploits the 'greenhouse' potential for glass to admit incoming solar radiation and 'trap' its heat inside the space when it is useful.

However, large areas of glazing for passive solar gain are not always a good thing as they can offset the free heat gain from the sun by losing excess heat from the building at night and in cold weather. Despite fivefold increases in the thermal performance of glass over the last twenty years, it still loses up to ten times more heat than is lost through a comparable piece of opaque construction which is well insulated.

In addition, glazing can also appear psychologically cold at night, often termed the "black hole effect". As part of the original competition proposals attempts were made to control this variable heat loss by using insulated shutters. Similar suggestions were made for an external shutter on a pivot to swing down and insulate the south wall at night as well as doubling as curtains and brise soleil for glare control. Such technology is not new, as is demonstrated by the use of oak board shutters in Y Garreg Fawr Farmhouse at the Museum and heavy curtains in our own homes. However these ideas proved too complex to prototype within the modest construction budget, and instead a conventional motorised roller blind has been installed to provide an element of dynamic control over solar gain and glare. This blind has been linked into the electronic control system which can be activated by voice commands or a remote control.

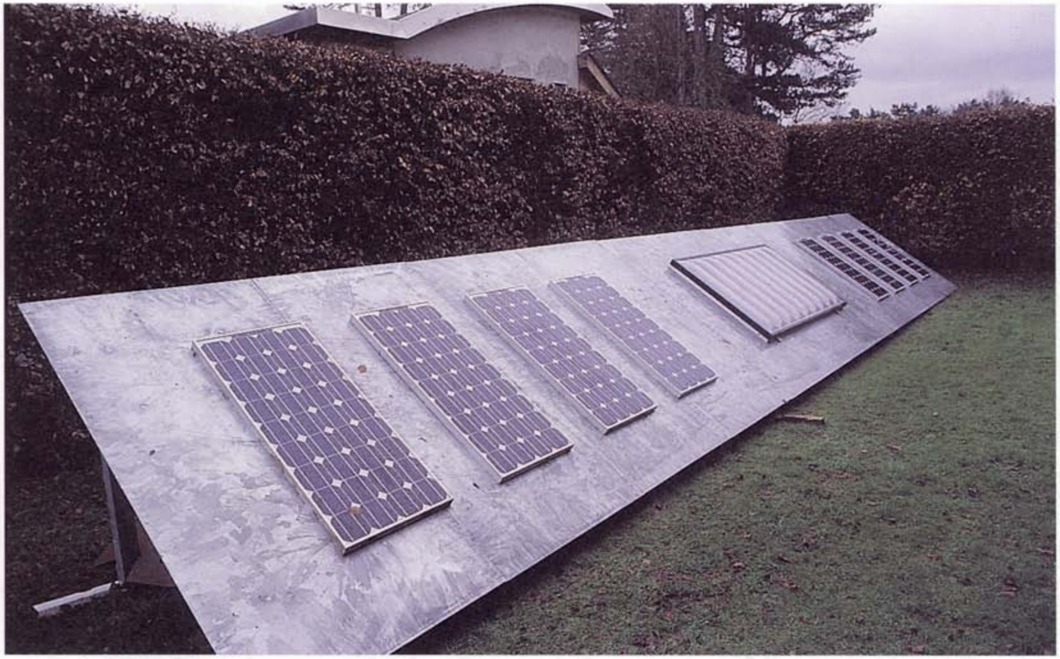
Solar water heating

A Filsol® flat plate solar water heater ($2m^2$), which is made locally in Carmarthenshire, has been mounted onto the rooftop array between the photovoltaic panels to provide hot water heated by the sun. This works by passing a thin film of water and antifreeze agent through the collector, which is heated by solar energy. The heated solution is then fed through an indirect hot water tank where heat exchange takes place between the solar heated water and incoming fresh water for the domestic hot water system. On days of low solar gain the temperature of the water can be boosted by means of an electric immersion heater. The hot water tank, which is located in a cupboard off the main bathroom, is heavily insulated to minimise the need for electric boosting of the hot water. The assumption is that solar heated water will meet hot water requirements for the majority of the time.

Lighting

Whilst large areas of windows and glazing maximise natural light penetration in the House and provide views of the surrounding landscape, lighting is still required for night time use. The majority of the lights used in the House for the Future are low energy uplighters and downlighters fitted with compact fluorescent bulbs. These use about one fifth of the energy used by conventional incandescent light bulbs.

The lighting system is controlled by a central control system which uses a radio-controlled device and voice activation software instead of conventional light switches on the ground floor. Such a system can be easily connected to a photocell detector to automatically switch the lights off when daylight levels are sufficient. It also offers opportunities for linking with the security system, turning off all internal lights when the House is locked and selecting a welcome home scene as you return. Another security feature enables lights to be switched on and off with a timing mechanism.



Photovoltaics

The need to use electricity was offset in part by the installation of a photovoltaic array of eight BP Solar monocrystaline panels, each generating up to 100 Watts of electricity. The electricity is generated as DC and is converted into mains voltage by means of an inverter mounted underneath the rooftop array. The amount of energy is approximately equivalent to the energy used to power the lighting.

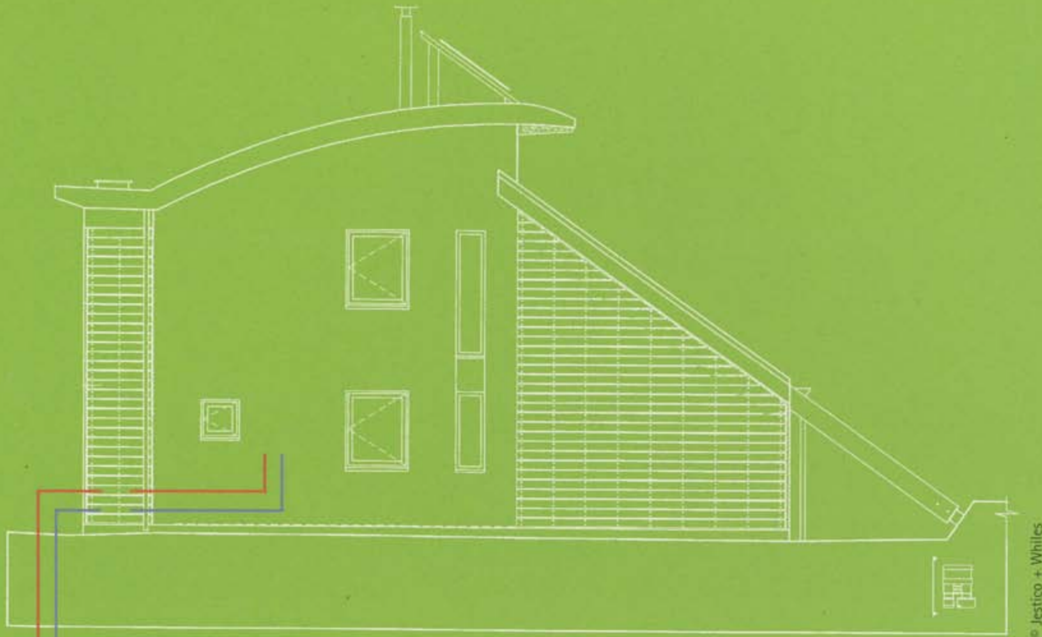
In the future, as the efficiency of photovoltaics improves, it is possible that domestic properties may generate enough electricity to offset their own consumption and even export some to the National Grid.

Wind generation

In the early design stages the team also investigated the possibilities of generating wind power at the domestic scale. Proposals were made in the first competition submission for a ridge-mounted wind turbine, which advanced ideas that Jestico + Whiles had previously proposed on other projects. During the second stage of the competition a commercial partner was found who had been developing a similar roof-mounted wind turbine and a feasibility study was carried out by Altechnica on the Aeolian™ Roof Wind Energy System. This design uses an aerofoil of the type used for aeroplane wings to increase the velocity of the wind within the slot of the roof and so increase the power available to the wind turbine. Other roof-mounted wind energy systems are also being prototyped by the University of Strathclyde.

At the time of construction, such a system was not available as an economically commercial system, and the budget was insufficient to allow such a system to be a prototype. However, the team remains convinced that there is enormous potential for wind generation on individual buildings.

Ground Source Heat Pump Schematic



Combined heat and power

A combined heat and power system was not considered appropriate for such a small project and instead measures were proposed to generate electricity from renewable resources such as the wind and sun. A CHP system might be more appropriate for the whole museum site where both hot water and electricity could be generated using renewable fuels such as timber, but this was beyond the scope of this project.

Heat pumps

The heating requirement of the House for the Future is greatly reduced by the passive solar gains and the very high levels of insulation.

The remaining heat requirement of the House is met by a 2.3kW heat pump (Markus 2500) backed up and boosted by a 3.4kW electric boiler, and is the primary source of space heating. The units were manufactured in Sweden where domestic heat pumps are much more common. The system has a coefficient of performance of 3.15, which means that for each unit of electricity purchased, the heat pump delivers more than three units of usable heat.

A 65m length of copper pipe is set into a 30m vertical hole bored through the bedrock at the front of the House. Refrigerant circulates in this loop of pipe from the heat pump which is located in the recycling store. The hot water produced by the heat pump reaches temperatures of about 50°C and is circulated around a conventional wet central heating system in the normal manner. Due to the lower distribution temperatures the radiators required to produce the equivalent heat output are slightly larger than normal domestic radiators.

The heat pump is powered by green electricity from SWALEC, which comes from windpower and hydro-electricity. These renewable forms of energy emit no carbon dioxide, in keeping with the zero carbon dioxide strategy.

Biofuels

An Enviro Fire® wood pellet heater has been installed by Welsh Biofuels to provide additional heating in periods of high demand, offering up to 11kW of additional heat. The system is so efficient that the ash collector only requires emptying once a month, depending on use. The heaters provide both radiant and convection heat, with the latter assisted by a fan built into the heater, which can be controlled by means of a temperature dial.

The wood pellets are made from waste sawdust and can be simply loaded into a hopper in the top of the heater. The hopper automatically feeds pellets into the burner and can last between two and three days before refilling is required. The pellets, which are about the same size as an eraser at the end of a pencil, are clean, pleasant smelling and smooth to touch.

Domestic appliances

Many of the appliances selected for the House for the Future have been chosen for their optimum performance in terms of energy efficiency. Both the fridge freezer (A) and the dishwasher (AAA) have the top ratings for energy efficiency and water consumption. The washer dryer is rated D for washing performance and A for spin drying performance. A microwave is regarded as a more environmentally friendly method of cooking as it uses less energy over shorter periods to do the same job as a conventional electric or gas fired oven.

Water

All rainwater that falls on the roof of the House for the Future is collected and stored in the small loft water tanks located adjacent to the gutter on the north side of the house. It passes through an oversized gutter which mechanically filters the water before it is fed through a series of plastic water tanks. Conventional float operated valves control the water inlet and once the tanks are full the overflow system directs rainwater back into the rainwater downpipe and into the drains.
These tanks, which are standard low profile polyethylene loft tanks, provide a storage capacity of 680 litres. They feed an additional 200 litre tank with an in-line filter located within the service cupboard accessed from the gallery. The water is used for toilet cisterns and the outside tap located in the recycling area for watering the garden.

Water use in the house is kept to a minimum as the toilets have a dual flush mechanism, which allows a choice between a two or four litre flush (most houses in the past had a nine or seven litre flush). Aerator mixer taps are installed on wash hand basins and sinks, and the washing machine and dishwasher use minimum amounts of water.

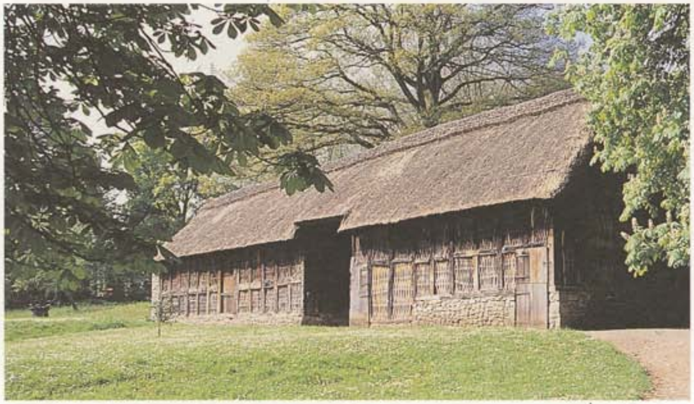
The prospect of creating a house independent in all respects was considered and early proposals included on-site waste water treatment in the form of reed beds. However the availability of sewage infrastructure adjacent to the site made these proposals unnecessary, particularly considering that the House would never actually be lived in for any extended period of time.

Waste

Construction waste minimisation initiatives included the provision of separate skips and containers within the site compound for the various recyclable materials, such as timber, metals and plastics. The landfill tax (which currently stands at £10 per tonne for active waste) adds to the incentives for contractors to recycle waste.

Recycled construction and demolition waste was used in the actual construction of the House for the Future, forming the hardcore layer under the ground floor slab, and also in the recycled aggregates used to form the concrete foundations and slab. Other recycled materials used in the construction included aluminium flashings and natural slates. The cellulose fibre insulation is manufactured from recycled newspapers, books and telephone directories.

Inside the House for the Future recycling has been promoted by the provision of a dedicated recycling area. This space is semi-external behind the open jointed timber cladding and is well ventilated to outside air. Segregating containers are provided both in the kitchen and in the recycling area to assist with household recycling.



Materials

Wherever possible materials for the House were selected on the basis of low embodied energy and minimal environmental impact. The Environmental Preference Method (Anink, Boonstra, & Mark) and guidance given by the Building Research Establishment/Post Office were used to inform all decisions relating to materials selection. Local materials have been used in order to reduce the energy of transportation, as well as to stimulate Welsh industry. The embodied energy for the House has been calculated using BE_2AM to be 18% lower than a typical house, and over a design lifetime of 60 years the House for the Future reduces the CO_2 emissions due to embodied energy by more than eight tonnes.

As an environmentally preferred material, timber is the primary construction material used in the building of the House. It is used as the primary structural frame, as infill to create the walls and roof, as external cladding and as a finishing material internally for the upper floors, balustrades and staircase. There are many other examples of timber framed buildings in the Museum of Welsh Life, some of which have lasted for many centuries. For example, the timber framed Stryd Lydan Barn (bottom left) is nearly 450 years old.

It was a major aspiration for the project to use renewable, sustainable sources of timber, preferably from within Wales and from companies that are committed to the objectives of sustainable forest management (FSC/WWF certified). The green oak for the structural frame was felled in Mid Wales and the secondary structural joists and rafters are homegrown Douglas Fir.

Externally, Welsh oak boards have been used to clad parts of the building. The other cladding material used for the external walls was lime render, which is less damaging to the environment than cement based renders and arguably produced using less energy intensive methods. The lime was manufactured in Brecon.

The roofs, which perform the important task of keeping the water out, have been treated differently on each side of the building. The curved roof on the north side demanded a form of sheet material to negotiate the curvature. Several options were explored during the early stages, including EPDM

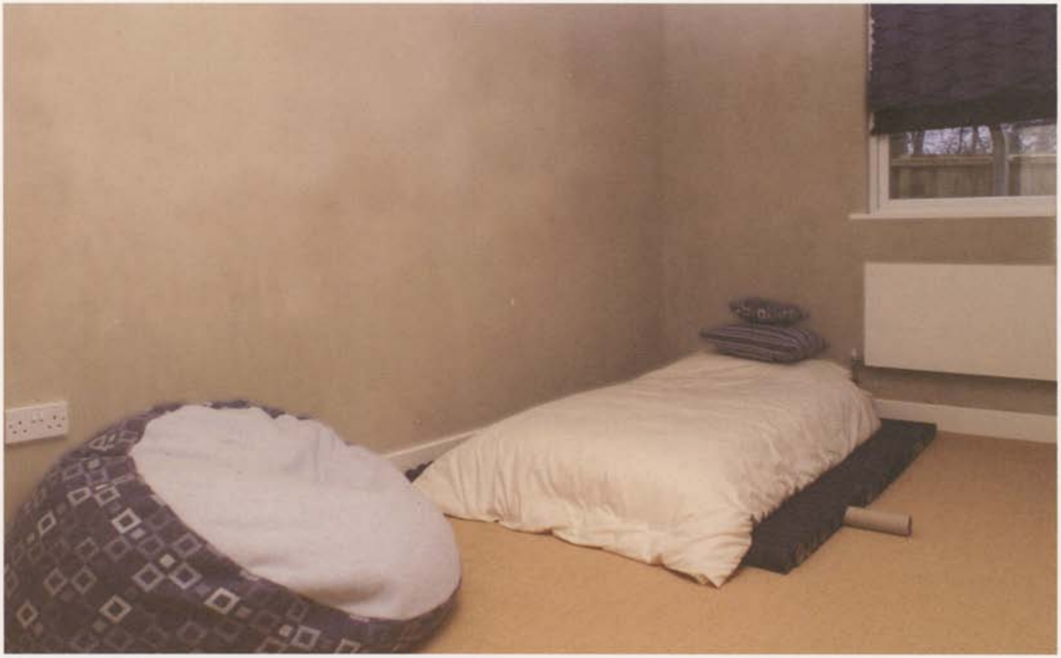
(rubber) and a turf roof. Aluminium was selected as a recycled product but also for the Nature Roof®, which provides a lightweight alternative for the greening of roofs. The south roof, which is more exposed to the prevailing weather, has been covered with recycled natural Welsh slates which were reclaimed from an old hospital in Abergavenny.

Aluminium has been used for a number of components in the building, and might be regarded by some as being at odds with the aspirations for sustainability. Aluminium is a unique construction material that is light, solid and non-corrosive, offering a long life material requiring little or no maintenance. The mineral bauxite, from which aluminium is extracted, is abundantly available, but is still a finite resource. Over 60% of the energy required to extract aluminium worldwide is generated from renewable sources such as hydropower. Approximately 35% of aluminium is from recycled sources, which uses about 5% of the original energy input. Recycled aluminium was specified for this project, and the aluminium kick plate at the base of the external walls was reclaimed demolition waste and was used without the need for any reprocessing.

Many natural construction materials were used in the House, such as clay board, clay plaster, sheep's wool insulation, slate and earth blocks made using clay extracted from the site. Clay is one of the earliest building materials, and it can be seen in a number of other buildings at the Museum, such as the Nant Wallter Cottage (lower middle, left) and the Abernodwydd Farmhouse (lower middle, right).

Biodiversity

Biodiversity has been promoted in the House for the Future both on the building itself in the form of the green roof and in the garden which is explained in more detail in later sections. The resilient sedum plants took to their new location extremely quickly and provide a wonderfully varied "carpet" of plants of differing colours, offering different shades of greenery throughout the year. The desire for a green roof was largely driven by the greenery and trees around the site and as an attempt to minimise the intrusion of the House in these luscious surroundings.



Transport and Communication

The House for the Future has been designed in recognition of the major contribution that transport energy makes to global energy consumption. The site is uniquely positioned in a museum environment, away from public roads, which led to the opportunity of not considering car use. Instead a small garage and workshop has been included within the House to accommodate bicycles, which are the most sustainable form of personal transport.

Other attempts to reduce transport fuel consumption include the provision of a space suitable for use as a home office (Study Bedroom). The opportunity to work from home, even for part of the week, eliminates one of the most significant reasons to use polluting transport – travelling to work. The storage area on the north side of the House facilitates internet shopping, and this was used by the family who lived in the House in December 2000.

During the fuel crisis in September 2000 the builders used their bicycles to get to the site in order to minimise their fuel consumption as supplies ran dry in south Wales. On one occasion they were even forced to stay overnight!

4

Designing the House for the Future

"The design of the House for the Future is based upon a wide range of principles. Embracing sustainability and flexibility as key determinants of form, the house will be a model for future housing, capable of reproduction and repetition as either a rural or suburban model, or located within existing urban brownfield sites."

Heinz Richardson and Jude Harris, Jestico + Whiles Architects

Introduction

The design of the House for the Future was conceived by a small team at the London-based architects Jestico + Whiles in the Spring of 1999 – a team which included several graduates of the Welsh School of Architecture. The newest building on the Museum site was intended to mark the new millennium by portraying a vision of the future rather than the vision of the past presented by the collection of historic buildings re-erected from around Wales.

It is likely that in the not too distant future all human enterprise will begin to replicate the behaviour and characteristics of natural systems. Various naturally responsive systems can be seen in nature, such as the thermo-regulatory powers of the human skin, the seasonal changes of coat in many mammals, and the opening and closing of flowers in response to sunlight. Much can be learnt from nature and from designing in harmony with it, rather than against it. The House for the Future has been designed to be adaptive and responsive, learning from and adopting many of the examples seen in the natural world.

Futuristic buildings are often regarded as high technology manifestations, piled high with 'gadgetry'. Whilst the House for the Future incorporates some 'intelligent' devices and appliances that will assist in the efficient operation of the House, it has also been designed to be 'responsive' like many of the naturally intelligent systems described above. It has been designed to eschew high energy consuming technologies, and embrace appropriate sustainable technologies incorporated within a contemporary design approach.

The design challenges the conventional approach to mass housebuilding in the United Kingdom and proposes a model for future housing which addresses many of the issues presented by a changing structure for society and global environmental change.

The House for the Future offers a chance to experience a prototype for housing in Wales for the next century. The House is a simple structure designed to enclose space that is very flexible so it can be adapted to suit individual lifestyle and circumstance.

The Design

In the future conventional ideas of traditional family life and consumer-led enterprise will be challenged by the necessity to embrace issues of sustainability. Such issues will not only affect our environment and the way we regard it, but also our socio-economic structures. As the traditional family unit of two adults and 2.4 children becomes increasingly uncommon, designers must consider how housing can respond to the need for flexibility. Changes in the structure of society have already led to an unprecedented demand for housing, leading to predictions by the government that there will be a need for over 4 million new homes in Britain by 2016.

The boundaries between working life and home life are also becoming blurred and our places of work are beginning to incorporate more and more home comforts. The idea of the 'office' at home is now commonplace, facilitated by the information technology revolution and the ease of access to worldwide communication systems. This dynamic, fast-moving rate of change will place increasing demands on our homes to be flexible and responsive to changes in family structure, work patterns, technological advance and other innovations.

The design approach combines proven 'best practice' ideas and technologies with innovative systems. Environmental sustainability should not be the exclusive domain of the committed few who have the time and ability to maintain complicated systems, and who are prepared to compromise comfort standards. All systems in the house are low maintenance, and the internal environment of the house is a key priority that has been considered along with the environmental strategy. High levels of comfort and daylighting will be achieved, and the health and well-being of occupants is of prime importance.

Sustainability

As is outlined in earlier sections, buildings are major consumers of energy, which in turn makes them major contributors to the demise of our environment. Domestic energy consumption can be significantly reduced through sensible design and appropriate specification to reduce the burden that our homes place on the environment. The House for the Future has taken this challenge as the major driving force behind the evolution of its design and construction.

Kennixton Farmhouse

The House for the Future has been designed to make no net contribution to carbon dioxide emissions, to utilise environmentally responsible materials and to promote a healthy indoor environment. New buildings offer the most realistic opportunities to reduce carbon dioxide emissions. Yet considering that less than 1% of the total UK building stock is replaced each year, each of those new buildings must make a significant contribution to reduced carbon dioxide emissions. Designers of the House for the Future therefore set themselves the ambitious target of zero carbon dioxide emissions.

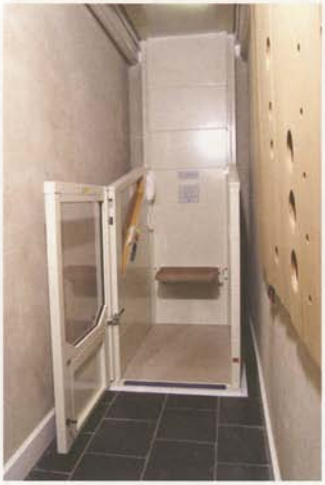
Flexibility and Adaptability

In the same way that many of the Museum's other buildings have developed over time, the House for the Future has also been designed for adaptability and flexibility. This is best exemplified by Kennixton Farmhouse, which was first built in 1610, and then as prosperity increased, had a living room added in 1680, a kitchen in 1750, and was then finally dismantled and re-erected on the museum site in 1953.

The number of households in Wales has increased by 10% over the past ten years, with only a 3% increase in population. Increasingly people are choosing to live alone, and young people who would once have lived with their parents are occupying their own homes. Conceived as either a 'loft on the ground' or more cellularised to suit larger family life, the house in its basic form can respond to a number of varying sociological types. The number of bedrooms can vary from one to five, with the option of a 'granny flat', teenagers' den or sub-let apartment as required.

Planning of the internal space has been kept deliberately fluid to respond to the particular needs of the residents now and in the future. Open living and daytime spaces are located to the south, whilst more private and enclosed cellular spaces are located on the northern side of the dwelling.

The outer zone on the north side has been designed for expansion. An extra metre could be added to internal rooms by moving the walls to the outer edge of these structural 'fins'. In the House this has already been done in the children's bedroom. In its detached form it may also be possible to add another structural bay in time for additional accommodation, although not on this site.



Accessibility

All homes should be built to be accessible for all people, whether able-bodied, frail or disabled. The percentage of the population over the age of 65 in Wales has increased from around 5% to around 20% in the last century, hence accessible environments will become increasingly important, particularly as the numbers of frail older people increase. The House responds to this trend in allowing people to remain in their home as mobility decreases. The House for the Future has been designed to meet the recent changes in Part M of the Building Regulations, which relate to access. Lifetime Homes Standards have also been met with regard to adaptability and flexibility. Indeed this approach is entirely compatible with the flexible design of the House.

The threshold of the House is level and doors and corridors are wide enough to allow wheelchair users to manoeuvre easily into and out of rooms. There is a downstairs WC that is accessible to all, as well as a potential bedroom on the ground floor. A wall-climbing 'through the floor' lift has been provided in a convenient location, making the House fully accessible to all visitors to St Fagans, including solo wheelchair users. Sockets, switches and all control panels are at a height that can be reached by all.

The lift has been incorporated within the house to demonstrate that disabled access can be provided to all areas of the home with ease. Home automation devices will provide great advantage to mobility impaired and elderly persons, enabling them to carry out many of the functions that they would not normally be able to perform in their own homes.

Variability

A building is a static, inanimate object that moves only slightly in response to structural and thermal stresses. Climatic conditions vary throughout the day and between the seasons. Yet one of the primary functions of buildings is to protect occupants from the extremes of climate, and as such they provide the interface between internal and external conditions. An element of variability is required to reverse the inertia of buildings, by giving them the capacity to respond dynamically to the variations of climate, occupancy and time. This is provided in the House for the Future by opening windows and the motorised blind beneath the roof glazing. The surrounding vegetation will also provide a form of variable shading and protection from the elements.

The glazed south-facing elevation of the House is designed to change according to the seasons of the year. Human beings moderate the body's capacity to store or lose heat by increasing/decreasing the wearing of layers of thermally efficient clothing. In summer, for instance, we wear fewer clothes and body heat is allowed to evaporate. Conversely, in winter the heat produced within the body is trapped under many layers of clothing. This analogy is replicated in the design of the House for the Future. By changing the thermal resistance (ie the effectiveness to retain heat) of the south-facing glazing, using the motorised roller blind, the heat build-up in the House can either be retained or allowed to escape. This principle can also be reversed to prevent heat from the sun from entering the House in the summer.

5

Constructing the House for the Future

"Redrow Homes are dedicated to the highest standards of construction and, of course, to environmental awareness. As a team we learnt a great deal about adapting our methods of work to environmentally conscious practices. We are delighted to be involved in this visionary project."

Huw Evans, Redrow Homes

Introduction

On 9 November 1999 the ground was broken for one of the most innovative projects ever constructed at the Museum of Welsh Life. Over the following twelve months the site underwent significant change, from being an unused area of the Museum's land, to a new and exciting showpiece. Here Jestico + Whiles provide a chronological diary of events as they happened on site, and Redrow describe their experience of constructing the House for the Future.

Construction was completed on 8 December 2000 and the Powell family from Bridgend moved in to test drive the House just before Christmas.

Substructure/ground floor

Before the House was built the ground conditions of the site comprised a layer of soft clay/gravel, which was probably 'fill' material relocated from other parts of the museum. Underlying the fill is a bed of weathered limestone, and bedrock was also found at shallow depths, providing an excellent foundation for the building.

The first step in the construction was to drill the two boreholes (about 150mm in diameter) that would later provide the ground source heating for the House via an electric heat pump. The large machinery required to drill 35m down into the bedrock below the site could only access the site before construction started. The boreholes were then capped to await the installation of the heatpump coils, nearly a year later.

Mass concrete footings using recycled aggregate concrete were cast in the positions of the timber columns to a depth of 400mm. The void between the footings was filled with a 200mm layer of well-compacted hardcore, made from recycled demolition material. On top of this was laid 100mm of rigid cellular glass insulation (CFC/HCFC free), which was also dressed up the side of the slab to minimise heat loss to the adjacent ground.

The site was identified as being located in an area prone to radon gas, albeit at low levels. Guidelines issued by the National Radiological Protection Board included the installation of a gas retardant damp proof membrane beneath the 150mm reinforced concrete ground slab, which also incorporated recycled aggregates. The floor slab has a construction U-Value of $0.22W/m^2k$, preserving valuable heat received from passive solar gain and using the floor slab as a heat sink.

Radon is a natural gas found in soil and rocks. It has no colour, taste or smell. In open spaces it is quickly diluted into the atmosphere, but in buildings concentrations can build up. Health studies around the world have linked radon with lung cancer. A radon sump (an empty space about the volume of a bucket) has been installed to remove the possibility of radon gas building up under the ground slab. The sump is ventilated passively to outside air by means of a small diameter chimney running up through the House and venting under the rooftop photovoltaic array.

Erecting the structural frame

The structure of the House has been built completely out of timber, utilising a material that offers one of the most sustainable forms of construction, releasing only $41kg/m^2$ of $(=CO_2)$ into the atmosphere, and also serving as a long term carbon 'store' through the natural process of photosynthesis.

The structural timber frame is an assembly of solid oak sections, which are joined together using traditional dry jointing techniques such as 'mortise and tenon' to form a 'Post and Beam' frame. The 'structural bays' are comparable to those of the Hendre'r-Ywydd Uchaf farmhouse on the museum site. This also consists of a series of similar bays, which are then wrapped in a timber frame infilled with wattle and daubed clay.

The oak used for the frame is green, which means that it has not been artificially seasoned to reduce its moisture content. This means that the oak will continue to dry out during the first few years after installation, which may cause some movement and cracks. It is in the nature of the material to bend, split and shrink as it dries over time.

Originally the timber for the structural frame was intended to be fabricated from solid and glue laminated softwood sections with highly engineered connections. However, it is extremely difficult to obtain the higher structural gradings (C24) of softwood within this country. The fabrication of

the structural frame was a key determinant of the construction programme and a source of Welsh hardwood in the form of oak was available within the shortest period, which led to the decision to make the frame out of green oak. On the larger scale the ability to produce large quantities of homegrown hardwood might prove difficult, and it is believed that softwood is an equally valid structural material that could have been used in this project under different circumstances.

The four timber frames were prefabricated off site in a workshop and craned into position on the site in March 2000. They form the three structural bays, each 3600mm apart. The posts are 175mm x 150mm sections of solid green oak and the primary beams spanning north to south are 250mm deep. The curved roof beams (15m radius) were formed from naturally curving oak trees and are 300mm deep.

The secondary structure consists of joists and rafters connecting the primary frames together. Homegrown Douglas Fir (C16) in section sizes of 175mm x 75mm for the floor joists and 200mm x 50mm for the roof rafters span 3.6m between the primary structural members.

Roof

The curved north roof contains 200mm of Warmcel® cellulose fibre insulation, blown between the deep timber rafters that span between the primary structural beams. This gives a construction U-Value of 0.17W/m^{2}K. Sheets of bitumen impregnated fibre board are nailed on top of the rafters to provide additional racking resistance to the structural frame. The standing seam roof made from recycled aluminium is fixed directly onto the sarking board and through into the timber rafters below. The aluminium pans of the roofing system have been overlaid with sedum plants to create a lightweight green roof. This approach to 'greening' the roof was chosen as a more cost-effective and environmentally responsible solution, as turf roofs are often very heavy.

The NatureRoof® system comprises a drainage board which sits directly onto the standing seam aluminium roof surface, allowing excess water to drain away whilst retaining sufficient water for plant growth, and a filter fleece prevents silting up of the drainage board. An inert and lightweight substrate that is pH neutral is spread on top of the drainage board and filter fleece to a depth of 70mm, which settles to a planting depth of 60mm.

The vegetation layer is made up of plant types specifically selected to withstand the potentially harsh environment of the roof. Sedums are a hardy, free flowering, sun loving plant which give a range of colours and textures not found in other plants. They were selected because they are drought tolerant and require very little maintenance once established. A liquid mulch is also applied during installation consisting of biodegradable matter, fertiliser and agricultural tackifiers. This conserves water, supplies nutrients and helps to stabilise the substrate whilst the plants become established. The saturated weight of the nature roof is about 90kg/m^2.

The inclined south roof consists of 300mm deep oak beams which span all the way to the ground and create the three structural bays. Two of the roof bays are opaque, and have been finished with recycled natural slate. Again 200mm of cellulose fibre insulation (recycled newspaper) has been stuffed between the 200mm rafters. The remaining central roof bay is fully glazed with fixed double glazed panels with a low-e coating that are set onto patent glazing sections.

External walls

The structural timber frame was 'wrapped' with a highly insulated timber studwork wall, which can be faced externally with any number of cladding materials to suit the site location. In this instance lime render and Welsh oak boarding were chosen. The frame for the House is infilled with 200mm sections of timber studwork that support the inner and outer sheathings of clay board and fibreboard respectively.

The void between the timbers was filled with 200mm of wool insulation, which contains no CFCs and HCFCs and is user-friendly to install. There are no known or expected adverse health effects associated with wool insulation. The wool gives a construction U-Value of 0.16W/m^2k. Although this product was not commercially available in Wales (only in Europe and New Zealand) at the time of construction, the British Wool Marketing Board provided large quantities of Welsh sheep's wool for processing into insulation batts in a German factory. The wool was washed and treated to make it resistant to fire and insects. A latex fibre is also woven in to give the insulation batts rigidity and tie the wool together. Plans are now underway for a factory to commence the manufacture of sheep's wool insulation in Wales.

Secondary timber battens fixed to the outside sarking board provide a ventilated cavity and a base for the lime render covering and timber rainscreen cladding. The Panelvent® sarking board is manufactured using wood chips, selected wood waste and forest thinnings that would otherwise be burnt or wasted. It is more vapour permeable than most types of sheathing and sarking board, which reduces the risk of interstitial condensation and facilitates breathability. Due to the nature of the manufacturing process and the raw materials used very little adhesive is used other than the wood's natural lignin and much of the timber's natural formaldehyde is removed during the curing process in the factory.

Lime renders are made from sand and lime putty and cattle or goat hair is added to give the render tensile strength. They use a high calcium lime (also known as fat or non-hydraulic lime) which requires exposure to carbon dioxide in order to harden. Lime renders take longer to go off than cement based renders. They set by a small lime silica reaction together with atmospheric CO_2 in the presence of moisture. This carbonation is slow, and the control of the drying is crucial to durability and long term performance.

The Welsh oak rainscreen boards have been mechanically fixed with stainless steel fixings set into a recessed hole in each board, and the fixings expressed. The hole for the fixing is slightly oversized to accommodate movement of the timber and avoid cracking and warping. An insect mesh prevents the possibility of insects nesting in the ventilated air cavity that is necessary to dispel moisture. When first installed the timber represented a warm honey colour, but will dull to a silver grey over time due to ultraviolet light.

The external walls and roofs have all been designed using the principle of the 'breathing wall', a method which relies on selecting materials of different vapour resistivity to control the passage of moisture through the wall, and so prevent condensation.

Windows and doors

All the windows and doors are made from timber and contain high performance double-glazing with a low-e coating and argon gas fill for increased thermal performance. These windows are considered to be far superior in both environmental and aesthetic terms to PVC and metal alternatives. The windows were factory finished in a fully automatic painting plant which applies the paint electrostatically, ensuring a uniform surface. The timber is pine heartwood, which comes from the hardest part of the trunk and offers the most resistance to rot and fungus attack.

The windows and doors are well sealed, but also contain permanent trickle ventilators to maintain a constant air change for the House. The sliding timber patio doors to the south wall allow the main living space to be fully opened to the outside air. An insulated window at high level, beneath the roof apex, provides an automatic outlet for ventilation air. This vent is linked into the automatic control system and is controlled by the same device which controls the lighting and the motorised blind. The internal doors and frames are also made of timber from sustainable sources.

Internal walls and partitions

The internal partitions are entirely freestanding and can be constructed anywhere within the confines of the outer walls. This philosophy also allows their relatively simple relocation as circumstances change over time. The lightweight construction has also been filled with additional sound insulation. In the original design proposals were made to add 'portable mass' to the partitions for acoustic insulation and thermal mass in the form of 100mm clay bricks (non-loadbearing), which were made on site using the clay waste. However the weight required to support these partitions essentially made them heavy loadbearing elements and this proposal was later discarded.

Handmade clay blocks

The clay reclaimed from the site was still put to use, and nearly one thousand blocks were cast and dried on site using a manually operated 'Cinva' ram to compress the earth. These were used to form the partition to the study bedroom where the concrete slab was able to tolerate the heavy loads (2300N/m^2). An area of the clay block wall has been left exposed within the study bedroom.

Services

The House has been well wired to allow the potential installation of computers and the Internet in all rooms. Digital television systems are able to provide the latest Web TV access to take advantage of interactive programming such as home education. All wires have been concealed within the timber construction, and remain easily accessible. An ISDN has been installed for premium speed internet access.

On the north side of the building large rainwater tanks were built into the eaves to store rainwater collected from the roof run off. Initial proposals suggested fabricating 3000 litre HDPE tanks, but the unusual shape made this prohibitively expensive. Standard domestic water tanks provide nearly 700 litres of rainwater storage at high level. This is fed by gravity to an internal storage tank, which further filters the water and provides 200 litres of internal storage. It is then used for flushing the WCs and watering the garden. The rainwater tanks have a custom-designed insulation jacket and the surrounding void is filled with wool insulation to avoid the risk of the water reaching temperatures where legionella might breed, caused by heating from the sun.

Low flush WCs have been used throughout, using a dual system of only two or four litres of water for each flush. The baths include an upright shower, which is a more efficient use of water. All wash handbasins have been fitted with mixer taps with an aerated 'mousser' device, which give the impression of more water being dispensed, and thus cut consumption.

The Ifö Sanitar Cera® dual flush WC installed in the main bathroom is heralded as one of the most water-efficient flush toilets available for use with normal gravity sewers. A double button mounted above the toilet pan selects full or part flush and is factory set to deliver 2 or 4 litres. The flush button requires minimal force so is easy to use for children and people with impaired arm or hand use. The toilet areas have stale air extracted through the toilet seat using the Ventalu® system.
A small and efficient 12 volt fan contained within the service riser is activated by passive infra red (PIR) detection and exhausts the air to outside.

The electric ground source heat pump was delivered to the site from Sweden in September 2000. The 65m copper collector coil was fed in to the pre-drilled boreholes and sand was added to act as a stabiliser and heat transfer medium. The wood pellet heater was later installed to provide backup on the coldest days. More details are included in the description section.

Finally the eight photovoltaic panels and the active solar panel were craned into place on a galvanised frame. Space has been allowed on the array for further panels to be installed when they become more commercially viable.

Staircase

The staircase positioned at the end of the space is fabricated from oak. The timber treads are deliberately contrasted with the slate risers to provide a visible contrast for visually impaired people. The flexibility of the space is such that it could always be demounted and re-erected in a different position, or to a different configuration.

In the original competition design, the staircase was intended to be mounted onto a sliding track mechanism at its top and bottom, which could be 'locked' into position anywhere along the length of the upper gallery. A modular balustrade system was intended to make this easier to perform without major works. However, the use of this building by large numbers of people as a Museum exhibit led to proposals for a more restrained and conventional staircase suitable for use by members of the public.

Wall Finishes

External walls are clad internally with clay board sheets which were used instead of gypsum based plasterboard. The clay board is a combination of clay, reed and hessian, and offers excellent thermal and vapour diffusion capacity. The board absorbs moisture and odours and also acts as an effective sound insulator.

The Claytec® plaster consisting of a natural mixture of fine sands and clays mixed with mica has been used to finish the clay board panels. The clay plaster also takes very well to the conventional plasterboard used for all internal partitions. On the upper storey gypsum plaster has been used in the bedrooms with a natural emulsion paint finish. Whilst the rough finish and self colouring of the clay plaster is not to all tastes it has been preserved to highlight the nature of the material used. It would also be possible to use natural paints, which still allow the wall to breathe, and to provide alternative colour options. The clay plaster provides a unique material that absorbs and diffuses water vapour, and can be restored and repaired simply by damping and repatching. This proved extremely useful during the final stages of the construction process, allowing the plaster to be simply reworked.

The use of non-petrochemical finishes eliminates many problems associated with conventional solvent based paints such as excessive static, synthetic chemical off-gassing and noxious smells. This also reduces the health risks, such as asthma, that are commonly associated with volatile organic compounds which are common in most paints.

Externally, the softwood timber was treated and finished with a high performance water borne paint but the oak was left untreated. The limewash used to finish the external render is a traditional paint made using high calcium (fat) lime. It sets when exposed to carbon dioxide in the air. It is naturally white and becomes more opaque as it dries.

Floor Finishes

The ground floor consists of an insulated mass concrete slab, which provides a large body of thermal mass. Onto this is laid a slate floor and the natural stone further provides exposed thermal mass as well as a durable floor finish. The disabled toilet and utility area have been finished in a smoother slate. The study bedroom has sisal floor-covering made from natural fibres. The coir fibre used to form a matwell in the lobby is obtained from coconut husk. Upstairs the bedrooms and gallery are covered with oak floorboards to provide an accessible, natural and durable finish. The lightweight upper floor is laid onto a rubber insulating mat made from recycled tyres in an attempt to limit the acoustic transfer between floors. The hard floor surfaces help to reduce the possibility of dust mites since there is less available habitable area for them to flourish in. The wet areas have been finished with a natural linoleum, made from linseed oil, rosin, wood flour and chalk mounted onto a backing of jute.

Fixtures and fittings

One of the principal elements in the House for the Future is the kitchen, where the architects have speculated about the future of the kitchen area in collaboration with Paula Rosa Kitchens and DFTA. It has been suggested that the kitchen will no longer be conceived as a room lined with perimeter floor and wall units, which are changed every five to ten years. Instead, there will be full height storage cupboards (which is the primary purpose of most kitchen units) and more freestanding work surfaces and cooking areas. It provides an open area for social contact with the rest of the family, including an adjustable computer screen for downloadable menus and homework assistance.

Utilising a combination of reforested timber, recyclable aluminium, slate and glass the kitchen makes use of the positive points of each material. Maple was chosen for its natural anti-bacterial properties, aluminium and glass add interest as well as being easy to clean and slate in the larder acts as a naturally cool shelf. The electrical goods have been chosen for their high energy rating, with combi-microwave ovens chosen over a conventional oven due to their superior performance and energy efficiency. Other elements for the furnishing of the House are described in later sections.

Contractor's experience

As someone who has built hundreds and possibly thousands of houses during his career within the building industry, being selected to take on the construction of one house in the idyllic setting of the Museum of Welsh Life seemed like a simple task. The reality was, however, far from simple. When those of us from Redrow Homes who formed the construction management team for the project first read the specification document we knew that this was not going to be an ordinary house. The introduction specified "minimising transport" and "segregating waste for recycling", and the first construction items specified were blocks made from clay excavated on the site.

Using our own construction experience, and information gleaned from some of the many specialists who were to supply their products and expertise, we set about programming the works. Builders are always optimists, and the reality of the project saw us revise the programme several times, generally because of problems which stemmed from the innovative products that originated from overseas. This required a great deal of organisation and co-ordination, especially because we often had no previous experience of the items. A perfect example of this was the ground source heat pump, which sounded simple once the installation manual had been translated from Swedish into English. It took us some time to arrange, but the installation was easy, and early teething troubles were resolved by telephone. From that point onwards, the heating worked well, though we all had to get used to a low energy, slow response system, that works differently to our own domestic heating systems.

In overall terms, the construction work flowed reasonably well, from the erection of the timber frame to the final decoration. We also played an important part in making quite innovative systems work. Rain water harvesting, green roofs and solar power no longer hold mystique, and cannot be claimed as the domain of the eccentric enthusiast. The materials used throughout the House are different to those used in conventional buildings. The clayboard, for example, which was made from mud, rapidly reverted to mud in the wet. The finishes are in no way traditional and the use of clay plaster brings a totally different feel to the building. Towards the end, the shape of the building made it difficult to work around, as the sloping south roof and the vents above were almost inaccessible once the roof glazing and slating were complete, but the warmth generated from that south facing glazing became very apparent.

There was, however, one factor that hampered our progress and could not be eliminated.
The weather played a great part in the construction of the House. It is quite ironic that this very project, which prides itself on being environmentally friendly, was affected by almost non-stop rain and high winds during spring and autumn 2000, which are widely acknowledged as a product of the global warming we are working to prevent.

Manufactures and Suppliers

- **AEG/Electrolux**
  (Domestic appliances)
- **Alfred McAlpine Slate**
  (Riven finish slate)
- **Allgood**
  (Ironmongery)
- **Bisque**
  (Radiators)
- **Boa Kemi**
  (Timber floor sealer)
- **Bob Jude Flooring**
  (Coir matwell, linoleum and sisal)
- **BP Solar/PV Systems**
  (Photovoltaic panels)
- **British Gypsum**
  (Plasterboard)
- **British Wool Marketing Board**
  (Sheep's wool insulation (Welsh Radnor Sheep))
- **Caradon Plumbimg Solutions**
  (Radiators and towel rail)
- **Carpenter Oak & Woodland**
  (Design fabrication and installation of oak frame)
- **Ceramiks**
  (Ceramic tiles)
- **Corus Building Systems**
  Kal Zip Nature Roof
- **Delta Light (UK)**
  (Lighting)
- **Elemental Solutions**
  (Low flush toilets)
- **Expamet**
  (Insect mesh)
- **Filcrete**
  (Sarking board for wall and roof)
- **Filsol/Solar Sense**
  (Solar water heating panel)
- **Genesis Lighting**
  (Lighting)
- **GFC Lighting**
  (Lighting)
- **Guthrie Douglas**
  (Motorised roller blind)
- **Hanson Aggregates**
  (Recycled aggregate)
- **Helios Fabrications Ltd**
  (Metal frame for solar panel array)
- **HEWA**
  (Internal rainwater storage tank/filter)
- **Ideal Standard**
  (Sanitaryware and shower equipment)
- **Into Lighting Design**
  (Lighting)
- **Jewson**
  (Homegrown softwood)
- **Lonsdale Metal Company Ltd**
  (Patent glazing system)
- **Mick Jones Timber**
  (Welsh oak for timber frame)
- **Markus Energi AB**
  (Ground source heat pump)
- **Metal Fabrication Co (Cardiff) Ltd**
  (Aluminium gutters, downpipes and flashings)
- **Natural Building Technologies**
  (Clayboard and clay plaster)
- **NBS Pennine Ltd**
  (Precast cills)
- **Paula Rosa Kitchens**
  (Kitchen)
- **Pilkington Processing and Merchanting**
  (Glass roof and canopy)
- **Pittsburgh Corning**
  (Cellular glass insulation)
- **Polytank Ltd**
  (Eaves rainwater storage tanks)
- **Quality Hardwoods**
  (Welsh oak cladding)
- **Rationel (UK)**
  (Windows and Doors)
- **Rose of Jericho**
  (Limewash)
- **Sheffield Insulation**
  (Tyvek breather membrane)
- **Smarta Systems**
  (Control system)
- **Sound Service (Oxford)**
  (Recycled rubber floor insulation)
- **Stairway Joinery**
  (Oak staircase, handrails and flooring)
- **Stannah Lifts**
  (Home lift)
- **Tŷ Mawr Lime**
  (Lime render)
- **Valtti Specialist Coatings**
  (External timber stain)
- **Ventalu**
  (Ventilated toilet seat)
- **Vicaima**
  (Internal doors)
- **Wavin Building Products**
  (Polybutylene plumbing materials)
- **Welsh Biofuels**
  (Wood pellet heater)
- **Wincilate Ltd**
  (Smooth finish slate)

6

Inside the House for the Future

"So what's all this House for the Future stuff been about?

Building the **Foundations** for future living that enable life to continue to **Flow**.

Designing to satisfy our future needs and **Emotions** and provoke **Thought** towards protecting our **Environment.**

That's our concept defined!"

DFTA (Designs from the Attic)

Introduction

As we move forwards and realise the impact everyday products are making on the environment the urge for us all to react is becoming greater. The products with which we surround ourselves are expressions of the way we want and need to live, and it is through our 'stuff' that we define ourselves. It is also through our 'stuff' that we will destroy ourselves! Many products have been designed over the years to be nothing more than 'desirable' items for the mass consumer audience, yet totally undesirable to the environment. Designers contribute to the collective pleasurable world we all aspire to. Designers' activities and ideas are what virtually shape our everyday lives.

Today's realisation that we need to change our thinking habits, needs and wants for the sake of the environment requires a new and higher degree of discipline. Driven by today's designers – the "future thinkers" – the design process has never faced a greater challenge. New qualities and values are designed into consumer products to ensure that we protect the world we live in.
This is a process of reinvestment in living and surviving.

As designers, we now face the most significant challenge of all time – the responsibility of balancing critical ecological issues, increasing consumer demands and aspirations, consumption and design expression. We can no longer treat these issues as separate, disconnected components during the design process, the product's production and its ensuing life. We can no longer afford to ignore the consequences of mass consumerism at the expense of our world. Designers are now urged to take a more holistic approach during the creative process. It is essential to design products with a difference that make a difference - an association of new, fresh ideas that have a significant and positive impact on our environment. It is designers who inform change, and that change must be for the better. Insensitive, short-term, commercially led solutions should be avoided.
Products should propose benefits to living in the future and inspire us to create a new culture – an innovative, sensitive culture that allows for self-expression and individuality.

Designing for the future – the challenge

Designing for the future requires vision and experimentation. The House for the Future has seen the emergence of a programme of innovation and initial exploration into the possibilities for living in the future. This has led to a portfolio of ideas all connected to a conceptual suggestion of a new way of living, a way of life that aims to seamlessly integrate with the environment. A more defined alliance with nature, and a whole new vocabulary of design, is now evident in the concept. Engaging with the future is about applying a considerate approach to design and potentially doing more with less. However, defining the future is a tricky business. Most fear the future, as we do the unknown. Change (even for the better) is often met with resistance, an emotion we demonstrate due to lack of knowledge and understanding. How do we assess our needs and respond to them when we have no idea what our needs for living in the future will be? The way forward is by learning, communicating and doing. The design and selection of products we choose to interact with will play a significant role in the critical path to a sustainable way of living. We are creatures of habit and comfort but must now be open-minded and prepared to accept new and unfamiliar ideas, different to the commonplace product we live with and use every day. Our perception of the 'stuff' surrounding us today will be challenged – why should we sit a certain distance from the floor to eat off a surface? Why would we need coat hangers in the future if textiles are so advanced that we do not need to iron our clothes? Why does a sink need to be made of a hard material when it could be soft? In the future many decisions such as materials selection will be informed by our desire and need to be more environmentally conscious.

Environmental criteria

The list below was developed as a guide for understanding some of the sustainable issues explored during the project.

Recyclable

- Uses mono-material components
- Uses existing recycling channels
- Suitable for future material separation, giving potential for recovery and disposal of components

Recycled content

- Product/packaging which has reached the end of its useful life
- Pre-consumer waste or scrap from the manufacturer

Renewable

- Materials replenished by humans or nature

Optimisation of material

- Reduction of number of materials used
- Reduction of amount of materials used
- Reduction of assembly/disassembly time
- Exploration of common materials in new and challenging ways

Optimisation of logistics

- Optimising transport loads
- Reverse logistics (create mechanism to take back packaging and products)

foundation

Environmental
Balance
Realistic
Honesty
Holistic
Less is more
Commerciality
Affordability

flow

Flexibility
Adaptability
Modular
Components
Connect
Locate
Location
Increase
Decrease
Disperse
Reconfigure
Nomadic
Migrate
Inside
Outside
Movable
Tip – rol
Push - pull
Stuff - expand
Twist - stack
Change function
Self produce
Self change
DIY

emotion

Emotional satisfaction
Pleasure
Delight
I want!
Interaction
Relationships:
Person with person
Person with product
Product with product
Preserve
Protect
Respect
Personality
Character
Product communication
Language

thought

Challenge the familiar
Provoke thought
Prevent boredom
Stimulate
Collaborate
Like minds
Exploration
Suggestion
Empower
Inspire
Educate

Strategies for durability

- Reuse (uses existing components as they are, for new product)
- Refurbishment (including servicing, repairing and upgrading a product before passing it on)
- Reappropriation (uses existing parts/components in a different way)
- Remanufacture (uses components/parts again in the same product)
- Teddy bear factor (giving a product character in order to encourage bonding and respect that can last a lifetime)

Dematerialisation

- Provides a service therefore increasing number of users per product
- Provides multiple services with one product, increasing functions per product

Partnerships

- Sustaining local business

Concept

The concept has been designed to provide an innovative, conceptual furniture solution that aspires towards sustainable living and challenges the way we currently think and live.

All products within this fresh concept are created to compliment each other and integrate with each other as well as work well independently. This level of flexibility will allow the living space to adapt to the individual's and family's needs and requirements, in turn encouraging the exploration of this space on a daily basis, as the house has been designed to be flexible. Areas and zones can be redefined – so can the furniture. It gives users a sense of freedom, fun and creativity where their imagination will allow them to turn their home inside out and upside down!

Walk through – the product

In addition to the critical criteria above the concept has also evolved around areas, zones and themes. The suggestions have been designed to stimulate the senses and life emotions. The effective use of space has been an important factor and the concept ensures that the architects' vision for an open, flexible way of living is achieved.

Living area

The living area aimed to encourage the following three activities:

- **Interaction** between household members and product
- **Flexibility** of product use
- **Adaptability** of individual product

The open nature of the house would naturally provoke social interaction between the different household members and it was important that the furniture encouraged this connection. Different scenarios were explored to give as much flexibility as possible to the way they could live, by providing a movable, modular furniture concept. The living space could therefore harmoniously function as a place to relax, work, play, entertain and eat.

The main elements in the living area are:

The Kitchen

A freestanding, renewable and energy efficient design, where the family can effortlessly combine the needs of cooking, on-the-go eating and working within a flexible space. The kitchen harmoniously blends in with the overall feel of the house and provides an open focal point to the living area.

Moovit

An alternative to the traditional way of manufacturing and purchasing a sofa. The concept focuses on leasing comfort, ease of upgrading the product and recyclability when it reaches the end of its useful life. Produced using three basic components: block, mattress and lumber plus a structural

slipcover, the design allows for easy manufacture and ultimate flexibility in the way the different elements can be configured. The foam blocks minimise waste during production, and because they can easily be broken down and recycled with virtually no contamination problems they could potentially be part of a collection scheme from the leasing company. The leasing idea allows you to change and refresh your sofa on a regular basis as the units can simply be refurbished in a cost - effective way to give the sofa a new look every time. This is easily achieved with a new slipcover or by adding new units to change the look and to customise it to suit the individual, thus extending the component's lifespan as much as possible.

The individual Moovit units in the house have been designed with the different family members in mind. Each unit is detailed with subtle stitch lines to reflect a body position and to give the units an individual character. The concept encourages a sense of ownership and respect and a desire to grow and develop with the unit, which becomes a favourite old chair without necessarily looking like one!

Slide.2

A simple, flexible solution in response to modern day eating and working habits, providing a low level or TV dinner situation that can easily be configured for single or group activity. Slide.2 works well with the Moovit sofa, as it can fit to the sofa in its upright position or alternatively the Moovit's top cushions work well as comfortable floor pads. The design is also quick and easy to assemble and disassemble using everyday bottle corks that simply lock the two elements together.

Anwen

Using the Welsh angle construction detail, developed by Coed Cymru, the Anwen console table utilises the small forest thinnings that are often avoided due to their restricted size. The table is made from a renewable source of Welsh oak and makes good use of the smaller pieces measuring no more than 2.5cm thick and 10cm wide to construct a simple but clever design.

Polly Box

The Polly box was chosen as it was a simple but clever modular storage system that could be stacked in many different ways, enabling the family to build up a collection of belongings, memories, objects etc. They can easily remove elements as needed, identifying their own belongings by colour. The boxes can act like a family tree, growing as new items are added, building up a story of the family.

Elliptical Aquarium

The elliptical aquarium is the result of extensive design and development, exploring alternative manufacturing techniques to the standard glass or plastic aquarium on the market. It is fabricated using premium quality materials combined with the use of a kilning process to shape the glass into unique forms, unachievable with more conventional plate glass fabrication. The free-standing aquariums in this series are of novel and unusual proportions based on the organic forms of the fish themselves.

Recycling area

The recycling area acts mainly as an area for storage of waste before collection. It is the activities that happen prior to its arrival here that are more important:

- **Segregate** all domestic waste into easy to dispose of categories
- **Decrease** volume of certain waste items to INCREASE amount of waste separated
- **Product communication** to make it clear how to use the product

The prototype products selected showed some interesting ideas regarding recycling, and aimed to encourage the user by simplifying a task.

Oscar

This recycling unit explores the concept of a movable, flexible, all in one unit that can be used to suit your needs. There are 4-6 main compartments allowing you to recycle any combination of waste types including paper, plastic, metal, glass, organic and miscellaneous waste. The waste can

be bagged for kerbside collection or the internal bins can be easily removed and taken to communal collection points. The bins fit neatly onto a two-part trolley that can be effortlessly moved from kitchen to recycling room for emptying, and are also designed to fit under a standard worktop for storing. The design involves simple component parts that are easy to assemble/ disassemble and recycle. These simple parts also make Oscar easy to clean and maintain.

Plastic Bottle Compactor

Aimed at improving the collection of plastic bottles for recycling by reducing their volume. It works on a simple lever principle (mechanical advantage and velocity ratio) and facilitates greater efficiency in terms of bottle collection via a kerbside collection system, such as that operated by Cardiff City Council.

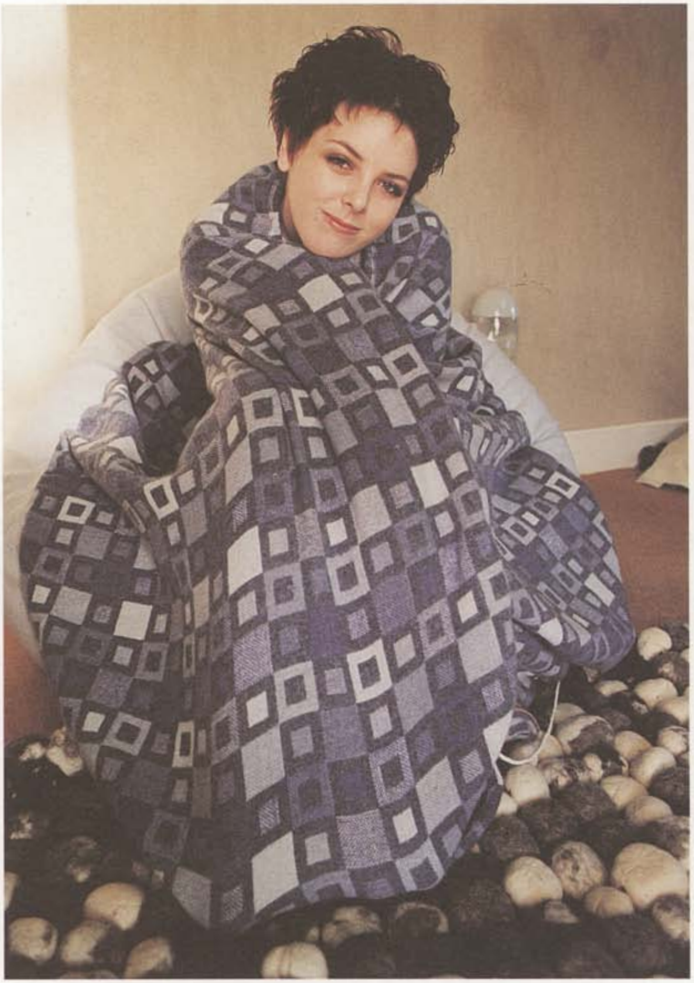
The recycled plastic material used for this prototype is particularly important, as it is made from recycled bottles. The unique aesthetic qualities of this material are directly connected to the process the prototype is designed to improve. In a practical sense, these material qualities, combined with the visible, self-evident mechanism also make the object highly conspicuous, encouraging user participation. The unit is supplied in a flat-pack format for easy home assembly and disassembly for repair and recycling purposes.

Ground floor study bedroom

The study bedroom aims to fuse together a very textural and tactile environment, exploring the following areas:

- **Indigenous** materials and skills
- **Self produce** concepts looking at alternative ways to buy and manufacture
- **Honesty** of materials

The room itself needed to provide a calm, soft environment with a focus on material use with an honest and natural feel. The aim was to utilise locally available skills and materials to create a simple but effective concept.



Platform

Platform is a simple bed idea, exploring the concept of 'self produce'. The design could easily be sold as a pattern as the main materials are easy to obtain from a local source, ironically using two materials very familiar to each other in their pre-consumer phase. It consists of a simple fabric sling with waste cardboard tubes slipping inside individual sleeves to form a futon style base. The tubes are a waste product from the fabric industry and the fabric is made from recycled plastic bottles. The mattress is produced using organic wool with an organic cotton cover. Regionally, materials options may vary but the essential concept remains the same.

Skylon

Springing from the idea of a 'minimum footprint' the structure balances between floor and ceiling. Built from component parts the system extends into a modular family of designs offering storage, display and work spaces. Built from native Welsh hardwoods, the Skylon System promotes the green objectives of Coed Cymru through modern, conceptual design. The concept also explores 'self produce' utilising what is often considered waste timber due to the size of the pieces left. As with Platform, Skylon explores alternative production methods, looking at simple construction, again through means of a pattern purchased by the user.

Snowdon Beanbag

This clever design takes the conventional beanbag a step further, integrating a warm, cosy blanket that unzips, rolls back and pulls over to create a snug, warm, comfortable sit. The blanket is produced locally by a well-established traditional woollen mill – Melin Tregwynt, who specialise in producing contemporary woven textile designs. The blanket itself is an original retro design, updated to give it a modern contemporary feel.

Cocoon Vessels

These hand-felted vessels are made using wool from different breeds to achieve a subtle variation in colour. With their gaping mouths they provide secret little pockets to store precious, personal items. Chosen to hang by a doorway, they provide an ideal place to drop off your keys as you leave and enter a room, acting as external pockets to keep all your small belongings safe.

Cable Blind

Focusing on a sculptural, tactile and three-dimensional quality, the Cable Blind continues to carry forward the natural, textural feel of the room. The blind provides an interesting window treatment, and adds a hint of colour through the use of the two-tone felt.

Upstairs kids' bedrooms

In contrast to the other bedrooms these two linked rooms aim to capture kids' behaviour through the product. The following ideas were highlighted:

- **Fun** and imaginative product
- **Modular** movable product
- **Animated, Expressive** product with **Personality**

The product needed to be fun, movable and reactive to kids' needs. It required a completely different approach, looking at ideas such as stuff, grow, build up, disperse, hide, throw and create: objects that, with a little imagination, became something completely different.

The main elements in both rooms are:

Pack Ups

These flexible, collapsible, multi-functional building blocks form part of a modular furniture system that can be used to create various configurations for sleeping, seating, working and storage.
The units are also available with optional denim, hemp and wool fabric covers that slip over the units and zip up at the front, 'clothing' the unit to give them a different look as well as hiding more personal possessions. The design can be easily manufactured with low tooling costs, minimum components and minimum fixings. It also takes into consideration storage and distribution factors, by making the units flat packed. The units are manufactured from fibreboard, which is a recycled cardboard material, produced by a local Welsh company. The design aims to give a well-established product a new direction, emphasising the product's qualities through the design.






Sleep On It

Sleep on it top mattresses utilise hi-tech Visco-elastic foam to provide a comfortable, supporting topper surface that moulds to the individual body. Produced in component parts, it is compatible with both the Moovit units and both sizes of the Pack ups or on its own as a floor mat.

The mattresses are subtly detailed, using stitching to suggest where the body makes an impression and fabric loops hold and support technology such as mobile phones and games console controllers.

Bung It

Developed as a fun storage solution, with hi-tech, non-crease clothing in mind, Bung it is the result of children's natural storage habits! It allows clothes to be rolled up or stuffed inside the tubes and bunged in with a balloon, creating a fun, visual exterior, alternative to a drawer front.
Reusing waste cardboard tubes, it forms an expandable storage system.

Hot Shot

A storage system that encourages children to tidy their rooms by making the task easy and fun. Utilising simple components, Hot shots springs shut when soft or light objects are thrown into the sleeves.

Whoosh Beanbag

This simple idea takes the humble beanbag in a new direction. Taking everyday nametags and applying them to a base fabric in a circular design creates a visual, tactile poem, therefore identifying the beanbag with the owner. The beanbag cleverly integrates a strap in the design, allowing easy portability wherever you go.

Jig-Rug

Jig-rug reflects the 'cardboard box' attitude to play, allowing for customisation and exploration. It was developed as an all-in-one kids' furniture, play and storage solution. The main element is made using six simple recycled fibreboard panels hinged together using hessian webbing.
The design utilises a simple square panel with a circle stamped out of the middle. This has two

functions, as it provides a decorative feature when used as a playhouse and a functional feature, utilising the waste circles as plugs to attach various components by locating them back in the holes to create an interesting play terrain. One of the components is the Felt Square Rug. This is made using a recycled woollen jumper and is felted in to form a textural rug. You can clearly see the various recycled threads within the felt, giving the rug a landscape feel.

Main bedroom

The overall aim of this room was to focus on:

- **Wellbeing**
- The room as a place of **Sanctuary**
- **Honesty** of materials

The emphasis here was on relaxation and well being, making the bed the focal element of the room. Natural colours and materials were chosen, concentrating on textural detail and subtle shapes. A hint of graphic colour was introduced to bring life to a neutral palette. Light plays an important factor, with daylight being gently revealed or soft sculptural light coming alive at night.

Catenary Bed

Catenary takes its name from the curve of a soft shelf, slung underneath to store bedding and perhaps a bedtime book. The bed's design directly addresses issues of woodland management and commercial viability. Removing smaller trees, or 'forest thinnings' is an important part of the silviculture promoted by Coed Cymru. While the quality of forest thinning timber is excellent, its limited length and section are viewed by some as a restriction. Coed Cymru is helping to rebuild a woodland tradition in Wales, offering free help and advice to farmers and woodland owners on management issues from timber sales to plant and animal habitat. The ecological rewards of broadleaf trees grown by their silviculture methods are multiple. Plants and wildlife, bio-diversity and rural employment benefit. The designer gains a furniture material that is sustainable, low in energy consumption, locally sourced and low pollution.

The mattress was chosen for its medically proven qualities, ensuring a comfortable night's sleep due to the high-tech Visco-elastic foam on the top layer and the combustion modified high resilience seating foam on the bottom. This top layer moulds to the individual's body providing support where needed. The Visco-elastic foam also has non-allergenic and anti-bacterial properties to add to its many benefits.

Therapy Cushion

The cushion acts as a sophisticated comfort blanket with twists of felted wool woven into a linen cloth, providing a tactile, strokeable surface to both calm and relax you.

Felt Rug

Made from natural Welsh organic wool, the felted rug provides an interesting, tactile and soft surface. The rug utilises wool produced by local farmers, with colour being achieved naturally through the choice of breed of sheep instead of additional dyeing. The design supports local design, crafts and the farming community.

Ammonite

Ammonite light is a long flexible tube constructed using individual hinged segments. These single repeated shapes bend around and connect to each other using a bolt and wing nut fixing. The flexibility allows the light to coil up, with the shape created resembling the ammonite fossil. It is made using natural opaque polypropylene and low voltage lights, giving out a soft, warm glow of light.

Main bathroom

As a bathroom shared by all the family it was essential that certain elements reflected the following:

- **Inclusive** for all family members, young and old, able bodied and disabled
- **Fun** cleansing and bathing
- **Challenging the familiar** use of materials and function

Membrane Sink

The sink was developed with the aim of minimising the amount of materials used to achieve the same function. Latex was used as an alternative to the traditional ceramic sink. Not only did it use fewer materials but it also provided a lightweight sink that could easily adjust in height for individuals from small children to wheelchair users. The tap explores the more fun element of water and encourages a more playful approach to washing and bathing.

Rubber–Dub–Dub

Rubber–dub-dub is a tactile, fun bathmat exploring alternative uses for everyday products. The rubber bands are cleverly woven to create an interesting, highly tactile and waterproof mat.

A reflection

Back in November 1999, DFTA made a decision to support and sponsor the House for the Future project. In November 1999 we also made a decision to learn to become 'responsible' designers. Our starting point in the programme was to take on board many of the key drivers in the original architectural competition brief such as an environmental approach towards a sustainable aim, adaptability and flexibility.

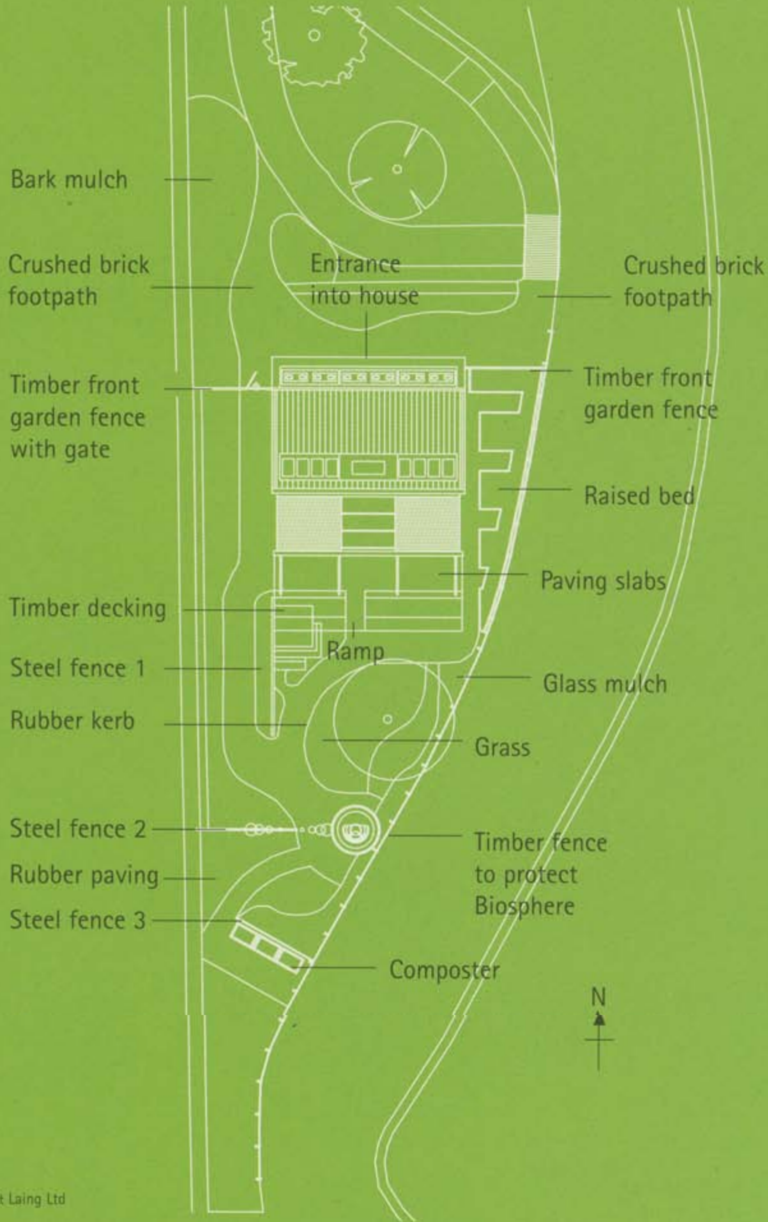
We have added honesty and realism to the inclusive criteria, with the latter being one of the key drivers that kept us focussed. We have been realistic about learning a new subject and applying our limited knowledge and experience. We have been realistic in the selection of materials, the collaboration with like minds, designing with restrictive resources and so on. Being realistic is essentially about striking a balance and that is what living in the future should be about.

7

The Garden for the Future

"When invited to design the Garden for the Future, it was recognised as an opportunity to demonstrate concern for the future of the planet and pose questions about how we should all live if we wish to leave something to make the lives of our grandchildren worth living. It is hoped that a visit to the garden will introduce the visitor to a mixture of the familiar and the unfamiliar, with the attractive and the unattractive, and that what has been done will raise questions in their minds."

Andrew Sumner, Landscape Architect, Richards, Moorehead & Laing,
Martyn Hughes, Gerald Davies Ltd.

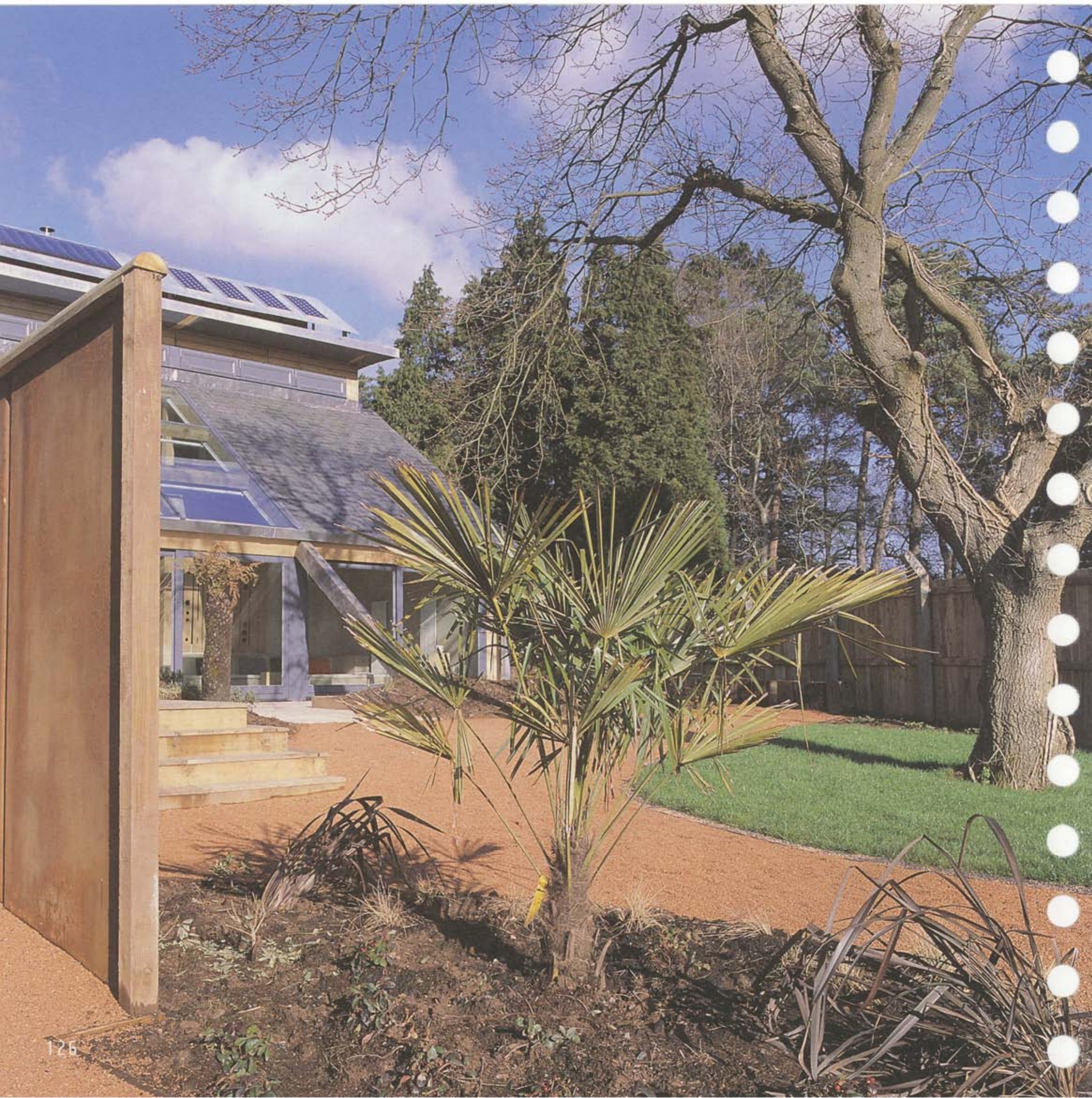

Bark mulch
Crushed brick footpath
Entrance into house
Crushed brick footpath
Timber front garden fence with gate
Timber front garden fence
Raised bed
Paving slabs
Timber decking
Ramp
Steel fence 1
Glass mulch
Rubber kerb
Grass
Steel fence 2
Timber fence to protect Biosphere
Rubber paving
Steel fence 3
Composter
N

The Garden for the Future

Imagine a world where the environment is deteriorating and the people who live there have to make significant sacrifices in their lifestyle and standard of living because of the misuse of the environment by previous generations. If we lived in that world how would each of us choose to use and manipulate our personal space and would we regard it as our own piece of paradise?

Some climatologists predict that the weather will be very different in the future. Many of us are aware that natural resources including energy, food and clean water could be in short supply. Scarcity will increase purchase costs so the essentials for life, and luxuries, could be a lot more expensive than they are today. Clearly these differences will affect the daily lives of our descendants and will influence many of their major life decisions such as where and how they live and what they will do for a living. Crucially, for the Garden for the Future, there is an element of speculation about how our descendants might respond to their environment and how they will behave when they interact with it. It is likely that our urban and rural descendants will wish for privacy, comfort and independence as much as people do now, although these might be more difficult or costly to achieve. It is also likely that they will hanker for some contact with the natural world and will make use of the outdoors in which to meet, play and relax. Today these activities provide a reason for a garden and will do in the future too, but what form will a garden take and what will it look like?

The design of the Garden for the Future is a best estimate of what the future may hold and has been governed by the designers, the culture of the day and by the constraints imposed by the site and the wider environment. So what have these influences produced? Designers of the Garden for the Future hope that in 50 years' time a better balance with nature will have been achieved, and that our passing will leave shallower footprints on the earth than those left today. However it is impossible to ignore the following possibilities, which were basic assumptions that influenced the design:



- natural materials for garden construction could be expensive and in very short supply
- the climate is likely to be hotter or colder and probably wetter than today, although the summers could be drier
- deterioration in the atmosphere and the ozone layer will have side effects such as increased levels of ultraviolet light in sunlight and could cause an increase in skin cancer problems to both humans and animals
- many of the natural species that inhabit gardens could be extinct or seriously endangered and exotic and invasive species could be flourishing in their place.

It is envisaged that the design of the Garden for the Future will raise questions in the minds of its visitors, questions about how we wish to hand on our world to future generations. Visitors should enjoy the experience, but also recognise that the Garden for the Future will be different and for good reasons. After all, maybe not all of what we see in the garden will be what we want to see.

Using the Garden for the Future

Small domestic gardens of today are a product of past evolution. Mostly, they are old ideas reworked. The changes that have occurred in the last 50 years are largely due to:

- the use of time saving chemicals, machinery and equipment that have been produced to create a self-sustaining market for more of the same;
- time consuming tasks to fill leisure time that generally involve creating particularly extreme and unsustainable conditions such as a perfect lawn, plant free soil or exotic or over-bred crops in a protected or totally artificial environment;
- the release of numerous new varieties of plants with ever more unusual or unnatural colouring and forms bred to attract interest from enthusiasts.

Ignoring these three most significant changes, what is left are ordinary gardens based on small urban backyards or suburban gardens of late Victorian Britain. Perhaps the biggest creative change in modern urban or suburban gardens is the introduction of the patio or timber deck, which in its best form is an external room that provides a degree of shelter, privacy, comfort and space for socialising. The patio can also be a point from which to view a garden or to offer the occupant a sense of control over territory. The patio is a product of foreign holidays and a desire to have a useful and low-maintenance space that can be used in some way throughout the year.

It is envisaged that the patio, as a feature of private space, will endure in some form. However, the use of herbicides, pesticides and artificial fertilisers is likely to be so restricted that they will not be available for domestic use. Clearly without these labour saving chemicals the creation of fine lawns, weed-free beds and mono-cultures of annuals will be dependant on hand weeding, mulching and other techniques that our great grandparents were familiar with at the beginning of the 20th century. Weeds of course will have a field day and will have become an important feature of the Garden for the Future. However, plant breeding and genetic manipulation will allow the development of a fantastic array of new plant varieties, none of which are known to us now.

The garden created today can only contain plants available now, so to create a sense of the unfamiliar, a range of species that are unknown in most gardens today have been specified. A herb bed was considered in the original design. These could have been presented as useful 'Genetically Modified' plants, including rhubarb producing a mild antibiotic, lavender containing paracetamol, mint containing a cure for the common cold and nettles that contain an instant cure for a hangover. A warning sign in the garden explaining the nature of the plants could support the pretence.

Government health warning

Genetically Modified Domestic Plants and Animals Regulations (2037)

Warning Signs must be shown

These plants contain powerful drugs. Misuse can result in death and termination of your home medical service-provider agreements. These plants are to be used only in accordance with Homehealth Inc© guidelines. In case of accident refer to: antidote@drugs.doc

How has the Garden been influenced by the House for the Future?

In considering the site of the House and Garden, it has been assumed that Government Policy in the year 2050 would, much as it does today, favour the use of 'brownfield' land. The House for the Future would be built on land made available by the demolition of the previous generation of housing. The garden would have to be built out of the demolition waste and the residual soils that cover the site. The only natural feature would be the remaining oak tree.

The family moving into the house would be faced with creating their garden out of the rubble and degraded soil that surrounds it. But in a world where the majority of materials would be recycled or reprocessed they would have to make use of what they can find. One example of how this has been interpreted in the Garden for the Future is by forming the paths from demolition rubble topped with fine crushed brick. A productive bed to grow fruit and vegetables has been formed to the side of the House, which is slightly raised so that a good depth of productive soil could be built up to provide space for fruit bushes and vegetables. The soil has been formed from brick dust ameliorated with home produced compost. The resulting combination would be both fertile and friable.
Compost to enrich the soils in this area would be produced from domestic waste such as paper, unwanted food, vegetable peelings and garden refuse. Six composting cells in the dedicated area at the narrowest end of the plot, furthest from the house, will allow the production of a substantial amount of compost.






The House for the Future contains a stove for burning wood and other material, so the garden contains some coppiced willow trees. This 'biomass' planting is an area of closely planted willow hybrids, which would be coppiced on a regular cycle. This encourages them to grow for a few years at a highly productive rate. The willow shoots are cut when they are large enough to provide fuel for the stove. They are then stacked for drying and are then burnt. The area included in the garden is small as the wood-burning stove in the House provides a 'top-up' to the heatpump system. If the wood burning stove were the sole source of heat in the House, an area approximately one and a half times the size of the garden would be required for coppicing.

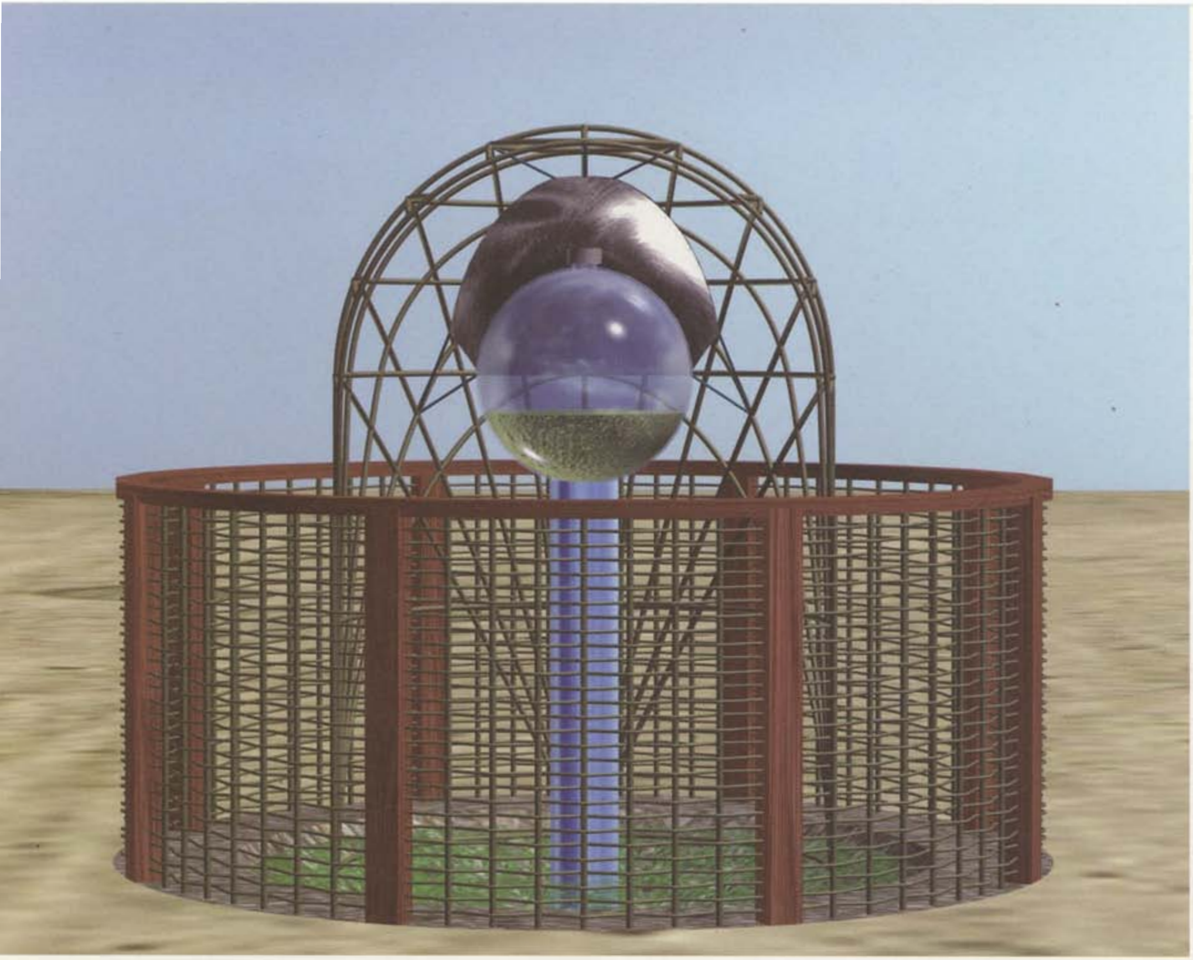
An important influence of the garden design was the relationship of the site with the House itself. The design was not primarily a response to the house as a piece of architecture, but a practical response to create a comfortable domestic environment for the resident family. The secondary consideration is the need to provide adequate space and robust surfaces to receive visitors to the exhibit. Unfortunately the requirement for wide paths took much of the site that might otherwise have been given over to garden space. This is one of the curious aspects of the garden. On the one hand the garden is speculatively designed for the future, while on the other hand the circulation space serves the visitor in "real time". These two separate elements (paths and garden) converge through time until in the year 2050 the garden and the circulation space are contemporaneous. The garden then becomes a product of the past, while the circulation space remains a means to visit it. The theme of time, both fixed and passing, seemed important within the design of the garden, particularly in the year that joined two millennia. The concept of the biosphere was developed to enhance this theme and to bring the two time elements of the design together. The biosphere was conceived to sustain some form of life living on the earth today, in isolation from its surroundings, through time from 2000 to 2050. Details of the biosphere and how it will work are provided later in this section.

The garden is structured around the semi-mature oak tree and the small lawn beneath the canopy of its branches. Good views into this central area of the garden from the south elevations of the house were felt to be important and were protected. Screens formed of waste steel subdivide the garden to create small areas dedicated to different domestic activities. One of these screens

provides a degree of protection to a raised timber platform; another divides the composting area from the rest of the garden. Each screen then becomes a richly coloured backdrop against which the lush growth of summer plants can be displayed. Progressively artwork will be added to enhance the screens with images that support the themes developed in the house and garden. The timber platform, raised slightly above the garden, provides an external room or patio to the rear of the house and forms a natural extension to the indoor spaces of the house. Being partly sheltered by the oak tree, the platform will receive dappled sunlight during the day.

The garden is surrounded by tall boundary fences and hedges which limit views in and out. The most dramatic of these is the original Museum boundary fence that is close-boarded timber topped by two strands of barbed wire on unattractive crank-topped posts. Although this fence is an ugly intrusion on the garden it was decided not to disguise it, but to retain it because it raises questions about the need for private security in the urban areas of the future. The boundaries of the garden have been reinforced with planting beds of shrubs and herbaceous plants. This planting consists of a range of exotic and unusual species with drought tolerant characteristics. For example a number of hardy banana plants, bamboos and palms will provide height, while lower growing species will create lush and colourful undergrowth. All of the beds will be mulched to discourage weed growth and to retain valuable moisture in the soil. This measure will aid the gardener by minimising the need for watering in the summer. It is intended that a significant proportion of the mulches will be formed of crushed glass that will give a strong blue and green colour to the planting beds.

The passage from the front door in the north elevation to the south elevation of the house forms a strong axis for the scheme and so has been extended through the garden. To terminate the view along this axis a rather unusual feature has been incorporated, one that might seem of more relevance to the contemporary visitor than to the resident of the year 2050. This feature is the biosphere.



The Biosphere

The biosphere is a glass globe approximately 700mm in diameter, which is mounted on a column at a suitable height for viewing. A canopy of woven willow and a steel shield protect the sphere from the heat of direct sunlight. A circular handrail and a shallow wetland surrounds the column and keep visitors at a safe distance. The glass globe contains the basic elements to support life taken from a 'clean' environment in 1999. The globe is filled partly with water, taken from a lake or pond with the remainder of the space filled with air. A sliver of weathered slate covered in lichen, moss and algae has been suspended in the globe so that it extends into the water. The whole globe has then been sealed so that nothing can escape or enter the interior. Assuming that nothing goes wrong, this biosphere will remain in position for 50 years. This tiny ecosystem with all the resources needed for survival, containing micro-organisms typically found in water, air and on the weathered slate, will develop and change through time taking its own course while the outer world takes another. The success and survival of the biosphere will demonstrate, to anyone who cares to speculate, the isolation, delicacy and vulnerability of our earth. For example what happens if all life in the biosphere dies and what does this say for our own future? On the other hand if life thrives in the biosphere maybe we can gain a little understanding of how life can be sustained with only limited resources.

What will people think?

The designers of the Garden for the Future have speculated about how visitors in the year 2000 and 2050 will respond to the garden. Perhaps they will be amused by their view of the future, however inaccurate it might be. It would be nice for visitors to be able to say that any pessimistic predictions for the future are inaccurate and that at the beginning of the 21st century the way people treat the atmosphere, soils, seas and rivers has finally changed. Perhaps the content of the biosphere, taken from a 'clean' environment in 2000, will be tested in 2050 and will be found to be more polluted than the outside world.

8

Living in the House for the Future

"United Welsh Housing Association builds properties with an emphasis on the future because they will be rented from us for many years. Environmental considerations are becoming more important and UWHA took part in the House for the Future project to inform our future developments. We recently achieved the Building Research Establishment's Environmental Standard for a development of 12 houses in Monmouthshire."

United Welsh Housing Association

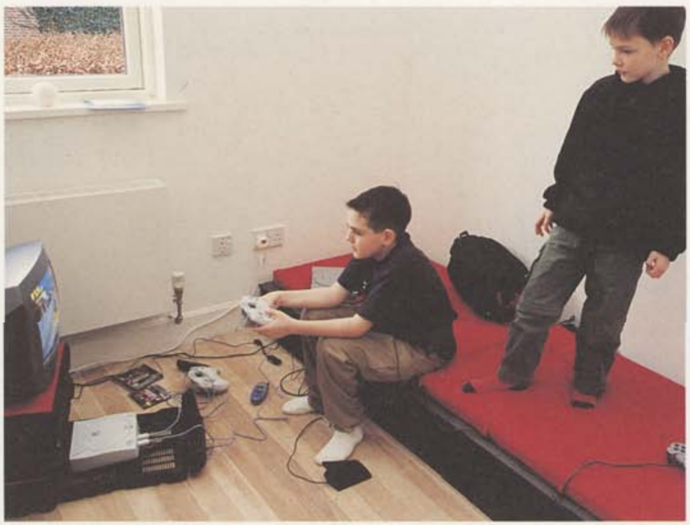
"The heating system comes from the ground, so basically we've got free central heating. It's environmentally friendly and I think it's the biggest and best thing about the house."

The Powell family from Bridgend lived in the House during December 2000.

"I like the space in the living room and the fact that it's open. I like the slate and the light coming in."

"The kitchen has been a big success – I'm not shut off all on my own, which makes it more pleasurable."

"The Internet is a marvellous way of shopping.
I have it brought to my door – I just unpack it and put it away."



"Anyone wanna play Streetfighter?!"

Useful addresses

Arts & Business Cymru

16 Museum Place
Cardiff CF10 3BH
Tel: 029 2030 3023
Fax: 029 2030 3024
Email: cymru@AandB.org.uk
Website: www.AandB@org.uk

Association of Environment Conscious Builders

Nant-y-Garreg
Saron Llandysul
Carmarthenshire SA44 5EJ
Tel/Fax: 01559 370 908
Email: admin@aecb.net
Website: www.aecb.net

Barton Engineers

33 The Cut
London SE1 8LF
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Fax: 020 7928 9949
Email:
mail@bartonengineers.co.uk
Website:
www. bartonengineers.co.uk

BBC Wales

Broadcasting House
Llantrisant Road
Llandaff CF5 2YQ Cardiff
Tel: 029 2032 2000
Website: www.bbc.co.uk

Centre for Alternative Technology

Machynlleth
Powys SY20 9AZ
Tel: 01654 702400
Fax: 01654 702782
Website: www.cat.org.uk

Construction Industry Research and Information Association (CIRIA)

6 Storey's Gate
London SW1P 3AU
Tel: 020 7222 8891
Fax: 020 7222 1708
Email: enquiries@ciria.org.uk
Website: www.ciria.org.uk

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