Cyngor Bwrdeistref Sirol
Pen-y-bont ar Ogwr
BRIDGEND
County Borough Council

SPG 12 CLIMATE NEUTRAL DEVELOPMENT

DOCUMENT STATUS

This document is Supplementary Planning Guidance
related to the Bridgend Unitary Development Plan.

This issue has the status of

Adopted
Supplementary Planning Guidance

Bridgend County Borough Council has formally adopted this document as supplementary planning guidance for the purposes of development control within the Bridgend County Borough Council area (20/12/2007, Minute No: 918).

Signed: 	Date: 10 January 2008

BRIDGEND COUNTY BOROUGH COUNCIL

Bridgend Unitary Development Plan
SUPPLEMENTARY PLANNING GUIDANCE
SPG 12

CLIMATE NEUTRAL DEVELOPMENT

Varied climate-neutral technologies – Centre for Alternative Technology, Machynlleth

1. INTRODUCTION

1.1 This guide is about sustainable development. It is intended to encourage anybody planning or designing a new development within the County Borough to consider the importance of sustainability.

1.2 The heart of the concept of sustainability is the simple idea of ensuring a better quality of life for everyone now, and for generations to come. Sustainable development is commonly defined as "…development which meets the needs of the present without compromising the ability of future generations to meet their own needs"[1].

1.3 The guide sets out objectives that outline the aspects of sustainability and gives greater detail in a series of advice notes.

[1] Report of the 1987 World Commission on Environment and Development

2. AIMS AND OBJECTIVES

2.1 This guide is one of a series prepared by Bridgend County Borough Council. The series has three main aims. They are: -

1. To make clear the Local Planning Authority's expectations for the design of development.

2. To encourage, as a consequence, development of a high design standard that will result in a benefit in environmental and landscape terms.

3. To reduce the need for revision of the design of proposals, and thus to increase the speed of the determination of planning applications.

2.2 The supplementary planning guidance series has five secondary aims. These clarify the criteria for judging the benefits that may be achieved by the design of a development. The secondary aims are:

A. To create a positive area image, a sense of local identity.

B. To ensure the integration of development into the surrounding area.

C. To ensure the protection, and enhancement, of the landscape or the townscape.

D. To ensure the protection and enhancement of the appearance or character of areas of special interest or character.

E. To ensure the protection and enhancement of the residential amenity of people living in the vicinity of, or who will live in, a development.

2.3 This specific supplementary planning guidance has five specific objectives. They are:

a. To ensure that development maximises the opportunities for 'green' communications (Notes 1).

b. To ensure that the useful life of development is maximised (notes 2, 3, 11,)

c. To make the best use of scarce resources (notes 4, 11, 12)

d. To ensure that development minimises future energy use for heating and cooling (notes 5, 6, 7, 8, 9, 10)

e. To ensure that development can accommodate future climate change (note 11).

3. BACKGROUND

3.1 The concept of climate change, is generally accepted by the majority of the world's nations as something that is happening, and that further change is inevitable. It is predicted[2] that Wales will be warmer by on average between 1.1 – 2.9ºC by 2080. Climate change is now viewed by the UK government and the National Assembly for Wales as an important issue. The UK government's sustainable development strategy "*Securing the Future"* (March 2005) identifies the need to adapt in order to better manage the future impacts of climate change on the environment, economy and society.

3.2 Whilst adaptation to climatic change is an important issue, measures need to be taken to reduce the causes of climate change, most notably the emission of greenhouse gases. The carbon dioxide already released into the atmosphere has already determined the climate changes that will occur for the next 30 – 40 years. However beyond this point we still have the ability to make a choice.

3.3 The European Union (E.U) has agreed to a cut of 8% in its carbon dioxide emissions as part of its commitment to the Kyoto Protocol. The distribution of this 8% among the E.U Member States has meant that the UK has to reduce its greenhouse gas emissions by 12.5%. The UK government has an additional target of reducing carbon dioxide emissions by a further 20% by 2010.

3.4 The need to both mitigate and adapt to future climate changes is therefore extremely important. This supplementary planning guidance is therefore focused upon how to adapt new developments to the impacts of climate change in order to ensure their long- term future.

3.5 It is important that the effects of climate change are considered over the lifetime of a development. A development may have a design life of 20 – 50 years (depending upon location and usage intensity) but in reality developments may well be used for considerably longer than this timeframe. For example many of the terrace houses constructed within the Bridgend Valleys were built prior to the First World War to house workers within the regions thriving coal industry.

3.6 Climate change could make a development unusable in the future whether due to being too uncomfortable or too expensive to operate (e.g. unaffordable insurance). However, if climate change is taken into consideration then a developer will be able to construct a climate proof development that can adapt to any climatic changes that may occur in the future.

Planet earth – precious and fragile

[2] *Climate Change Scenarios for the United Kingdom,* UKCIP, April 2002

4. CLIMATE CHANGE IMPACTS

4.1 Due to the build-up of carbon dioxide and other greenhouse gases from the burning of fossil fuels in the Earth's atmosphere our climate is changing. The main impacts of climate change are:

- Warmer, wetter winters.
- Hotter, drier summers.
- Doubling of extreme rainfall events by the 2080's.
- Rising sea levels.
- Potentially higher peak wind speeds.
- Greater unpredictability of extreme weather events

4.2 The UK Climate Impacts Programme (UKCIP[3]) produces the latest climate change scenarios for the UK. The UKCIP scenarios illustrate how our climate may change in response to four different rates of greenhouse gas emissions, namely:

- Low Emissions
- Medium-Low Emissions
- Medium-High Emissions
- High Emissions

4.3 They are only predictions based upon computer simulations that need to be used in conjunction with other climate models in order to make decisions regarding adaptation to future climate changes.

4.4 Temperature: The climate of Wales is predicted to become warmer by 1.1 – 2.9ºC by the 2080's. This is a quite significant temperature increase that could have an effect upon buildings and how they are used. Also higher external temperatures are likely to create higher internal temperatures, which will cause particular problems within residential buildings such as domestic properties, care homes and hospitals. Failure to deal with increase temperatures could cause heat stress, which could increase summer deaths especially amongst the elderly.

4.5 Rainfall: Climate change predictions for Wales are that rainfall will increase by 7% to 15% by the 2050's depending upon which emissions scenario is looked at. However, this increased rainfall will not be uniform throughout the year; rather winter rainfall will become more intense, with summer rainfall decreasing. This is likely to cause problems with flooding in the autumn and winter and drought in the summer months.

Rivers: a growing threat?

5. FINANCIAL ADVANTAGES OF CONSIDERING CLIMATE CHANGE

5.1 Developers should consider the financial implications of how climate change could affect developments in the future. Currently, the thinking about how we are going to adapt to a changing climate is very much in its infancy. As the impacts of climate change are more widely understood, developments that are properly protected from climatic risks may become easier to sell or let and possibly at a higher market price.

5.2 **Financial**

- Higher future asset values due to lower running costs.
- Loss in property value as asset holders want to sell their building because it is not climate proof.
- Reduced insurance costs for "climate proof" buildings.

5.3 **Market Forces**

- Clients are attracted to well-designed and properly protected buildings.
- By climate proofing a development there is the opportunity for the developer to become a market leader and gain a competitive edge over their competitors.

5.4 **Risk Management**

- The developer will be able to better identify and control risks associated with climate change if consideration is taken at the design stage of a development.

5.5 **Staff Retention**

- If a building is climate change proof the building will be pleasant to work in and this will encourage staff retention.

5.6 **Socially Responsible Investor**

- Investors are increasingly interested in ranking organisations according to their sustainability. This is reflected in the creation of the Dow Jones Sustainability Index.

5.7 **Legislation**

- Building regulations will change in the future and by taking voluntary measures at the design stage the developer may be avoiding expensive remedial works later.

5.8 **Funding**

- Public subsidy may not be available to developers that have not incorporated climate-proofing measures into their development.

5.9 **Operational**

- Failure to consider and adapt to climate change may mean that a development becomes too expensive to maintain, too uncomfortable to live/work in and possibly even unusable later in its life-span.

5.10 **Increased Weather Risks**

- Future weather conditions are uncertain, adverse future conditions could increase insurance premiums, which will increase running costs and affect the value of the development. The Association for British Insurers has stated that insurance claims, due to weather induced incidents are increasing by 2 – 4% per annum. Insurance claims due to storm and flood damage have risen to over £6 billion during the 5 five-year period 1998 – 2003[4].

[4] *A Changing Climate for Insurance*, Association of British Insurers, June 2004

6. DEVELOPMENT AND USE OF THIS GUIDANCE

6.1 The climate of the 21st century is predicted to be warmer, with far greater seasonal variation (i.e. warmer, wetter winters and hotter, drier summers) and more frequent intense storm episodes. This rapidly changing climate will have an impact upon new developments. However, the principles presented within this supplementary planning guidance document can help to consider what the future impacts of climate change are likely to be and what actions can be taken to optimise future weather conditions and thereby reduce the vulnerability of a development.

6.2 The main areas affected by climate change in relation to the design of a development are:

- Location, Layout & Design
- Construction
- Water
- Energy
- Transport
- Sustainable Drainage

6.3 The design of new developments should attempt to consider the impact of future climate changes and incorporate features into the development at the design stage in order to mitigate against the worst affects of climate change.

6.4 Features that are incorporated into the design and construction phase of the development can generally be achieved for a relatively low cost. In the longer term, building climate change resilience into the development will incur excess costs.

6.5 The local Planning Authority has an important role to play in ensuring that new developments take account of climate change adaptation. The local Planning Authority is responsible for ensuring developers construct buildings within the parameters of current planning legislation and within the framework of Planning Policy Wales.

6.6 Several chapters of Planning Policy Wales relate to climate change, most notably:

Chapter 2 Planning for Sustainability
"*Contribute to climate protection by encouraging land uses that result in reduced emissions of greenhouse gases, in particular energy-efficient development, and promoting the use of energy from renewable sources*".

Chapter 12 Infrastructure and Services
"*In determining applications for any form of development local planning authorities should encourage developers to integrate energy efficiency and conservation measures as part of the design of new development*".

Chapter 13 Minimising and Managing Environmental Risks and Pollution
"*Meeting the Assembly Government's objectives for sustainable development requires action through the planning system to move away from flood defence and the mitigation of the consequences of new development in areas of flood hazard towards a more positive avoidance of development in areas defined as being of flood hazard. Planning authorities should therefore adopt a precautionary approach when formulating UDP policies on development and flood risk, and when considering planning applications. In this context, the precautionary principle should be applied on the basis that climate change is likely to increase the risk of coastal and river flooding as a result of sea-level rise and more intense rainfall*".

6.7 A number of other chapters within Planning Policy Wales cover issues relating to climate change such as Chapter 8 which covers transport.

6.8 Planning Policy Wales is supported by a number of topic based Technical Advice Notes (TANs). There are a number of TANs relating to climate change issues such as:

TAN 8 Renewable Energy
TAN 12 Design
TAN 15 Development and Flood Risk
TAN 18 Transport

6.9 This SPG and the associated Climate Neutral Development Scheme Applicants Checklist are aimed at both new and re-developments. However, it is recognised that whilst new developments could incorporate many of the principles highlighted within this document it would be acceptable for re-developments to incorporate certain features in a staged manner.

6.10 The document aims to highlight to developers the potential changes that climate change may bring and what options are available to them in order that developments are climate proofed against future changes.

Aero-generator, Centre for Alternative Technology, Machynlleth, Powys

7 SITE LOCATION

7.1 **Background** In line with the principles laid out in the Wales Spatial Plan, the layout, location and design of a development can have a major impact upon its sustainability both in terms of its lifespan and its fitness for use. The location of a building can affect people's need to travel, its design can maximise opportunities for the efficient use of resources and its layout can take advantage of naturally occurring elements such as sunlight.

7.2 **Transportation** The location of a new development can affect people's need to travel and, through car use, consumption of fossil fuels can increase which in turn generates greenhouse gases.

7.3 **Flooding** With significantly higher levels of winter precipitation predicted for South Wales by the 2080s it will become increasingly important to locate developments away from areas liable to flooding and ensure that all access links to the development are also not susceptible to flooding.

7.3.1 Development in flood risk areas should be avoided where possible. The Environment Agency provides information on areas that are prone to flooding in its flood maps. The maps are regularly updated and take into account the risk of flooding due to climate change. The advice of the Environment Agency should be adhered to when planning any development in a flood risk area.

7.3.2 A Flood Risk Assessment should be undertaken to demonstrate that the risk of flooding to the development can be minimised for the life-span of the development (this may even be undertaken for developments outside the floodplain). The Environment Agency can provide advice on carrying out flood risk assessments.

7.3.3 Effective land-use planning can reduce flood damages by minimising exposure to flooding. Avoiding building on any flood risk site is the most sustainable long-term option, leaving the flood plain to function as an open space for flood storage. It is however recognised that this is often difficult in a country such as Wales with its long coastline and numerous river valleys.

7.3.4 Housing Densities Non-floodplain Areas should be maximised. By increasing the housing densities on non-floodplain areas already designated for development, the pressure can be relieved upon floodplain areas that would otherwise be developed. The Government guidance upon housing density is 50 homes per ha for low-medium density and 100 homes per ha for high density.

7.3.4 Developments in Higher Probability Areas should be avoided. If development in the floodplain is unavoidable then differentiating between high and low risk areas of the floodplain is important, with developments being targeted for the lower risk areas of the floodplain.

7.3.5 There are a number of measures that can be employed to protect properties from flooding or to mitigate properties against the worst effects of flooding. These are:

Walls, Windows & Floorings

- Extended concrete footings and a waterproof membrane laid in the foundations of the house;
- Apply waterproof sealant on exterior walls and use water resistant paint for internal ground floor decoration;
- Walls should not be plastered with gypsum based plasters as these have no resistance to flooding. Floors should be constructed of a solid material such as stone rather than floor boards;

Drains

- Floodwater can back up in drains and enter property through sinks, toilets etc. To avoid this install anti-backflow valves to drains and sewers.

Other Measures

- When the ground floor of homes are being wired all wiring, switches, meters etc should be located at least 900mm above the ground floor level;
- Boilers, air conditioning units etc should be situated on the second floor of all developments.

7.4 **Subsidence** Particular areas are more at risk from subsidence than others, for example sites underlain by clay soils are especially vulnerable to subsidence. The areas most vulnerable to subsidence are usually found south of a line drawn between Bristol and Hull, although there are significant pockets of clay soils across South Wales.

7.4.1 The unusually dry summers of recent years has led to a rise in the number of homes affected. With Welsh summers predicted to be warmer and drier by the 2080s there is likely to be a rise in the number of homes affected by subsidence. Subsidence is the movement of a building's foundations. It is caused by:

- **Soil Type:** Certain soil types such as clay shrink and swell depending on their moisture content and this can a problem during prolonged periods of dry weather.
- **Vegetation:** Trees and scrubs can extract moisture from deep within the soil which causes shrinkage especially during periods of dry weather as roots extend in search of water.
- **Leaking Drains:** Damaged drains can leak and cause foundations beneath buildings to become eroded. This is especially a problem with sand based soils.

7.5 **What to Do**. Trees planted around developments need to be given careful consideration. Broad leaf species tend to cause more damage than evergreen because of the amount of moisture they require. Species to be sited with particular care:

- **Oak**
- **Ash**
- **Willow**
- **Elm**
- **Wisteria**

7.5.1 As a general rule any trees planted within a new development should be planted the same distance away from the development as their expected mature height. For further guidance reference should be made to SPG07.

Questionable proximity of mature tree and new house

8. SITE LAYOUT

8.1 The layout of a new development needs careful consideration in order to maximise the potential for passive solar gain, whilst also providing adequate shade. Passive solar energy (the energy provided by sunlight entering buildings through windows and skylights etc) can provide significant levels of heat and light to a development which negates the need to use mains power to provide all the heating and lighting requirements of the development. This use of natural energy will reduce the CO2 emissions arising from the operation of the development.

8.2 **Benefits of Passive Solar Energy.**
New developments that utilise passive solar gain will receive a number of benefits:

- Good layout and design results in warm and sunny developments that are attractive to buyers.
- Passive solar developments will cost no more than conventional development techniques.
- Passive solar design is not dependant upon technology and therefore has no ongoing cost implications.
- Providing thermal massing during the construction phase of a project will maximise the benefits of passive solar energy and help to buffer against high internal temperatures during the summer months.

8.2.1 Developments designed to maximise passive solar gain through the minimisation of shading and the orientation of principally occupied rooms to face south will make savings of between 3 – 10% of the total energy costs for the operation of the building.

8.3 **Site Layout Principles for Passive Solar Gain.** The layout of the site within a new development needs to be carefully considered if passive solar gain is to be optimised. The main glazed area of a building needs to be located within 30° of the south, with a small proportion of the northern side of the building glazed as well.

8.3.1 Other site layout principles to consider are:

- Minimise shading by locating tall buildings within a development to the north of the site.
- Locate car parks and garages to the north of housing.
- Land shadowed by woodland should be used for parking.

8.3.2 For those developments located to the north of main access routes there are likely to be issues relating to privacy since their front gardens and living rooms are likely to be facing the road. It is likely therefore that within these properties screening around the edge of the gardening will be required. If the screening takes the form of trees, they may overshadow the house, and therefore reduce any benefit that passive solar gain will offer.

8.3.3 Within these areas, if appropriate, it would be more suitable to locate flat accommodation where dwellings can be located off the ground with the areas at the front of the building being communal gardens where privacy is not such an issue.

8.4 **Landscaping for Passive Solar Gain.**
Landscaping needs to be carefully considered when arranging the layout of a new development to maximise the benefits of passive solar gain. If not properly considered landscape features such as trees and tall shrubs can overshadow buildings and obstruct natural sunlight. If properly integrated into a development landscaping can complement passive solar gain.

8.4.1 The main principles of landscaping for passive solar gain are:

- Shelterbelts should be orientated to the south-west of a development and distanced, on average, 3 – 4 times their mature height from the south facing side of a new development.
- Trees that will grow above the shadow line of the development should be deciduous, as these trees will allow sunlight to pass through in the winter months but provide shading in the summer.
- Only small-scale tree and shrub planting should be used to provide

screening for ground floor south facing rooms.

8.5 **Controlling Passive Solar Gain.**
There is very little advantage to incorporating the principles of passive solar gain into your development to save money upon winter heating only to waste money upon summer cooling. Therefore a good passive solar design will be able to provide warmth in the winter and shade in the summer. Summer shade can be achieved through:

8.5.1 **Window Awnings**: Window awnings can reduce solar heat gain in the summer by up to 65% on south facing windows and up to 77% on west facing windows. Modern awnings are made from synthetic fabrics such as polyvinyl and are water-resistant. The awning should have openings around the tops and sides to vent hot air. The awning can cover the whole side of a building and can be retracted in the winter months to allow natural sunshine to warm the building.

8.5.2 **Window Shutters**: Window shutters (both interior and exterior) can help reduce both heat gain and loss in your home. Properly designed exterior shutters are probably the best option since they offer: added security, weather protection and no use of interior space. Exterior shutters must be integrated into the architecture of the building and therefore are best considered at the design stage of a building. Exterior shutters will need to be operated from inside the building and can be constructed from metal (although these provide good protection against vandalism they are of limited use in providing a barrier against air infiltration) or wood panels.

8.5.3 **Roof Overhangs**: Exterior roof overhangs provide a practical method for shading windows, doors and walls. Overhangs are most effective for south facing elements, if the building is more than about 30° off true south then the effectiveness of the overhang is greatly reduced. Overhangs can be solid or louvered or a combination of both. There is no universal formula for the sizing of overhangs, but it is important that the overhang provides adequate shading. Many variables such as latitude, climate, solar radiation and window size must when be considered when fitting a roof overhang.

Brises soleils and roof overhangs
Ravens Court, Bridgend

9. SITE DESIGN

Passive solar gain: Centre for Alternative Technology, Machynlleth, Powys

9.1 Designing for Passive Solar Gain

9.1.1 At the design stage of a development careful consideration needs to be given to what actions need to be taken to ensure that the development is able to adapt to a changing climate. The design of a development able to embrace the principles of passive solar gain need not be significantly different to that of conventional housing. The key principles are:

- Avoid the use of high roofs that overshadow neighbouring buildings.
- Avoid over-shading of living rooms within domestic dwellings, this can be achieved by installing adjustable shading.
- Provide thermal mass by using solid walls and floors to buffer against levels of heat change as well as providing cooler conditions in the summer.
- Locate the main glazed area on the south side of buildings.
- Ensure that the internal layout of domestic dwellings is arranged so that the most frequently used spaces such as the living room are south facing whereas the kitchen is located on the northern side to prevent against excessive heat gain.
- Arrange internal layout to ensure that solar energy is distributed naturally using through rooms.

9.1.2 Developments designed within the principles of passive solar gain do not require large south facing windows. If window areas become too large heat loss can occur which outweighs the benefits received from passive solar gain. Conversely if windows are too small then occupants will resort to artificial lighting in the daytime to meet their lighting needs. Window areas should normally be 20% of the room's floor space.

9.1.3 Within domestic dwellings conservatories can harness passive solar energy, however they need to be incorporated into the development with care and thermally separated from the

house. Otherwise they will not be able to distribute heat effectively and could cause excessive solar gain in the summer months and heat loss in the winter.

9.2 **Preventing Excessive Solar Gain**

9.2.1 Climate predictions for the 21st century are that temperatures will increase by 2°C - 3.5°C (UKCIP02[5]). In order to cope with future temperature increases buildings need to be designed so that their internal temperatures can be properly controlled otherwise they may be rendered unusable in the future. Controlling rising temperatures created by excessive solar gain can be achieved through the use of shutters or other shading devices. Shutters are employed within Mediterranean countries for this purpose to great effect.

9.2.2 Reducing the effects of excessive solar gain may not be enough to control increased internal temperatures within buildings. Ventilation will be an important issue within buildings and one that needs to be addressed at the design stage. There are two methods of cooling a building:

9.3 **Natural Ventilation**

9.3.1 Buildings need to be designed to use natural ventilation as much as possible in place of mechanical air cooling systems. There are a number of ways to utilise natural ventilation within a development:

- Reduce solar gains in summer by using shading devices such as blinds.
- Design, secure ventilation systems that can be opened and closed in response to natural temperature variations.
- Construct the building with high thermal mass materials such as concrete that soak up unwanted heat during the day.
- Treat the outside of the building with light coloured paints that will reflect heat back into the air.

[5] *Climate Change Scenarios for the United Kingdom,* UKCIP Scientific Report, April 2002

9.4 **Mechanical Cooling Systems**

9.4.1 As temperatures rise natural ventilation may not be enough to cool a building and the demand for mechanical cooling will increase. Within large buildings natural ventilation alone may not be sufficient to adequately meet all the cooling needs of a building. Mechanical cooling systems will then need to be employed.

9.4.2 Mechanical systems are very energy intensive and some use harmful refrigerants that are more efficient greenhouse gases than carbon dioxide. However, when mechanical systems are employed a number of options exist:

- Free Cooling
- Slab Cooling
- Night Cooling
- Evaporative Cooling
- Ground Cooling

The first three points above can be achieved without the need for mechanical cooling.

9.4.3 Gas and heat fired absorption cooling systems are more energy efficient than electricity powered cooling systems. Systems need to be as energy efficient as possible and where renewable energy is employed the emissions can be reduced to make the system as climate neutral as possible.

9.5 **Low Embodied Energy Materials**

9.5.1 Embodied energy is the energy consumed by all of the processes associated with the production of a building, from the acquisition of natural resources to product delivery. This includes the extraction and manufacturing of materials as well as their transport, maintenance and disposal.

9.5.2 Buildings are a complex combination of a variety of materials, with each one contributing to the buildings total embodied energy. The most important factor in reducing the impact of embodied energy is to design long life, durable and adaptable buildings.

9.5.3 The relative embodied energy value for a variety of materials are listed below:

- Sand/gravel – 0.01
- Timber – 1
- Cement – 2
- Glass – 3
- Steel – 8
- Plastic – 30
- Aluminium – 80[6]

9.6 **Importance of Embodied Energy**

9.6.1 Embodied energy varies enormously between products and materials and the choice of material within a building will greatly affect the embodied energy within its structure. It is estimated that the average domestic dwelling contains about 1000 GJ of energy within its construction. This will be equal to around 15 years of the operational energy use of the building.

9.6.2 Embodied energy content varies greatly with different construction types. In certain cases a higher embodied energy level can be justified if it contributes to a lower operating energy cost. For example materials with a high thermal mass will be high in embodied energy but they will significantly reduce the operating energy costs of the building.

9.7 **Assessing Embodied Energy**

9.7.1 The embodied energy within a building cannot easily be measured and the only way to fully quantify it is through a full Life Cycle Analysis. There are two methods of assessing embodied energy, these are:

Gross Energy Requirement: This is a true measure of the embodied energy of a material which would encompass:

- Energy used to transport materials to the building site.
- The amount of upstream energy used to produce the materials
- All the materials used to construct the development
- The embodied energy within the transport infrastructure (roads etc).

(In practice this is usually impractical to measure.)

Process Energy Requirement: This is a measure of the energy directly related to the manufacture of the material. This is simpler to measure and subsequently most figures quoted for embodied energy are based upon this measure.

9.7.2 Estimates of embodied energy can vary by up to a factor of 10 and as a result figures quoted for embodied energy are broad guidelines only and should not be taken to be correct. Well insulated "lightweight" materials can be just as energy efficient as high thermal mass materials.

9.8 **Guidelines for Reducing Embodied Energy**

9.8.1 Lightweight building construction such as a timber frame is usually lower in embodied energy than heavyweight construction. This will not be true if lightweight materials such as aluminium are used within the construction.

9.8.2 Each development should select the best combination for its application based upon climate, transport distances, availability of materials and budget. When attempting to reduce the embodied energy of materials used within a development the following guidelines should be considered:

- Design the development to have a long life. This can be achieved by using durable, low maintenance materials.
- Ensure materials can be easily separated for future re-use.
- Avoid building a bigger development than you need.
- Modify or refurbish where possible rather than adding new.
- Try and re-use or re-cycle materials wherever possible.
- Use locally sourced materials wherever possible.
- Select materials that are known to have a low embodied energy value wherever possible.
- Select materials that can easily be re-cycled at the end of their life.
- Give preference to materials that have been manufactured using renewable energies.
- Use an efficient building envelope design to minimise* the materials needed.

**Insulation materials should be maximised.*

[6] Journal Building and Environment vol 17 no1 1982

9.9 Thermal Mass

9.9.1 Thermal mass is the ability of a material to absorb heat energy. A lot of heat energy is required to change the temperature of high-density materials like concrete, bricks and tiles. Each of these materials has a high thermal mass. Lightweight materials such as timber have a low thermal mass.

9.9.2 Appropriate use of thermal mass throughout a building can have a major impact upon reducing energy bills. The correct use of thermal mass can moderate internal temperatures by averaging day and night temperature extremes. Poorly designed thermal mass can exacerbate the worst extremes of climate change.

9.10 How Thermal Mass Works

9.10.1 Thermal mass acts as a thermal battery. During the summer it absorbs heat keeping the house comfortable. In the winter heat from the sun or internal heaters are stored, and released at night helping to keep the house warm. Thermal mass is not a substitute for insulation it does not stop heat flowing out of a building rather it stores and re-radiates heat and therefore is most useful within buildings where there is a big difference between day an night temperature.

- **Winter:** Allow thermal mass to absorb heat during the day from direct sunlight or from radiant heaters. It will then re-radiate this warmth back into the home during the night.
- **Summer:** Allow cool, light breezes to pass over the thermal mass drawing out all the stored energy. During the day protect thermal mass from excessive summer sun by shading.

9.11 Using Thermal Mass

9.11.1 Thermal mass is most appropriate within regions that have a large diurnal temperature range. A range of greater than 10°C is generally considered to be suitable for thermal mass application.

Thermal Mass Properties

- **High Density:** The more dense the material the higher its thermal mass. For example concrete has a high thermal mass.
- **Good Thermal Conductivity:** The material must allow heat to flow through it. For example rubber is a poor conductor of heat but brick is a good conductor. However, if the material is too good a conductor (e.g. steel) energy will be absorbed and given off too quickly to create the lag effect needed for diurnal temperature moderation.
- **Low Reflectivity:** Dark, matt or textured surfaces absorb and re-radiate energy better than light, smooth surfaces.

9.12 Where to Locate Thermal Mass

9.12.1 The location of the thermal mass within a building will have an enormous impact upon its performance. Generally thermal mass should be located inside the insulated building envelope and must be left exposed internally to allow it to interact with the house interior. Also:

- **Heating Application:** Locate thermal mass in areas that receive direct sunlight or radiant heat from heaters.
- **Heating and Cooling:** Locate the thermal mass inside the building on the ground floor for ideal winter and summer efficiency. The floor is usually the most economical place to locate heavy materials and earth coupling can provide additional thermal stabilisation.
- **Location:** Thermal mass should be located in south facing rooms which have good solar access, exposure to night breezes in the summer and additional sources of heating (heaters).
- **Cooling Application:** Protect thermal mass from summer sun with shading or insulation if required.
- **Additional Thermal Mass:** This should be located near the centre of the building Brick walls, slabs and water features can provide this.

9.12.2 Thermal mass elements (e.g. concrete floor, masonry party wall, or chimney-breasts) can be effective within timber frame construction.

9.13 Where Not to Locate Thermal Mass

- Rooms and buildings with poor insulation from external temperature

extremes and with minimal exposure to winter sun or cooling breezes.
- Avoid locating on the upper levels of buildings (unless the climate is very cold) as natural convection creates warmer temperatures in the upper floors of buildings.

9.14 **Quick Tips**

- Thermal mass should be used in conjunction with good passive design.
- Add shading to protect thermal mass from summer sun as its ability to absorb summer heat and release it during the night means that it can cause problems unless shaded.
- Remove carpets, curtains and other insulating materials from thermal mass features to allow winter sun to be most affective.

9.15 **Climate Neutral Design**

9.15.1 In addition to passive solar gain a number of other design principles need to be addressed in order to produce a climate neutral development:

- **Interior Layout:** Large floor to ceiling heights will allow hot air to rise above the heads of people using the room.

- **Energy Efficient Buildings**: Use high levels of insulation and high performance windows. Choose glazing with low solar heat gain.

- **Renewable Energy:** Design renewable energy features such as solar water heating into the development.

- **Optimise Material Use:** Adherence to the principles of value analysis will minimise the volume of materials used in construction as well as the volume of waste produced. This principle does not apply to insulation which should not be minimised.

- **Low Maintenance Landscaping:** Drought resistant native plant species should be used for all landscaping.

- **Waste Recycling:** In order to minimise waste going to landfill provision should be made for a recycling area within the development. Provision for a recycling area would only need to be made within developments such as apartment flats or factory units, where space is either limited or not available.

- **Feasibility of Grey Water:** The potential use of grey water within the development should be considered at the design stage and if possible integrated into the construction of the development. Rainwater harvesting systems should also be considered at the design stage of the development. Rainwater is more cost effective than grey water recycling since it does not require pre-treatment for grease removal.

- **Reuse and Adaptability:** The structure should be designed to be adaptable to other uses.

- **Encourage Mixed Use Development:** Mixed residential and commercial developments reduce the need to use private transport.

- **Minimise Vehicle Dependence:** Locate buildings close to public transportation as well as cycle and walking paths. Consider designing the development to make it easy for people to work at home, reducing the need to travel to work.

- **Responsible Water Management:** Design landscapes to absorb rainwater runoff rather than have it carried off into sewer systems.

9.16 **Costs**

9.16.1 Applying the principles of climate neutral design may not significantly add to the cost of the development. Passive solar houses cost no more to construct than conventional houses and there are no additional running costs.

9.16.2 Buildings that are designed around the principles of climate neutrality do have marketing potential with reduced energy and water bills.

10 SUSTAINABLE CONSTRUCTION

10.1 **Background**

10.1.1 The principle of sustainable construction incorporates and integrates a variety of strategies during the design, procurement and construction of a development. Sustainable construction offers a number of benefits such as:

- Reduced maintenance costs.
- Energy conservation.
- Improved occupant health.

10.1.2 Building and construction activities world-wide account for around 3 billion tons of raw materials annually. Using green building materials and products promotes the conservation of non-renewable resources and reduces the contribution to climate change that the extraction, transportation, processing and installation of raw materials makes.

10.1.3 Materials used within a development will be affected by climate change. Materials like brick and concrete once warmed will stay warm for a long time. In contrast wood will warm up quickly but also cool down quickly.

10.2 **Issues**

10.2.1 The materials used within a development will be affected by climate change. For example, materials such as brick and concrete once warmed up stay warm for a long time whilst light materials such as wood cool very quickly.

10.2.2 It is important to use materials that are appropriate to the building as well as being able to withstand potential future extremes such as high temperatures and heavy rainfall.

10.3 **What is Sustainable Construction?**

10.3.1 Sustainable construction is the use of renewable rather than non-renewable resources as well as using locally sourced and salvaged material.

10.4 **Using Sustainable Construction Materials**

10.4.1 Before sustainable materials can be used within a development a number of considerations need to be made. These can be summarised under the following four headings:

10.4.2 **Resource Efficiency**: This can be achieved by using materials that meet the following criteria:

- **Recycled Content:** Materials should be recycled wherever possible.
- **Natural, Plentiful or Renewable:** Materials should be harvested from sustainably managed sources (e.g. timber).
- **Resource Efficient Manufacturing Process:** Products that are manufactured should have processes that aim to reduce energy consumption, minimise waste and reduce the emission of greenhouse gases.
- **Locally Available:** Wherever possible building materials should be purchased from local suppliers in order to reduce the emission of greenhouse gases caused by the transportation over long distances of raw materials from the supplier to the customer.
- **Salvaged and Refurbished:** Materials that are to be disposed of may have a reusable value within the new development. This will reduce the amount of virgin material that is needed within the construction of a development.
- **Re-usable or Recyclable:** Materials used within the construction of a development should be easily dismantled and reused at the end of their lifespan.
- **Durable:** Materials should be long lasting, reducing the need to replace with new materials within a relatively short period.

10.4.3 **Indoor Air Quality**: Indoor air quality and subsequent building emissions can be improved by a development meeting the following criteria:

- **Low or Non-toxic:** Materials should emit few or no carcinogens.
- **Minimal Chemical Emissions:** Products should have minimal emissions of Volatile Organic Compounds (VOCs).
- **Moisture Resistant:** Materials should be resistant to moisture and the build up of biological contaminants within the building.
- **Low VOC Assembly:** Materials to be installed within a development should generate minimal levels of VOCs during installation.
- **Maintenance:** Materials should require only small cleaning that does not require the use of polluting solvents.

10.4.4 **Energy Efficiency**: Can be achieved by using materials that meet the following criterion:

- Reduce the need for energy within a development.

10.4.5 **Water Conservation**: Can be achieved by using materials that meet the following criterion:

- Reduce water consumption and conserve water in the surrounding area.

10.5 **Selecting Sustainable Construction Materials**

10.5.1 The process of selecting materials will need to go through a three-stage process:

- **Research:** This stage involves gathering all the various information and technical data as well as looking at good practice guides and legislative requirements. This will allow the full range of a development's building material options to be assessed.

- Evaluation: This stage involves evaluating the technical information found at the research stage of this process. This process essentially compares the different types of materials that can be used within the construction process against set criteria. The developer, depending, upon what their particular aims for the project can formulate the criteria. Life Cycle Analysis is a tool that can be employed at this stage to assess the relative merits of different types of materials and their environmental impact.
- Selection: This stage can often involve the use of an assessment matrix for scoring the products that have been identified and evaluated at stage two. The scores can be used to assess the products with the highest environmental attributes. For further information please see the BRE's Green Guide to Specification.

10.6 **Green Purchasing Plan**

10.6.1 At the Selection stage a Green Purchasing Plan should be produced. This ensures that materials used within the development are:

- The least quantity required to undertake the development with regard to non-renewable resources without compromising the quality.
- The lowest in terms of environmental impact. This includes how they are constructed, their operational phase and their disposal.
- Low maintenance. This will reduce any environmental impacts that will occur during maintenance operations.
- Sourced locally to minimise transport requirements and reduce emissions of greenhouse gases from transportation.

10.6.2 The aim of the Green Purchasing Plan is to select materials that are produced in the most environmentally friendly way. For example products could be selected because:

- They are made from recycled materials.
- They have low embodied energy values
- They are not made from environmentally damaging materials.

10.6.3 In practice this can be difficult but not impossible. Products with Eco-labels are generally considered to be a good guideline upon which to base material purchasing decisions. An example would be to source timber from sustainably managed forests. Timber from a

sustainably managed forest will carry the FSC (Forestry Stewardship Council) logo. Another useful indicator is those materials that have an "A" rating from the BRE (Building Research Establishment) "Green Guide to Specification".

10.6.4 Where possible materials selected should:

- Be non-toxic, water based building products. An example would be paints, sealants, and flame-retardants that do not contain VOCs (Volatile Organic Compounds).
- Minimise the use of chemical treatments.
- Avoid the use of products that contain ozone depleting chemicals or greenhouse gases.

10.6.5 The scope of the purchasing plan can be extended to suppliers through the tendering process to ensure that they carry out their work practices with a regard for the environment and the potential impacts that their actions could have upon the environment. An example would be to check if all suppliers have:

- An Environmental Policy.
- A proven environmental work record on similar developments.
- An accredited environmental management system.

10.6.6 The Green Purchasing Plan should be used in tandem with a Waste Plan for the development. A Waste Plan identifies the types of waste that are going to arise during the construction of the development and will try to find alternative uses for these wastes rather than disposal. For example demolition waste could be reused within a development for purposes such as paths and roads. This contributes to making a development climate neutral by diverting material away from landfill where it can generate greenhouse gases such as methane.

10.7 Sustainable Construction in Practice

10.7.1 It is important that a development should have the optimum thermal mass to maintain a comfortable internal environment with the least use of energy. High occupancy buildings such as hospitals will tend to have a high thermal mass whereas warehouses would have a low thermal mass.

10.7.2 The characteristics of materials may also change with temperature and humidity. For example:

- Concrete: Strength is affected by curing at higher temperatures.
- Limestone: Affected by increased CO_2 and driving rain.
- Plastics: Affected by increased UV.
- Bricks: Strength affected by change in moisture content.
- MDF/Chipboard: Not to be used where flooding is expected.
- Roofing Felt: Increased UV is likely to accelerate disintegration.

10.7.3 The susceptibility of different materials to climate change needs to be considered at the design stage of a development so that potential future climate changes can be incorporated into the design in order that developments can be "climate proof".

10.8 Examples of Sustainable Construction Materials

10.8.1 **Avoid Ozone Depleting Chemicals within Equipment and Insulation**: CFCs have largely been phased out but their replacements HCFCs also damage the ozone layer and should be avoided where possible.

10.8.2 **Use Durable Materials**: Manufacturing is very energy intensive and therefore a product that lasts longer will save energy and so reduce CO2 emissions.

10.8.3 **Choose Low Maintenance Building Materials**: Where possible, select building materials that require little maintenance, as this will reduce the environmental impact of the maintenance process.

10.8.4 **Choose Materials with Low Embodied Energy:** This refers to the amount of energy used to extract, manufacture and transport a material.

10.8.5 **Buy Locally Produced Building Materials:** Transportation is a major source of CO2 emissions and therefore wherever possible local supplies should be

sourced rather than transporting materials into an area.

10.8.6 **Use Recycled Products**: Reusing recycled materials means less waste being deposited into landfill sites, which are major generators of greenhouse gases.

10.8.7 **Use Salvaged Materials where possible:** Using salvaged products diverts material from landfill as well as reducing the need for virgin materials to be manufactured and used.

10.8.8 **Use Sustainable Wood Supplies**:

- Use timber from independently certified well-managed forests.
- Don't use tropical hardwoods unless the supplier can document that the wood comes from well-managed forests.

10.8.9 **Avoid Materials that give off Gas Pollutants:** Solvent based paints, adhesives, carpeting and a variety of other building materials can release VOCs into the air. These materials contribute to air pollution and threaten human health.

10.8.10 Summary for Developers: Ensure that the materials selected for use within the construction of the development will perform adequately over the life span of the development.

11 ENERGY

11.1 **Background**

11.1.1 Buildings consume approximately 47% of the total delivered energy in the UK. Of this total building energy use 63% is used in domestic buildings compared to 9% industrial use and 28% service sector usage (IEMA 2003[7]). The Welsh Assembly Government has an Energy Efficiency Policy Agreement with local authorities that requires a 12% improvement in domestic energy efficiency by 2007.

11.1.2 Buildings contribute the highest percentage (40%) of the UK's carbon dioxide emissions. Within the building sector, domestic dwellings account for 26% of the total CO2 emissions with transport contributing 33% and the industrial sector contributing 26% (IEMA 2003[7]).

11.1.3 Agriculture is the second largest, greenhouse gas, producing sector within the UK (Defra 2006). Agriculture faces three important challenges with regard to climate change, that is namely contributing to a low carbon economy, mitigating direct emissions from agriculture and adapting to the impacts of climate change.

11.1.4 Climate change is expected to affect energy consumption in two ways:

- There is likely to be a greater demand for energy. Predictions are that the UK will experience milder winters (thereby reducing the need for heating) and increased summer temperatures (thereby increasing the need for air conditioning). The annual prediction for Wales is that the country will be 1.1 – 2.9°C warmer than at present. Within luxury homes and town centre developments natural ventilation may be reduced due to issues surrounding security and noise resulting in an increased demand for air conditioning systems. Generating and distributing the energy required to power air conditioning systems contributes to carbon dioxide emissions and the refrigerants used for cooling are extremely efficient greenhouse gases.

[7] *Energy Management in Buildings*, Institute of Environmental Management and Assessment, Vol 4 October 2003

- Climate change is expected to generate greater extreme weather events such as storms and floods. These events are certain to result in disruptions to the power supply of the National Grid.

11.2 Opportunities within New Developments

11.2.1 The most opportune moment to introduce energy efficient measures is during the design stage of a new development or during a major refurbishment development. This allows the designer to:

- Optimise the location and layout of a building,
- Utilise the layout and fabric of the development to optimise energy requirements,
- Reduce heat demand by utilising insulation,
- Meet the remaining heat demand of the building through the installation of efficient plant,
- Minimise the need for air conditioning through the use of the buildings fabric,
- Maximise the use of natural ventilation,
- Install sub-meters within the development so that energy consumption can be measured at different points within to assess which areas are the most energy intensive, which will greatly assist in the monitoring of energy usage within the development.
- Install micro-generation technologies within the development to assist users of the development to meet their own energy needs.
- Create space for a waste storage and collection area. This will allow waste to be easily stored and collected, where it could be taken to a energy from waste plant.

11.2.2 A well designed energy efficient building, using the form and fabric of the building to allow plentiful daylight and natural ventilation provides a better more productive place to both live and work.

11.3 Methods of Energy Efficiency

11.3.1 Combined Heat & Power Systems

11.3.1.1 The primary local source of energy available to developments is a combined heat and power (CHP) system. Combined heat and power is the simultaneous production of power (ideally from renewable sources e.g. biomass) (usually electricity) and usable heat. During the generation of electricity the heat can be put to a positive use rather than being lost to the atmosphere which is the case within many power stations.

11.3.1.2 **Benefits of Combined Heat & Power Systems:**

- **Increased environmental savings:** Significant carbon dioxide savings can be achieved when employing good quality CHP systems. The energy generated is up to 90% efficient and will therefore reduce carbon dioxide emissions by up to 60% (IEMA 2003[7]).
- **Cost Savings:** Quality CHP systems can make significant savings as well as qualifying for Enhanced Capital Allowance Schemes and exemption from the Climate Change Levy.
- **Supply Reinforcement:** A CHP system can increase the energy usage authorisation capacity of the site.
- **Supply Reliability:** If there are interruptions in power supplies to the development a CHP system could prove the answer with self-generation of power.

11.3.1.3 **Installing Combined Heat & Power Systems:** The following criteria need to be satisfied before installing a CHP system:

- At least 4,000 full load running hours per year;
- More hours may be possible if standby generation or boiler replacement is considered;
- Best sites have all year round heat demand;
- CHP should always be the lead boiler.

11.3.1.4 CHP systems range from those serving industrial sites on a multi-MW level to small systems serving individual leisure

centres and residential developments. The best sites are industrial sites, leisure centres, hotels, hospitals and universities. CHP is essentially a revenue-earning device that will only make savings if it is running.

11.3.2 **Absorption Cooling**

11.3.2.1 This process can be used for both air conditioning and refrigeration. Absorption cooling allows heat energy to be the predominant driver in producing a cooling effect. Absorption cooling works because certain chemicals have a strong affinity to dissolve in one another (e.g. lithium bromide in water will draw water vapour from its surroundings to dilute the solution).

11.3.2.2 This affinity is used within the absorption cooling process, to draw water, which in this case is the refrigerant, from a conventional evaporator into the absorber. From there the weakened solution is pumped at a higher pressure, to the generator. Here heat is applied and the water is driven off to a conventional condenser. The re-strengthened solution is then recycled back to the absorber.

11.3.2.3 Absorption cooling can be utilised where there are high temperature waste streams that cannot be utilised elsewhere.

11.3.2.4 **Benefits Of Absorption Cooling:**

- Heat for the absorption cooling system will be provided by CHP, which replaces the electricity, that would normally be used to power traditional cooling systems. This will reduce CO2 emissions within the electricity generation and cooling system usage process.
- Heat fired absorption cooling does not use refrigerants such as CFC's, HFC's or HCFC's. It therefore reduces the potential release of major global warming gases in the Earth's atmosphere.
- The absorption cooling system can be powered by solar energy thereby reducing its reliance upon fossil fuels even further.

11.3.3 **Renewable Energy Usage**

11.3.3.1 Renewable energy is defined as sources of energy that can be readily replenished such as solar, wind, tidal or biomass for example. Traditional sources of energy have been fossil fuels and nuclear. However, both these energies have detrimental impacts upon the environment whether through the emission of greenhouse gases or extremely hazardous wastes. Renewable energy offers the opportunity to generate heat and power without causing harmful emissions or depletion of natural resources. There are a variety of renewable energies that could be incorporated into a new development, as listed below.

11.3.3.2 **Small Scale Wind Power:** Modern wind turbines use wind to turn the

Wind power: Centre for Alternative Technology, Machynlleth, Powys

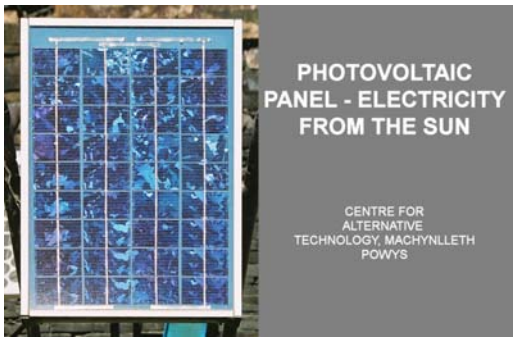
turbines that turn a rotor, which creates electricity. The UK has 40% of Europe's total wind energy, but only around 4% of the UK's electricity requirements are provided by wind power.

- **Wind Energy and New Developments:** Wind speed increases with height so it is more efficient to site turbines on hilltops away from obvious obstructions such as trees and buildings. However small scale building integrated wind turbines suitable for urban locations are beginning to be available. Whilst these will not meet the entire energy needs of a building they will contribute

to a reduction in the demand for traditional forms of energy.

- **Types of System:** Turbines can be either stand-alone or grid connected systems. Small wind turbines generate direct current (DC) therefore battery storage and an inverter, to convert DC into AC (Alternating Current), are needed. It is common for this type of system to be combined with a diesel generator to cover periods of low wind-speed. A grid connected supply will require a special inverter to convert DC to AC, however no battery storage is needed since electricity is exported directly to the National Grid and sold to a local electricity company.
- **Costs and Maintenance:** Small scale systems generally cost about £3,000 with larger schemes costing between £4,000 - £18,000. This figure includes the turbine, mast, inverter and battery storage if required. Turbines will need annual service checks and have a life span of about 20 years.

11.3.3.3 **Solar PV:** Solar PV (Photovoltaic) uses energy from the sun to create electricity. PV requires only daylight not sunlight to generate electricity.



- **How it Works:** PV systems use cells to convert solar radiation into electricity. The PV cells consist of several layers of a semi-conducting material, usually silicon. When light shines on the cell it creates a reaction across the layers causing electricity to flow. The greater the intensity of sunlight the greater the flow of electricity. PV systems generate no greenhouse gas emissions.

- **Solar PV Systems and New Developments:** PV systems can be used within buildings that have a roof or wall that faces within 90° of the south. No other buildings or large trees should over shadow it. Solar panels are not light and the roof needs to be strong enough to support their weight. The panel can be roof integrated i.e. form the weatherproof layer in place of slates/tiles.

- **Costs and Maintenance:** Prices vary depending on the size and type of cell. The size of the system is dictated by the amount of electricity that is required, the average cost of a domestic PV system is between £4,000 - £9,000 per kWp. Solar tiles cost more than a panel and a panel that is fully integrated into a roof costs more than one which sits on the top. Grid connected systems require very little maintenance generally little more than ensuring that the panel is clean and free from shade. The wiring will need to be checked by a qualified technician. Stand alone systems not connected to the grid, need maintenance regularly on complicated parts of the system such as the storage batteries.

- **Planning Issues:** The local planning authority may require planning permission to be given before a PV system can be fitted, especially within listed buildings and/or sensitive localities (i.e. conservation areas).

11.3.3.4 **Biomass:** Biomass is often referred to as biofuels. These biofuels are produced from organic matter either directly from plants or indirectly from industrial, commercial, agricultural and domestic waste. Biomass can be divided into two categories:

- Woody biomass from forest products, untreated wood products and energy crops,
- Non-woody biomass includes animal waste, high-energy crops (e.g. maize) and biodegrable waste from food processing.

- **Biomass and a New Development:** There are two main ways of using biomass to heat a building:

- **Stand alone stoves** providing space heating for a room. These can be fuelled by logs or wood pellets.

Generally they have a 6-12 kw output and are suitable for domestic properties.

- **Boilers** connected to central heating and hot water systems. These can be powered by pellets or wood chips and generally have an output larger than 15 kw and are more suitable for larger buildings such as schools, leisure centres, churches etc.

- Stoves can be 80% efficient and are used for background heating in domestic properties. Large boilers can be used to heat water and can either be hand-fed or automatic.

- **Suitability for a New Development:** If a biomass boiler or stove is to be installed within a new development a number of considerations need to be addressed:

i. It is important to have storage space available where the fuel can be stored as well as providing access to the boiler/stove.
ii. The vent (flue) for the boiler/stove must be specially designed for wood fuel appliances to ensure that sufficient air movement is allowed for proper operation of the stove.
iii. The installation must comply with all relevant safety and building regulations.
iv. If the system is to be installed within a listed building then planning permission may be needed.

- **Costs and Maintenance:** Capital costs depend upon the size of the system that is being installed. Small domestic stoves cost between £1,500 - £3,000. A larger boiler suitable for non-domestic premises would cost upward of £5,000. Unlike other forms of renewable energy biomass systems require that you pay for the fuel. Like any other appliance a biomass system requires regular maintenance.

11.3.3.5 **Ground Source Heat Pumps (GSHP)** GSHP transfer heat from the ground into a building.

- **How Does GSHP Work?** There are three elements to a GSHP:

i. The ground loop. This is comprised of lengths of pipe buried in the ground within a trench or borehole, which is filled with a liquid. The liquid absorbs heat from the ground and is pumped around the pipe.
ii. The heat pump. This has three elements the evaporator (which takes heat from the ground into the pipe), the compressor (this compresses the fluid within the pipe and moves it around the loop) and the condenser (this passes heat to a hot water tank that feeds the GSHP).
iii. Heat Distribution System. This consists of under-floor heating or radiators.

- **Suitability for a New Development:** If a GSHP is to be utilised within a new development a number of factors need to be considered:

i. What type of heat distribution system will be employed? GSHP can be combined with radiators.
ii. Is there enough space for a trench or borehole to contain a ground loop?
iii. What fuel is being replaced by a GSHP? Heat pumps are a good option within areas where mains gas is unavailable.
iv. Can a solar PV system be employed to provide the power to operate the compressor and pump?
v. Will a back up heating system be required?
vi. Will a cooling system be required as part of the development?
vii. Can insulation measures be incorporated into the development as wall, floor and loft insulation will reduce total energy demand from the system?
viii. Can the system be combined with any other buildings within the development to reduce total costs?

- **Costs and Maintenance:** A typical installation with an 8kw output costs between £6,400 - £9,600. The running costs of the system depend upon the efficiency of the system in terms of units of heat output for each unit of electricity required to drive the compressor and pump. Under the current high fuel prices a GSHP could be a cheaper form of space heating than oil and LPG.

11.3.3.6 **Solar Water Heating**

Solar water heating systems use heat from the sun to work alongside a conventional water heater.

- **Benefits of Solar Water Heating:**

i. Solar water heating can provide almost all your hot water during the summer months and up to 50% for the rest of the year.

ii. The system reduces impact on the environment. Carbon dioxide emissions are reduced by around 400kg per year per property.

- **Solar Water Heating and New Developments:** Solar water heating can be used within domestic properties or for larger applications such as leisure centres. There are three components of a solar water heating system:

i. Solar Panels
ii. A Heat Transfer System
iii. Hot Water Cylinder

The solar panels are fitted to the roof where they collect heat from the sun. The heat transfer system then uses this heat to heat water. In order to use solar water heating a building will need 2 – 4 m² of south-east to south-west facing roof. Space for an additional water cylinder may also be required.

- **Costs and Maintenance:** A typical domestic installation will cost £2,000 - £3,000, with larger non-domestic systems costing £3,500 - £4,500. Solar water systems generally come with a 10-year guarantee and require very little maintenance, although checks should be made every 3-5 years.

11.3.4 **Heating**

Within new developments, the heating systems need to be carefully designed so as to be appropriate to the nature of the development (i.e. an office development will have differing requirements than an industrial development).

11.3.4.1 **Types of Heating System**

i Hot Water:
- Radiator
- Convectors
- Underfloor

ii Air Heaters
- Direct
- In-direct

iii Radiant
- Electric
- Gas
- Steam

iv Electric Storage Heaters
- Plain
- With Fans

11.3.4.2 **Boilers**

Boilers vary from small domestic central heating boilers to large power station water tube boilers and therefore the type of boiler installed within a development will depend upon its end use. A number of considerations need to be made when selecting a boiler:

- Ensure that all boilers fitted have a seasonal efficiency of at least 80%.
- Ensure that all boilers fitted can only run when there is a demand.
- Install a heater other than the main boiler to produce hot water during the summer when the main boiler is switched off.

11.3.4.3 **Distribution of Heat**

Heat is lost from the boiler casing and from the heating system via pipework and storage tanks. All parts of the system should be insulated and heat should only be supplied when and where it is needed.

11.3.4.4 **Heating Controls**

Heat may be generated and distributed efficiently but unless there are effective controls it can still be wasted. Types of control include:

- **Time Control:** A time switch that turns heating on and off at a fixed time each day. This works well within office buildings.
- **Optimum Start Control:** This automatically switches the heating system on so that the building reaches the desired temperature in time for occupation.
- **Weather Compensation:** This automatically varies the buildings

temperature in response to weather conditions.
- **Room Thermostats:** These keep the temperature within the room at the required level. Modern electric thermostats can control temperatures to within 0.5°C and cost less than £100.
- **Zone Controls:** These are useful when certain parts of a building require more heat than others, or when only certain areas need to be heated.
- **Building Energy Management Systems:** These are computer based systems which automatically monitor and control a range of building services such as heating, lighting and air conditioning.

11.3.4.5 Building Fabric

A number of measures can be incorporated into a development to increase the energy efficiency of its fabric:

- Insulation of loft spaces and all building elements.
- Draught stripping around windows and doors.
- Fitting secondary glazing, ideally sealed double/triple glazed units where applicable.
- Installing cavity wall insulation.
- Replace glazed areas within the design with insulated wall panels.
- Fitting low emission glass to reduce heat loss in winter.
- Ensure automatic closers are fitted to all exterior doors.
- Provide window blinds within the development to minimise summer solar heating and reduce heat loss in the winter.

11.3.5 Lighting

Lighting accounts for 20% of electricity usage within buildings in the UK. Modern effective, efficient lighting systems can reduce energy costs by 40%. The best opportunities occur when designing a new building. Good lighting systems:

- Optimise the use of natural light.
- Provide appropriate illumination for the activity being performed.
- Should be easy to maintain.
- Are energy efficient.
- Illuminate areas when and where needed.

11.3.5.1 Lamp Selection

The choice of lamp to be used is significant. Four factors need to be considered:

- **Luminous Efficiency:** This is a measure of how much light is emitted per unit of energy consumed. Sodium lamps produce greater levels of light than tungsten.
- **Colour Appearance:** This is used to describe the colour of light falling on a white surface.
- **Colour Rendering:** This is a measure of the extent to which light discolours an object. Within certain situations such as a factory production line good colour rendering is essential.
- **Lamp Life:** This is important when accessibility and maintenance costs are important issues.

11.3.5.2 Lamp Types

- **Compact Fluorescent Lamps (CFL's):** CFL's provide significant savings of up to 75% over tungsten equivalents. CFL's last 8-12 times longer than tungsten lamps and will save money in terms of energy usage and maintenance costs.
- **Spot and Display Lighting:** For display lighting low voltage tungsten lamps are a more economical alternative than mains voltage lamps.
- **Fluorescent Lighting:** On average savings of 8% can be achieved by installing T8 slimline fluorescent tubes within a building.
- **High Pressure Sodium Discharge Lamps:** These lamps have a high light output and are suitable for large open spaces such as factories and large retail outlets. They are also useful as flood lights.

11.3.5.3 Lighting Controls

Substantial savings can be made by installing lighting controls within a development. There are four main types of lighting system:

- **Time Controlled Systems:** Time controlled systems will switch off lights according to a specified schedule. Lights are often switched on in the

morning but not switched off when no longer required. Occupants have a manual override system to switch lights back on if needed.
- **Occupancy Linked Lighting:** These systems use presence detection such as infra-red or acoustic to control lighting. Lights are switched on when occupancy is detected and switched off when a presence is no longer detected. This system is usually employed within storerooms and toilets.
- **Daylight Linked Controls:** This system can switch off or dim lights when daylight is adequate. They are often employed within reception areas.
- **Localised Switches:** Within large open plan areas banks of switches can cause high levels of energy wastage due to inappropriate use with people reluctant to turn lights off. Localised switches allow individuals to control their own work space lighting.

11.3.5.4 **Lighting Maintenance**

A lighting system needs to be properly maintained. All buildings should have a lighting maintenance programme that includes cleaning and lamp replacement.

11.3.5.5 **Light Pollution**

In recent years the increasing amount of lighting (e.g. street, security etc) has meant that urban areas often experience excessive night-time lighting. The need for lighting is not disputed, with lighting required for safety and security. However, this lighting is often excessive causing vast amounts of energy to be wasted. Although light pollution is not new, it has increased significantly over the past 40 years. Light pollution occurs when too much artificial illumination enters the night sky and reflects off airborne water droplets and dust particles causing a condition known as “Skyglow”. There are some easy solutions to prevent this excessive use of electricity:

- Shield the light so that it is channelled down to where it is needed and not up into the sky.
- Use the right amount of light.
- Use light timer controls whenever possible.
- Avoid using round globe lights unless they are properly shielded.

11.3.6 **Air Conditioning**

Air conditioning systems have a high capital cost and are intensive energy users. Air conditioning systems can add 50% to the running costs of a building. Wherever possible the mechanical need for ventilation should be eliminated by careful design of the building. If a mechanical air conditioning system has to be employed a number of energy saving measures can be employed that will reduce carbon dioxide emissions:

- Review motor sizing and consider using variable speed drives on larger fans and pumps where possible.
- If humidifiers are being used use ultrasonic humidifiers, but ensure precautions are taken with regard to Legionella.
- Minimise air leakage from ductwork to prevent wasting fan power.
- Ensure that the system is set correctly to avoid simultaneous heating and cooling.

11.4 Energy Management within Developments

11.4.1 A climate neutral development will need to combine features of passive solar design, energy efficiency and local generation from CHP/or renewable energy. The type of energy management system employed within a development will depend upon the nature of the development. Within small-scale developments such as a few individual houses a micro CHP system will achieve significantly lower CO2 emissions than simply installing efficient boilers.

11.4.2 Micro CHP systems can be used within developments, consisting of five or fewer domestic dwellings and small commercial enterprises. Within larger developments community wide CHP systems can be employed.

11.4.3 Renewable energy options can be incorporated into developments from the design stage and can incorporate electricity generation from photovoltaic cells, wind turbines and biomass. By integrating renewable energy systems into the fabric of the building the higher costs of these systems can be offset against the costs of the normal building materials. An

example would be solar tiles placed on the roof of a development rather than traditional roofing tiles.

11.4.4 Within small developments such as small buildings and single dwellings sustainable energy systems such as micro CHP would be the responsibility of the owner/occupier with them having responsibility for the operation and maintenance of all systems employed on site.

11.4.5 Within larger developments the developer would probably need an external energy service company to assist in the design, construction, operation and maintenance of a large-scale CHP system. When the development is completed the owners/occupiers of the development would then become the customers of the energy service company.

11.4.6 The Utilities Act 2000 enabled electricity to be generated and distributed by anyone who has an appropriate licence.

11.5 Costs

11.5.1 The energy service company would normally finance the majority of the sustainable energy system employed within a development, although it is likely that a financial contribution will also be sought from the developer. A full feasibility study into the possibilities and financial implications of a sustainable energy project needs to be carried out before any sustainable energy project is carried out.

12 WATER

12.1 Background

12.1.1 Water is a valuable resource and with the increased pressure caused by climate change its value will continue to rise. Wales receives more rainfall than England, but the rainfall is not uniform across the country, with certain areas being prone to periods of flood and drought. Approximately 45% of rainfall is absorbed by plants or evaporated with the other 55% either percolating through the ground into underground aquifers or being run-off into streams and rivers and ultimately the sea.

12.1.2 Climate change is likely to affect the availability of water resources due to:

- Population/household increases
- Hotter, drier summers
- Increase in consumer goods (e.g. dish washers)
- Increased leisure time
- Increased irrigation

12.1.3 It is estimated that each person within Wales uses 146 litres of water per day (EAW Water Resources Strategy 2001[8]). Climate predictions for the 21st century are that summers will become hotter and drier and winters wetter, but the increased winter rainfall may often be in the form of intense storms which will contribute very little to the replenishment of water resources.

12.1.4 Although water shortage is not viewed as a problem within Wales in comparison to the south-east of England this situation may change by the middle of the 21st century. As the climate changes it will become necessary to plan for reduced water availability and the increase in water demand.

12.2 Issues

12.2.1 **Water Services**: Water is a finite resource and due to climate change it is likely that the availability of water will become restricted in the future. Climate change predictions are that summers will become hotter and drier and coupled with predictions of population and household growth there will be an increased demand for water in the future (for details upon future climate change predictions please

[8] *Water Resources for the Future*, A Strategy for England and Wales, Environment Agency, March 2001

see the section upon Sustainable Drainage Systems within this SPG.

12.2.2 **Water Efficiency**: It is important to minimise the use of water from the mains within new developments. Water is likely to be a scarce resource in the future and with greater demands placed upon its usage it may be that the supply of water will be restricted in future years.

12.2.3 **Water Leakage**: Leakage is the loss of water from the supply network that has escaped through means other than a controlled action. This water is not permanently lost from the environment because it will eventually flow back to rivers or groundwater, but leaked water is essentially a lost resource because of the delay in this process. Water is lost from pipes for many different reasons:

- Joints – these are weak spots in a pipe and it is here that leaks and bursts will occur most. This type of leak is very hard to detect (depending on the volume of water seeping from the joints.
- Pressure in the network – To ensure that everyone is supplied water is moved around the distribution network under greater stress. Higher pressures put great stress on pipes leading to bursts. There is evidence of a close relationship between higher pressures and higher burst rates.
- Weather – Cold weather with frosts can cause soil movements, which can cause pipes to bursts. Frosts can cause some pipes to freeze, thereby expanding it and causing it to fracture. Dry weather can also cause certain types of soil to contract and cause bursts.
- Soil Type – Soils that can swell and contract over seasons will move water pipes and this can lead to bursts (clay is a good example).
- Pipe Materials and Corrosion – There are many different materials which pipes can be made from, for example cast iron, concrete, plastic and lead. Different materials have different properties and some break/leak more easily than others do.
- Load Bearing – Water pipes are often placed in the centre of the road, where the pressure of constant traffic can cause pipes to burst.
- Accidental and deliberate damage to water pipes.

12.2.4 Not all leaks are the same, you can have:

- Bursts – High volume of water is lost over a very short time.
- Leaks – Water loss is from holes or cracks in pipes where lower volumes of water are lost than within a burst.
- Seepage – This occurs from joints or small holes and a small volume of water is lost over the short term, significant quantities can be lost over the long term. This is the most common type of leakage.

12.2.5 The Office of Water Services (Ofwat) set leakage targets for each water company. These leakage targets are determine on the basis of when the cost of controlling further leakage becomes more expensive than the value of the water saved.

12.2.6 Water companies search for leaks (called active leakage control) and once found they will be fixed. Leaks can happen upon customer pipes (pipe becomes customers property at the boundary of the customers site). Most water companies will provide a free leak repair service, where they will repair the first leak free.

12.3 Water users

12.3.1 **Domestic Use**: Due to the fact that there are few houses within Wales that are served by water meters it is not possible to provide a completely accurate figure as too how much water is used per day by the domestic sector. The Environment Agency in its 2001 Water Resources Strategy for Wales estimated that 146 litres per person per day are used within Wales.

12.3.2 Of that 146 litres it is estimated that:

- 14.4% is clothes washing;
- 29.4% personal washing;
- 8.1% dish washing;
- 0.7% car washing;
- 4.9% garden watering;
- 0.1% heating;
- 27.7% toilet;
- 15.4% miscellaneous.

12.3.2 **Industry**: The traditional heavy industries of Wales were heavily dependent upon water. With their decline the demand for water has dropped accordingly. Today directly abstracted water for industrial purposes represents only around 24% of the total licensed abstractions within Wales. Mains water supplied to businesses is provided by water companies and is normally metered. The quality of the water can vary where quality is not an issue. 22% of all public water within Wales is supplied to industry.

12.3.3 **Agriculture**: The agricultural sector uses great quantities of water, which unlike the other sectors offers virtually no return to its local point of extraction. Spray irrigation within agricultural practices is probably the most water intensive activity, especially as this usually takes place within the summer months when rainfall is at a minimum and therefore places great stress upon local surface and groundwater sources.

12.3.4 Apart from spray irrigation the other main water uses within agriculture are vehicle washing, equipment cleaning, animal watering, dilution of chemicals and specialist farming operations such as dairying. Farming relies upon both public and private water supplies, which do not need to be formally licensed due to the small quantities of water abstracted.

12.3.5 **Hydropower Generation**: The issue of climate change has caused the government to look at methodologies to reduce the impact that man's activities has and is having upon the environment. One such result of this review process is a commitment to reduce the volume of greenhouse gas emissions. Within this commitment is the declaration that by 2010 10% of the UK's electricity supply will be secured from renewable sources. Hydropower is one area that is being examined as possibly being able to contribute positively to meeting this target.

12.3.6 To date most hydropower schemes have taken place high up in river catchments with turbines being fitted within reservoirs to utilise the passage of water from these storage facilities.

12.3.7 **Leisure**: Tourism and recreational activities are major contributors to the economy of Wales. A high percentage of these activities are based in and around water, with water-sports and fishing being two examples of popular water reliant activities.

12.3.8 Both of these activities may well be greatly affected by climate change with reduced levels of summer rainfall and increased temperatures likely to cause low river flows during the summer months that may cause problems with many leisure based activities within the aquatic environment.

12.4 **Water Conservation Measures**

12.4.1 There are a number of measures that can be incorporated into a new development to reduce water consumption during its lifetime. Much of the cost of water efficient devices can often be included in the sale price of a new development and will deliver benefits to the owner of the development in the long term. A major incentive to install water conservation measures should be the fact that within the UK the cost of water has risen by 125% since the industry was privatised.

12.4.2 In order to adapt to any future water resource shortage that may be caused by climate change it is important to minimise the use of water within new developments. With regards to residential developments, in order to reduce water consumption new homes should be constructed to the BREEAM Eco-Homes standard of Excellent, although in practice the rating of Very Good is more often the standard that residential developers work towards which also gives very good levels of water conservation. The BREEAM standard addresses a number of water conservation techniques. These include:

- **Fitting Spray Taps:** Spray taps can potentially save up to 80% of the water used within conventional hand basins.
- **Water Efficient Toilets** Dual flush and low flush toilets can save more than 50% of the water used for flushing and up to 20% of the total water consumption of a domestic property.
- **Water Efficient Showers** Water efficient showers create finer droplets

of water, thereby reducing total water consumption.
- **Water Efficient Devices** This involves the installation of A-rated washing machines and dishwaters.

12.4.3 **Other Measures** A number of other water conservation techniques are available to developers such as:
- Installation of waterless urinals
- Minimising the distance between the boiler/hot water tank and the most frequently used appliances (e.g. kitchen sink). This will reduce the volume of cold water that has to be drawn off before the hot water can be accessed.
- Installation of tapered shaped baths within residential developments which provide more space for bathing but use less water
- Insulation of baths maintains heat thus reducing the need to regularly top up the bath with hot water.
- Installation of water meters within existing properties that are being re-developed (water meters are now compulsory within all new developments)
- For major industrial water users leak detection systems should be installed.

12.5 Water Recycling

12.5.1 Water recycling is a common feature upon many large-scale industrial sites and many water recycling techniques can be incorporated within the design and construction of a new development. Although traditionally water recycling was under used in domestic properties, the requirement for all new developments to be fitted with a water meter has led to a high level of support from the public for water recycling to be included within residential developments. Retrofitting properties with water recycling features can be costly, but incorporating them into a new development costs very little. There are a number of methods of water recycling, such as:

12.5.1 **Grey Water Re-use**: Grey water refers to water from baths, showers and wash basins that can be collected and cleansed and then re-used either within a single dwelling or on a development wide scale. Grey water can be used for toilet flushing and will require only minor disinfecting or microbiological treatment.

12.5.1.1 **How does it work?** Grey water from baths, showers and hand-basins is usually clean enough for toilet flushing with only minor disinfecting. Problems arise when the warm, nutrient laden grey water is stored due to the spread of bacteria in the water. There are two treatment approaches:
- Filtering: a coarse filter prior to disinfecting can remove Gross matter such as hair and skin debris. This will prevent biological activity long enough to allow the water to be stored prior to usage.
- Treatment: This system is better suited to larger scale schemes and involves treating the grey water in a similar way to the sewage treatment process. Traditional biological methods such as membrane filtration technology make it possible to treat the combined sewage flow without separating the grey water. The treated water is then free of odour and with a greatly reduced organic matter which allows it to be stored after only limited levels of disinfection.

12.5.1.2 **Installation**: Currently the economics of installing grey water-recycling systems within single dwellings make it expensive to install at this level. However within industrial developments and upon larger residential developments the systems are financially viable to implement.

12.5.1.3 **Costs**: Re-using grey water from baths, showers, and washbasins can save up to 18,000 litres of water per annum per person within domestic properties. This would amount to approximately a third of all domestic water use. The cost of installing a grey water recycling system depends on the type of system to be installed.

12.5.2 **Rainwater Harvesting**: The collection and reuse of rainwater can be incorporated into a new development relatively easily and cheaply. Rainwater can be used for irrigation, car washing and toilet flushing. Rainwater harvesting provides two kinds of benefits:
- It reduces domestic water demand and eases pressure upon mains water

supply, particularly during the summer months;
- It reduces the risk of flooding during storm periods by storing rainwater and preventing it overloading the local drainage system.

12.5.2.1 **How does it work?** Rainwater harvesting at a basic level can be achieved by collecting rainwater in a water butt and using it at a later date for garden watering. A more sophisticated (but still relatively simple) system would be:
- Rainwater is collected from the roof area or hard standing by downpipes. A filter stops leaves and other debris getting into the holding tank.

Rainwater collection: Centre for Alternative Technology, Machynlleth, Powys

- A suction filter prevents the uptake of floating matter when the water is drawn up from the tank for use. As the water is non-potable it is drawn through a separate series of pipes as specified in the Water Supply (Water Fittings) Regulations 1999.
- The water level within the tank is monitored via a control unit, which can display information to the user. If the water level drops too low the control unit will trigger an automatic change over to mains water. The system will require a type AA air gap to be installed to prevent backflow of rainwater into the mains.
- When the water reaches a certain level an overflow trap allows floating material to be skimmed off into the storm drain. A non-return valve should be fitted to prevent contamination of the tank via backflow as well as a rodent trap.

12.5.2.2 There are several variations on the above system such as:

- Header Tank: Rainwater is pumped from a underground tank to a header tank usually located at a high level. If there is not a plentiful supply of rainwater then mains water is used. Mains water top-up can be achieved using a float operated valve that activates when the level of water within the tank falls below a certain level.
- Cistern Top-up: Mains water top-up is fed either into the non-potable top-up pipes or into the storage tank. If fed into the storage tank the cistern top-up water is then pumped back into the house to fill toilet cisterns. This means that more electricity is used and if there is a power failure the toilet must be flushed manually.
- Module System: Commercial/industrial users tend to use this system. The system involves a suction pump, which takes water from the tank when rainwater levels are low. These systems are easier to install but may cost more to buy and install.
- Dual-feed WC System: WCs are available or can be adapted with dual feeds for mains and rainwater. The dual-feed system allows both mains and pumped rainwater to be utilised without losing supply if pump or power fails.

12.5.2.3 Advanced rainwater harvesting technology can provide a water supply for a wide variety of domestic and industrial purposes. The UK does not have regulations that cover the quality of water used for toilet flushing and laundry. The general principle within the UK is that all domestic water should be treated to potable standards. This has meant that historically little study has been devoted to the use of rainwater.

12.5.2.4 Within Germany where rainwater harvesting is extensively used, research has shown that rainwater harvesting, once filtered, can be used for toilet flushing and laundry washing without the need for disinfecting. Rainwater used for personal washing requires purification via UV treatment for example.

12.5.2.5 **Installation**:

- **Legislation:** The Water Supply (Water Fittings) Regulations 1999 are designed to prevent rainwater-harvesting systems becoming health hazards. The Regulations require that a type AA air gap be fitted at the point where the mains water top-up enters the rainwater storage tank to prevent back contamination.
- **Demand**: On average each person within Wales uses 146 litres of water per day. Of this amount 46% could be sourced from rainwater. This amounts to a saving of 68.75 litres per person per day. With the changes in technology such as low flush toilets the demand for non-potable water particularly within homes is declining. Rainwater can be used for clothes washing although potentially there could be problems resulting in odour and loss of colour. The demand within industry depends upon the volume of non-potable water used.
- **Maintenance**: Rainwater harvesting systems require regular maintenance. For example filters need cleaning 3 times a year, the tank needs to be visually inspected at least once a year, the system needs to be checked for sediment build up and the mains top up needs to be checked to ensure it is functioning at least once a year.

12.5.2.6 **Costs:** The simplest rainwater harvesting system is a water butt that can be installed at very little cost. For the more complex systems there are costs for:

- The equipment (approximately £1,500),
- Labour, excavation equipment hire and plumbing costs (over £1,000).

Suppliers of rainwater harvesting systems currently estimate a 14% saving in water usage for the average household per annum. Larger scale housing developments with shared maintenance make the systems financially attractive, as costs can be co-ordinated. The biggest savings from rainwater harvesting systems can be seen within agricultural and industrial organisations.

12.6 **Summary for Developers**

- The total water consumption of the development should be estimated under normal conditions as well as drought conditions for the lifetime of the development.
- Water use within buildings should be minimised and therefore water saving features such as rainwater harvesting systems should be considered for installation at the design stage.
- A target of 30m³ of water use per person per year should be aimed for within domestic developments and 1.05m³ per person per year for office developments. The developer can assist the user of the development to achieve these figures by incorporating many of the features highlighted within section 12 of SPG 12.

13. TRANSPORT

13.1 **Background**

13.1.1 It is estimated that the average car generates over 3 tonnes of carbon dioxide (CO^2) per year. This is the equivalent to approximately a third of the carbon dioxide emitted by the domestic sector. Transport is a major contributor to U.K CO^2 emissions, making up 27% of the total UK greenhouse gas emissions in 2004 (DEFRA 2006[9]).

13.1.2 Cars, vans and lorries have an adverse effect on air quality, causing health problems (about 24,000 people suffer an early death annually because of air pollution.), accidents, noise and poor local air quality. There are a number of measures that can be considered within developments to reduce the CO^2 emissions generated by transportation. These can be summarised as:

13.2 **Issues**

13.2.1 **Greenhouse Gas Emissions**: The transport sector is a major emitter of greenhouse gases most notably carbon dioxide. Carbon dioxide accounts for roughly 80% of the total emissions from the transport sector. The transport sector generates other greenhouse gases such as nitrous oxide from catalytic conversion and hydroflourocarbons from vehicle air conditioning systems.

13.2.2 Carbon dioxide emissions from road transport grew by 10% between 1990 – 2000 and they are expected to grow by a further 9% between 2000 – 2010. Emissions are expected to fall within other sectors during this period.

13.2.3 **Health**: Traffic fumes can create a variety of health problems such as respiratory disease, which can be exacerbated during periods of warm weather.

13.2.4 **Congestion**: New developments have the potential to generate increased levels of traffic, which can place pressure upon local traffic systems as well as contributing to poor local air quality.

13.3 **Location of New Development**

13.3.1 The location of new developments can have a significant impact upon local CO^2 emissions. A new development can increase the need for people to travel to places of work, shops, schools, entertainment and back to their homes. New developments where possible should incorporate some of the following features:

- Developments should have access to public transport), thereby reducing the need for private vehicle travel.
- The proposed development should be accessible by cycle routes and walkways.

13.3.2 **Public Transport Routes**: There are a variety of reasons why individuals do not consider using public transport such as unreliability, cramped and overcrowded travel conditions and inflexible timetables and routes. There are a variety of measures that can be incorporated into a new development to encourage public transport use:

- **Bus Services:** Improved or enhanced bus services can be achieved through the development of partnerships with local bus operators to achieve better bus services. Improvements could include more frequent services to the development or modified routes and timetables to be in line with the occupants of the site.
- **Train Services:** The developer may be able to work with the local train company to develop a bus link from the site to the nearest train station.
- **Voluntary Planning Obligations/Planning Agreements:**

[9] *Climate Change The UK Programme 2006,* Department of the Environment, Food and Rural Affairs, March 2006

The developer may undertake a voluntary planning obligation/reach a Planning Agreement with regard to a particular site. Such obligations are used to: mitigate a development's impact; secure a contribution to compensate for loss or damage created by the development; and/or prescribe the nature of the development. Such an arrangement may be entered into in order to enhance public transport links within an area where a proposed development is to be sited, but may not be used where these links are not fairly and reasonably related to the site.

- **Public Transport Information:** The provision of up to date information within a workplace and other centres of activity can encourage people to use public transport. This can take the form of a designated area where information can be disseminated from or via a link to an external site where information can be accessed.

13.3.3 **Cycle Routes and Walkways**: Cycling and walking are considered to be the most environmentally friendly mode of transport. There are a variety of factors why employees may not cycle to work such as lack of safe cycle routes, variable weather, no storage facilities or showering/changing areas available. Planning for cycling/walking within new developments can mitigate against some of these. Cycling may be encouraged by:

- **Parking and Storage of Cycles**: This includes cycle stands or racks for short term parking, locking stands that can be operated by coins or wall mounted loops which provide storage up against buildings. For long term parking cycling sheds can be designed to be included within the development. Cycling sheds should contain protection from the elements. It is important that cycle parking areas are well lit and contained within the boundary of the development.
- **Showers and Changing Rooms**: The provision of showering and changing facilities is an important factor in encouraging cycling. These should be located within the main building, but close to the cycle storage area.
- **Cycle Access**: There are a number of cycle networks across Wales and ideally new developments should link their routes into local, regional and national networks. However, time constraints have a role to play unless public transport can be factored into the journey.

13.3.4 **Walkways**: The issue of making developments more conducive to the pedestrian is one that needs consideration. It may be possible for certain people to walk to their place of employment or to walk to a shop from their home. These issues can be addressed within the scope of new developments with walkways being developed along riverbanks, canal towpaths and disused railways. However, as a general personal safety principle walkways should not be segregated from the roadway. A number of measures that encourage pedestrians are:

- Traffic Calming
- Pedestrianisation of Areas
- Improved Lighting
- Wider Pavements
- Pedestrian friendly road crossings
- Safe, well designed and attractive routes
- Shorter travelling routes or times
- Proximity to public transport routes.

13.4 Car Free Housing

13.4.1 Car free housing developments can be defined as residential development with no car parking facilities for residents or visitors other than needed to meet the needs of disabled people. The general principle is that car free housing should be provided in locations that can support it. The schemes are designed not to ignore cars but demonstrate that cars are not always a necessity. Whilst schemes can reduce car parking within the development they have the potential to increase parking outside the development. Car free housing developments are common place within Holland and Germany, but have made only a limited impact within the UK.

13.4.2 **Why Have Car Free Housing?**

- More green space instead of paved parked areas.
- More opportunity for children to play outside their homes.

- Improvements in air quality and noise levels.
- Encourages alternative forms of transport.
- Gives opportunity to develop smaller sites.

13.4.3 **Design**: All car free developments should meet the following design criteria:

- Good quality cycle and pedestrian access routes should be provided as part of the development. These routes will link up with external services such as recreational facilities, retail outlets etc.
- Secure covered cycle parking should be provided.
- Within larger developments, a pedestrian drop off point for the elderly or disabled people will also need to be provided. Access will also need to be provided for emergency vehicles.
- On site parking may be provided for people with disabilities.
- Where vehicle access is allowed it should be strictly controlled so that it doesn't dominate pedestrian areas.

13.4.4 Developers may also be required to contribute towards:

- The provision of car club facilities for residents.
- Improving public transport infrastructure.

13.4.5 **Management**: In terms of management the following should apply:

- Residents need to be aware that they cannot keep a car within the development. This information may be included within the sale or lease agreement.
- There may need to be a legal agreement between the Council and the developer confirming the car free status of the development.

13.4.4 **Incentives**: Whilst car free housing is widely used within continental Europe it has made only a limited impact into the UK. If car free housing is to be more widely used within the UK then it may be necessary to offer incentives to house buyers to locate within car free developments. Incentives will involve partnership working between the developer, the local authority and possibly local transport companies. Incentives could take the form of:

- Discounted bus fares for residents,
- Reduced Council Tax for residents within car free developments.

13.5 **Car Clubs:**

13.5.1 Car clubs are neighbourhood-based short-term car rental facilities. Members pay a membership fee, which allows them to access a vehicle within 5-10 minutes walk of either their home or workplace. Clubs offer a range of vehicles allowing members to choose whichever is most appropriate to their needs. Members usually pay a monthly membership fee and then an hourly and mileage rate for each journey. There are usually between 12 – 20 members per car depending on the size of the car club. Car clubs are beginning to get established in the UK with around thirty in operation at the moment (www.carplus.org.uk). The largest operate in Edinburgh, London and Bristol. When a member wants to use a vehicle they contact the booking office and reserve the car they want.

13.5.2 Benefits of having a Car Club within a Development include:

Design Benefits:

- More space will be available for communal uses such as play areas and recreational activities.
- With less land allocated to roads there will be more space to promote cycle routes and walkways.
- Public transport can be better integrated into the development.
- Fewer cars within the development will mean a safer, cleaner environment.

Financial Benefits

- With less car parking space required there would be the potential to increase the number of units constructed.
- A reduction in the requirement to construct parking spaces.
- A reduction in on-site infrastructure costs from reduced traffic.
- There is the potential to develop sites that were previously not possible due to constrictions upon traffic levels.
- Potential increase in value of the units due to the innovative use of space within the site.

13.5.3 **Costs**: The financial responsibility of setting up a car club is shared between the developer, the operator and the scheme users, although there may be scope for a car manufacturer to sponsor the scheme. The financial contribution of the developer to the scheme could contribute towards:

- Setting aside land for the car parking space for use by car club members.
- Free membership to residents for the first year.
- Setting up the club.

13.5.4 **Who Will Run the Club?**

- Residents Association
- Facilities management company
- Separate enterprise: there are currently four companies that operate car clubs within the UK.

13.5.5 **Are Car Clubs Popular?**

Experiences within Europe suggest they are and early trials within the UK would seem to agree with this. The success of any car club scheme will depend upon the options offered to residents and how well the package is presented and organised.

13.6 **Use of Low/Zero Emission Vehicles**

13.6.1 There are a variety of low emission vehicles currently available. However if these are to be encouraged they will need to be considered at the design stage of new developments. Many low emission vehicles will require a refuelling or re-charging system on site and this activity will require space to be set aside within the development. The main low emission vehicle technologies, are summarised below:

- **Alcohol and Bio-fuel Cars:** Powering cars using alcohol has been the main fuel for vehicles within Brazil since the 1970's. Alcohol is a slightly cleaner burning fuel and therefore is more efficient. Alcohol is also a renewable fuel.
- **Electric Cars:** An electric car's power comes solely from electricity. While electric cars produce no direct emissions, the electricity used to charge the batteries may be generated from fossil fuel powered power stations with their associated CO^2 emissions. However because of the efficiency of the power stations the total CO^2 emissions are less than they would be from a petrol/diesel powered vehicle. The batteries used to power an electric vehicle are very large and would require a designated area within any new development.
- **Fuel Cells:** Fuel cells generate electricity within the car using a combination of both hydrogen and oxygen. This removes the need for large batteries and the fuel (hydrogen) originates from a renewable resource (water). One disadvantage is that in order to generate the hydrogen a great deal of power is required.
- **Hydrogen Powered Cars:** Hydrogen could be used within an internal combustion engine without radical changes in technology. However, there would still be emissions from the vehicle, in the form of nitrous oxides due to the high temperature within the vehicle. The hydrogen within the vehicle is contained within a liquid form.
- **Liquid Petroleum Gas (LPG):** LPG is liquid propane or butane, which at atmospheric pressure is a vapour but has undergone compression to turn it into a liquid. LPG vehicles produce 15% less CO2 emissions than their petrol alternatives.
- **Solar Powered Cars:** Solar panels or photo voltaic cells are made out of a semi-conductor called silicon. The technology behind solar powered vehicles needs to improve before they are readily available, as currently they are generally impractical for every day use.
- **Hybrid Vehicles:** Hybrid electric vehicles (HEVs) combine the internal combustion engine of a conventional vehicle with the battery and electric motor of an electric vehicle, and attain twice the fuel economy of conventional vehicles. This combination offers the extended range and rapid re-fuelling of a conventional vehicle, with a significant portion of the energy and environmental benefits of an electric vehicle. The practical benefits of

HEVs include improved fuel economy and lower emissions compared to conventional cars. Hybrid cars are economical and can get up to 55 – 60 mpg in city driving. Hybrid cars are better than all electric vehicles because they recharge while the vehicle is driving and can achieve significantly higher speeds than their electric counterparts.

13.7 Car Parking Management

13.7.1 The management of a car park is an effective way of influencing the number of people commuting by car. Considerations need to be taken at the design stage of a new development in order to plan how much of a development is going to be devoted to car parking in relation to the number of people wishing to park at the site. Aside from people using the building or development there may well need to be provision for visitor parking, unless sustainable transport is to be promoted to people visiting the site as well as those living or working at the site.

13.7.2 Features such as barriers, gates and tyre flaps can also be designed into the project to restrict access to the development to those people who car share or who use pool vehicles. However, space will still need to be provided for disabled access as well as emergency and delivery vehicles.

13.8 Green Travel Plans

13.8.1 Green Travel Plans are an effective an important element within any Sustainable Transport Strategy. A Green Travel Plan is essentially a means by which an organisation can manage the transport needs of its staff and customers to reduce the environmental impact of their travelling to and from the site.

13.8.2 A Green Travel Plan will contain a package of measures that are designed to promote the use of public transport, cycling, walking and car sharing. Green Travel Plans promote a variety of benefits such as:

- Reduced environmental impact.
- Increased space within the development, which can be used for more productive measures.
- Making the site less congested and enabling deliveries to move around the site more easily.
- Helps to provide staff with travel choices as to how they will get to work.
- Promotes health among staff by offering walking and cycling as alternatives to driving to work.

13.8.3 Essentially the Green Travel Plan will look at incorporating the options discussed within this SPG into the activities that will be carried out within the development.

13.9 Summary for Developers

13.9.1 A mixture of transportation alternatives is often the best solution when dealing with transport related issues within new developments. Often measures taken by developers can act as a disincentive to users and therefore the key to success is often implementing a number of sustainable transport measures within a development that enables the user to have a variety of options.

13.9.2 Developers should:

- Work with local transport providers to establish public transport links to the development as a viable alternative to using private transport.
- Provide cycle routes and walkways that are linked to local, regional and national routes.
- At the design stage of the development ascertain if car free housing, car clubs or low/zero emission vehicles can be employed within the development.
- Produce a Green Travel Plan to formalise the sustainable transport needs of the development.

14 SUSTAINABLE DRAINAGE SYSTEMS

14.1 Background

14.1.1 Climate change projections for Wales predict an increase in annual rainfall of between 3-5% by the 2050s. Within this annual increase, winter precipitation increases by between 7-15% by the 2050s with the summer months seeing decreases by up to 10% (NAW 2000[10]). These figures will not be uniform for the whole of Wales with the higher ground of Mid Wales expected to see greater levels of precipitation than the coastal areas.

14.1.2 Although exact figures pertaining to future precipitation levels for Bridgend County Borough do not exist it can be expected that precipitation levels will rise across the County Borough in line with the rest of Wales. The predicted drier summers could also potentially generate flash floods when rainfall does occur. Sudden rainstorms that create rapid run off over dry, impermeable ground cause flash floods. Flash floods within urbanised areas can cause the sewerage system to be inundated resulting in sewer flooding where foul water enters buildings.

14.2 Issues

14.2.1 **Increased Surface Water Run-off:** Developments will reduce the surface permeability by covering permeable virgin ground with impervious paved ground. This reduces the volume of water that can infiltrate the ground and will increase the volume of water that will be run-off the surface. Climate change in the 21st century is predicted to increase the risk of flooding due to increased rainfall in the autumn and winter months as well as increased storm intensity.

14.2.2 **Flash Floods**: Flash floods within urban areas can occur when sewerage and drainage systems are inundated with water during periods of intense rainfall. This water can enter buildings and may carry sewage that can pose problems for people's health.

14.2.3 **Traditional Drainage**: Urban developments generally reduce surface permeability by replacing permeable ground with impervious roofs and paved areas. This reduces the amount of water infiltrating the ground and increases surface run-off.

14.2.4 The traditional solution has been to install underground pipe systems designed to convey water as quickly as possible away from the development and prevent flooding locally.

14.2.5 However, the increased speed of run-off can cause erosion of riverbanks and damage to habitats. Water quality issues are also a concern because pollutants from urban areas are washed into rivers.

14.2.6 The increased speed of run-off can also alter the flow regime of the catchment and cause flooding problems elsewhere. This is especially a problem within urban areas when downpours overwhelm drains and sewers. In addition to flood damage there can be a risk to human health from sewage mixing with floodwater.

14.3 Sustainable Drainage Systems

14.3.1 Sustainable drainage systems (SuDS) mimic natural drainage patterns. SuDS can attenuate surface water run-off, encourage re-charge of groundwater, provide wildlife enhancements and maintain water quality.

14.3.2 *Tan 15 Development and Flood Risk* recognises that flood risk is expected to increase as a result of climate change and advocates the greater use of SuDS to cope with urban flood problems.

14.3.3 By replicating natural drainage, SuDS can assist aquifers to re-charge. Groundwater is an essential source of water to rivers and streams in the summer months helping to maintain their flow.

[10] *Wales: Changing Climate, Challenging Choices*, National Assembly for Wales, May 2000

14.4 Implementation of Sustainable Drainage Systems

14.4.1 Before any SuDS scheme can be implemented within a new development, a number of factors need to be first considered. These are:

- **Ground and groundwater considerations:** Ground and groundwater conditions may limit the types of techniques that can be employed. Certain circumstances such as a high water table or an impermeable layer of rock beneath the site could increase localised flooding rather than assist the process of flood attenuation if the incorrect SuDS technique is utilised.
- **Drainage Impact Assessment:** It is becoming increasingly common for planning authorities to request a drainage impact assessment be carried out as part of the planning application process in order to ensure that the impacts of the development upon the river catchment are fully understood.
- **Foul Water Sewers:** Where there are no separate surface and foul water drainage systems on site, Section 106 of the Water Industry Act 1991 effectively allows the discharge from SuDS to the foul water system. This however may increase problems with flooding by overloading the sewer system. Surface water, should be dealt with solely by SuDS on site to prevent sewage contaminated flooding occurring.

14.5 Sustainable Drainage Technologies

14.5.1 There are a wide range of SuDS techniques and they are often used either singly or in combination on a site-specific basis. The core technologies are listed below.

14.5.2 **Preventative Measures**: This technique utilises rainwater or grey water by trapping it within water butts or storm water tanks to be utilised later for toilet flushing, vehicle washing or plant watering.

14.5.3 **Swales:** Swales are basically broad, shallow ditches cut into the ground and are generally found at the edges of roads. Surface water is directed into the Swale where it flows to a suitable storage or outfall point and can gradually soak into the ground below. Swales are often dry for long periods of time, unlike traditional drainage ditches. Swales are often installed as part of a drainage network connected to a balance pond.

14.5.4 **Filter Drains**: Filter drains are centuries old and are a major SuDS technique being widely used by highway authorities for draining roads. Filter drains assist in the storage, filtering and ultimate discharge of water. A filter drain can be a stone filled trench with a perforated pipe running through them. Filter drains slow down water movement and provide some filtration**.**

14.5.5 **Permeable Sources**: Porous paving systems are a direct break from traditional drainage systems in that surface water is directed into the pavement and then released in a controlled manner. Permeable paving is a key technology behind SuDS as it enables "source control", this means that stormwater is controlled at its source rather being directed to a treatment works several miles away.

14.5.6 As more and more of the country is developed and therefore covered by roads, pavements and buildings two problems will come to prominence:

- The increased load that will be placed upon already overstrained wastewater treatment works,
- The risks to water quality when the treatment works are not able to fully cope with the increased levels of water passing through their plant at times of flood.

14.5.7 In addition to the pressure placed upon treatment plants, water can also be discharged to local watercourses where the increased flows can cause greater erosion of the river bank. Pollution from the increased numbers of vehicles that cause hydrocarbons and heavy metals to be washed off roads and into watercourses and treatment plants are also a problem.

14.5.8 Permeable paving offers an effective solution to this problem. There are two types of permeable paving:

- Infiltration – Surface water is directed via voids within areas of solid paving.
- Porous – Surface water is drained directly through the special paving units.

14.5.9 The paving can be either grass or concrete, with concrete being suitable for trafficked areas and grass being suitable for non-trafficked areas. Depending upon ground conditions the stormwater may:

- Infiltrate directly into the subsoil,
- Be stored in an underground reservoir (such as crushed stone layer) before soaking slowly into the ground.

14.5.10 **Infiltration Devices**: Infiltration devices collect rainwater and gradually return it to the environment. Soakaways are one type of infiltration device. A soakaway historically has been a ditch filled with stones to assist drainage. Today, soakaways are engineered cells made of concrete or heavy-duty plastic. In addition to there being suitable geology, the site of a soakaway must also:

- Be located in a spot lower than the area being drained,
- Be at least 5m away from any building,
- Be sited so that it will not saturate the foundation of any structure,
- Be sited so that the base of the soakaway is permanently above the water table,
- Be sited far enough away from other infiltration devices to ensure their capacity is not impaired,
- Be sited so that there is no risk of pollution.

14.5.11 Once the site requirements have been established a site investigation needs to be carried out. The site investigation will involve:

- Digging a trial pit to determine the rate of percolation (Vp) to assess if the soakaway is to function properly.
- The trial pit should be constructed according to the criteria listed in BS 6297.
- Small soakaways serving a single property will not need excavated trial pits deeper than 1.8m, however for larger projects a trial pit as deep as 6m may be required.
- The trial pit will need to be left overnight (after being made safe by either fencing off or covering with a board).
- The pit will need to be inspected the following day and if no water is within the pit then a soakaway will be suitable for the site.

14.5.12 A simple formula is used to calculate the size of the soakaway. This is the area to be drained by the soakaway multiplied by the product of the storm rainfall rate (assumed to be 50mm/hr in the UK) divided by 3000.

14.5.13 Construction of the soakaway can utilise pre-cast concrete or plastic soakaway chambers that are placed in the excavated hole and covered with a suitable material.

14.5.14 A relatively new development are modular storage/soakaway cells. They are usually manufactured from recycled polypropylene and offer high levels of strength and durability for very little weight. The units can either be used individually as standard soakaways or joined together to serve as an underground storage system for stormwater.

14.5.15 A soakaway should not require any maintenance but it is a good idea to check it every few months for signs of silting or contamination. If silting is a problem, constructing a catch pit to trap and remove silt before it enters the soakaway would be a solution. Older soakaways can cease to function and in these cases it is often necessary to excavate the structure and rebuild it.

14.5.16 **Balance Ponds**: A balance pond is a structure that is designed to hold water when it rains. Essentially the pond will contain water at all times, but is designed to hold more water when it rains. The pond will store and filter stormwater runoff through settling and through nutrient uptake by plants and other aquatic organisms.

14.5.17 Balance ponds are often one of the most common methods chosen by site designers to handle stormwater flows within developments. Balance ponds generally have restricted uses within urban areas due to their space requirements and

for balance ponds to maintain a permanent water coverage they will need more than 5 acres of available drainage land.

14.5.18 Balance ponds have many advantages such as:

- Effective flood control,
- Effective stormwater treatment,
- Ecological value.

14.5.19 Balance ponds are cost-effective SuDS tools. Although they require initial capital investment, this can be spread over the long life span of the pond. Balance ponds will require regular maintenance such as sediment removal, repair of inlet and outlet structures etc.

14.5.20 **Green Roofs**: Green roofs are an important SuDS technique since they divert rainwater away from drainage systems. A green roof in basic terms is an extension of an existing roof which will involve high quality water proofing, a drainage system, filter cloth, plants and a growing medium. There are two types of green roofs:

- **Intensive:** A deep layer of soil supports a variety of plants (e.g. flowers and shrubs) and can grow a variety of plants and even some small trees and can provide an excellent habitat for wildlife.
- **Extensive:** A light layer of soil, which supports shallower growing plants, and generally requires little maintenance.

14.5.21 The ideal time to consider building a green roof is when a new building is to be developed. The design of a green roof needs to look at a number of considerations:

Green roof: Centre for Alternative Technology, Machynlleth, Powys

- **Irrigation:** Ideally green roofs should be designed to eliminate the need for watering by planting drought resistant plants.
- **Drainage:** Excess water not absorbed by the garden must be drained to prevent added weight or rotting of the roof.
- **Plant Selection:** The type of plants selected will depend on the level of maintenance that will be available. Typical plants consist of meadow-grass and mosses.
- **Maintenance:** Green roofs should be checked annually and unwanted plants removed. Larger plants should also be pruned. Drains must also be checked to remove blockages.

14.6 Selecting the Most Suitable Sustainable Drainage System

14.6.1 It is important to consider using SuDS as early as possible in the design stage of a development. By considering the land-take implications at the design stage the land requirements of the different types of SuDS will be understood (in some cases the land-take will be zero e.g. permeable paving).

14.6.2 An appraisal of the suitability of the different SuDS techniques for a development needs to be carried out at the design stage. Such an appraisal will need to address the following components:

- The topography of the site, particularly any flood prone areas,
- Distance from water courses,
- Bodies of marsh or wetland close to the development,
- River flow regime,
- Water quality,
- Ecology of the site,
- Groundwater conditions and local geology,
- Current water abstraction rates within the area.

14.6.3 The development should address each of the above points to ensure that the chosen SuDS technique does not cause flooding or create pollution problems that will be detrimental to local water quality.

Once each of these factors has been properly looked at a suitable SuDS can be considered, where appropriate, and integrated into the development.

14.7 Maintenance

14.7.1 For SuDS to operate effectively on a site the systems must be adequately maintained. Planned maintenance schedules are needed and vegetated SuDS such as swales will require routine maintenance to control growth. De-silting and sediment clearance will also be needed to maintain the SuDS capacity. This will be especially important if balance ponds are present on site since these features have the tendency to quickly fill with sand, silt and other solid matter especially after the construction phase.

14.7.2 The developer, the Environment Agency and the local authority will need to agree who will be responsible for the on-going maintenance of the SuDS and indeed this may be a material condition of planning consent being granted. Indeed it is important that at the outset the developer and the Council need to establish who will be responsible for the maintenance of the SuDS. It could be that the freeholder of the site, a management company or the Council itself through an adoption agreement may take maintenance responsibility for the SuDS.

14.7.3 To ensure the continued effectiveness of the SuDS a specific source of revenue may need to be secured by the management body of the development, for whilst local authorities can adopt SuDS infrastructure, their ongoing maintenance can only be funded through agreements. Historically these agreements have been facilitated through commuted sums taken from the developer.

14.8 Examples of Using Sustainable Drainage Systems

14.8.1 **Industrial Units**

- A soakaway can be installed at the perimeter of the site to receive water from roofs and paved areas.
- Water butts could be installed to collect rainwater on the roof and later used to flush toilets.
- Porous paving or porous drainage systems could be used for access roads and car parks (although water drained from car parks can be contaminated.

14.8.2 **Medium Housing**

- Water butts can be installed on rainwater downpipes
- Where the hydro-geology permits rainwater can be channelled to soakaways.
- Permeable paving can be installed for driveways and access roads etc.
- A community SUDs scheme such as a balance pond could be constructed, whereby rainwater drains into a pond.

14.8.3 **Large Housing**

- Water Butts installed on rainwater down pipes,
- Large driveways and paved areas could be surfaced with permeable paving,
- Low density developments will have space for soakaways, swales etc.

14.8.4 Large housing developments give greater flexibility in terms of what SuDS techniques can be employed within the development.

14.9 Summary for Developers

- Carry out a site survey to determine which SuDS technique will be appropriate for use on the site.
- Consult with the relevant statutory bodies to ensure that the proposed scheme does not breach any legislation.
- Ensure that the responsibility for maintaining the SuDS is clear at the design stage.
- Ensure that where feasible all pavements, driveways, footpaths and car parking areas have permeable paving.
- When the drainage plan for the site is being developed ensure that the potential changes caused by climate change are considered and that elevated levels of future run-off can be safely dealt with.

15 UNITARY DEVELOPMENT PLAN

15.1 Sustainable development is a guiding principle of the Bridgend Unitary Development Plan. *"The aim is to produce a more sustainable pattern of development which focuses on the better use of the existing urban areas of the County Borough whilst encouraging economic growth, reducing dependence on the private car, and promoting the greater use of more sustainable, alternative modes of transport; thereby securing a higher quality of life, and respect for the environment."*[11]

15.2 This supplementary planning guidance extends and interprets the following policies of the deposit Bridgend Unitary Development Plan.

PART 1 Policies

Policy 1 - THE ENVIRONMENT OF BRIDGEND COUNTY BOROUGH IS A VARIED AND FINITE RESOURCE. DEVELOPMENT WHICH ENHANCES, PROTECTS OR CONSERVES IT, WILL BE ENCOURAGED; WHEREAS DEVELOPMENT WHICH DIMINISHES, ENDANGERS OR NEGLECTS IT, WILL NOT BE PERMITTED.

Policy 3 - DEVELOPMENT PROPOSALS WILL BE FAVOURED WHERE THEY EMBRACE OR ENCOURAGE:-

1. CONSERVATION, REDUCTION, RE-USE AND RECYCLING OF WASTE, POLLUTION CONTROL, AND THE CONSERVATION OF NATURAL RESOURCES;
2. REDUCTION OF TRAVEL BY PRIVATE CAR AND VEHICLE MOVEMENTS, AND THE PROMOTION OF CYCLING, WALKING AND THE USE OF PUBLIC TRANSPORT;
3. RECLAMATION OF DERELICT, DEGRADED OR CONTAMINATED LAND, AND ITS REMEDIATION TO BENEFICIAL USES; AND
4. REGENERATION OF THE URBAN ENVIRONMENT.

Policy 20 - ALL DEVELOPMENT PROPOSALS SHOULD SEEK TO MAXIMISE ENERGY EFFICIENCY AND WATER CONSERVATION IN THEIR LAYOUT, DESIGN, MATERIALS AND CONSTRUCTION.

PART 2 Policies

Policy EV16 NEW DEVELOPMENT IN AREAS IDENTIFIED AS BEING LIABLE TO FLOODING WILL NOT BE PERMITTED, UNLESS IT CAN BE DEMONSTRATED THAT:-

1. THEY CAN BE PROPERLY PROTECTED BY APPROVED ENGINEERING WORKS AND/OR BY OTHER FLOOD PROTECTION MEASURES;
2. SUCH REMEDIAL MEASURES WILL NOT PUT OTHER AREAS AT RISK FROM FLOODING; AND
3. THE DEVELOPMENT, INCLUDING ANY REMEDIAL MEASURES, CAN BE SYMPATHETICALLY ASSIMILATED INTO THE ENVIRONMENT IN TERMS OF ITS SITING, SCALE, DESIGN AND LANDSCAPING, WITHOUT ANY DETRIMENTAL IMPACT ON ACKNOWLEDGED SITES OF ARCHAEOLOGICAL OR HISTORIC INTEREST, AND HABITATS AND SPECIES OF IMPORTANCE TO BIODIVERSITY CAN BE SAFEGUARDED.

Policy EV45 NEW DEVELOPMENT WHICH ACHIEVES A GOOD STANDARD OF DESIGN BY:

1. HAVING A CONSISTENT STYLE OR CHARACTER;
2. RESPECTING THE CONTEXT OF THE DEVELOPMENT;

[11] *Bridgend Unitary Development Plan, paragraph 3.1.1,* May 2005

3. BEING APPROPRIATE TO THE SCALE AND PROMINENCE OF THE DEVELOPMENT;
4. INCORPORATING THOSE EXISTING FEATURES OF THE SITE THAT ARE IMPORTANT TO THE LOCAL ENVIRONMENT, INCLUDING ITS TOPOGRAPHY, BIODIVERSITY, AND STRUCTURES OF HISTORIC INTEREST;
5. USING SITING, LAYOUT, FORM, MATERIALS, AND ARCHITECTURAL DETAIL, AND PUBLIC ART, TO CREATE A NEW, OR ENHANCE AN EXISTING, SENSE OF PLACE;
6. REASONABLY PROTECTING THE RESIDENTIAL AMENITY OF NEIGHBOURS, INCLUDING PRIVACY, A QUIET ENVIRONMENT, DAYLIGHTING AND SUNLIGHTING;
7. BEING COMPATIBLE WITH THE ADEQUATE PROVISION OF AMENITIES (INCLUDING OPEN SPACE) FOR RESIDENTS OR USERS OF THE DEVELOPMENT;
8. BEING COMPATIBLE WITH THE CREATION OF AN ENVIRONMENT WHICH IS SAFE, FRIENDLY TO THE DISABLED, SUSTAINABLY ACCESSIBLE, MANAGEABLE, AND POLLUTION-FREE;
9. BEING COMPATIBLE WITH THE USE OF SUSTAINABLE METHODS OF CONSTRUCTION, MATERIALS, ENERGY CONSERVATION, AND WATER MANAGEMENT;

WILL BE PERMITTED.

Policy U1 DEVELOPMENT WHICH ENCOURAGES THE MORE EFFICIENT USE OF ENERGY AND/OR WHICH CONSERVES ITS SUPPLY WILL BE FAVOURED.

FURTHER INFORMATION

This guidance can only offer general advice. If it is not clear how the advice notes apply to a particular development the proposal may be discussed with staff of the County Borough Planning Department. Letters should be addressed to:-

Mr David Llewellyn BA MSc MRTPI
Group Manager Development
Bridgend County Borough Council
P.O. Box 4, Civic Offices
Angel Street, BRIDGEND
CF31 1LX

If telephoning, ring Bridgend **(01656) 643155** (the Supplementary Planning Guidance reference to quote is **SPG 12).**
The fax number is Bridgend **(01656) 643190**.
Emails may be sent to ***planning@bridgend.gov.uk***