energy and climate change

Contents

Key

Different development sectors are colour coded below. To aid navigation through the case studies in this Guide, the colour codes denote the applicability of case study sustainability solutions to each of the various development sectors. The colour coding can be found in the bottom corners of each of the case studies.

Hertfordshire energy facts

In Hertfordshire in 2009, an estimated 2,070 GWh of gas were consumed in the residential sector, a reduction of 8% on 2005 levels. (decc.gov.uk)

In 2009 the household sector consumed 28.5% of all fuel consumed in the UK. Only the transport sector consumed more - (Digest of UK Energy Statistics, 2010)

The 'Herts and Essex Energy Partnership (HEEP)' offers discounted insulation and low carbon technologies to householders. Contact HEEP - www.heepgrant.org or on 0800 980 6026.

The Climate Change Act makes the UK the first country in the world to set legally binding targets for the reduction of carbon emissions.

The 2010 Hertfordshire Renewable and Low Carbon Energy Technical Study identified numerous localities where low carbon technologies could be used to meet the County's targets.

The **Climate Change Levy is a tax on the use of fossil fuels in the non-domestic sector** and forms a key part of the UK Government's Climate Change programme. Energy from renewables and approved Combined Heat and Power schemes is exempt from the Levy.

Hertfordshire's forecast **population growth over the 25 years from 2006 to 2031 is 195,100** a percentage increase of 18.4 (ONS 2008). That means electricity and gas consumption are also set to increase, making renewable energy generation more important.

The Climate Change Act aims to reduce carbon dioxide emissions through domestic and international action to 26-32% below 1990 levels by 2020, and at least 60% by 2050.

Hertfordshire County Council and several local authorities purchase green electricity from renewable sources for their public buildings. The use of Combined Heat and Power generation is reducing the county's CO_2 emissions. An example is the Letchworth Leisure Centre in North Hertfordshire.

Turning electrical equipment off at the mains rather than using the standby mode makes a difference - 8% of household energy is used by appliances on standby.

The Community Sustainable Energy Programme (CSEP) offers funding to not for profit organisations, such as community groups, charities, schools, colleges and faith groups, to install energy saving measures and renewable energy technologies.

Legislation seeks to reduce the energy consumption of buildings by 25% and to increase the provision of renewable energy to meet 10% of on-site demand (PPS22: Renewable Energy).

Turning down the thermostat by 1^{0}C can save you a further 10% of a household energy bill whilst not negatively affecting the comfort of occupants.

Financial incentives for reducing energy consumption and generating renewable energy are continually emerging. These include the CRC-EES, Green Deal, FiT and RHI.

The Climate Change Act aims to reduce carbon dioxide emissions through domestic and international action to 26-32% below 1990 levels by 2020, and at least 60% by 2050. (www.goeast.gov.uk)

Basic principles

Principles of energy and climate change

Approximately 50% of all UK carbon dioxide emissions are generated in serving the energy needs of buildings. Reducing energy consumption in buildings is a key objective of national government. Excessive energy consumption is not only an environmental concern, but also raises economic concerns, as energy prices have increased significantly in recent years and there are approximately 4.5 million households living in fuel poverty.

Legislation has recently been introduced to increase energy efficiency in building stock throughout Europe. In the UK, this takes the form of revisions to Building Regulations, which now require an improvement in energy performance of 25% against the 2002 Regulations for all new build projects. Refurbishments and extensions are subject to different requirements.

The Climate Change Act 2008

The Climate Change Act sets legally binding long-term targets to cut the UK's carbon, ultimately leading to an 80% reduction in CO2 emissions by 2050. The UK is the first country in the world to set a legally binding target of this nature. It also creates a framework for developing the ability to adapt to future climate change impacts.

PPS1

Planning Policy Statement 1 states, "local authorities should promote resource and energy efficient buildings; community heating schemes, the use of combined heat and power, small scale renewable and low carbon energy schemes in developments." In response to this policy the Hertfordshire Renewable and Low Carbon Energy Technical Study was published in 2010.

PPS 22

Planning Policy Statement 22: 'Renewable Energy', places an obligation on regional planning bodies to encourage local renewable energy projects, to support the Government's policy on the reduction of CO2 emissions. Further information is available at: communities.gov.uk

Legislation has recently been introduced to increase energy efficiency in building stock throughout Europe. In the UK, this takes the form of revisions to Building Regulations Part L. The 2010 revision has been introduced to deliver a 25% reduction in regulated CO2 emissions from a new building compared to the same building built under Part L 2006.

Refurbishments and extensions are subject to different requirements, with separate Part L Approved Documents. Part L is divided into four distinct categories: new-build domestic (L1A); existing domestic (L1B); new-build non-domestic (L2A); and existing non-domestic (L2B). This is reviewed further later.

EU Energy Performance of Buildings Directive

The EU Directive on the Energy Performance of Buildings came into force in January 2006, with the aim of reducing energy use and associated emissions from the built environment throughout Europe.

Each country within the European Union will set minimum standards for energy efficiency in buildings, including the consideration of alternative energy technologies for new buildings and the improvement of the energy performance of existing buildings when renovations are carried out. In the UK, these requirements are being addressed through Building Regulations and revisions of Part L.

From 1st October 2008 the Directive required all landlords and property owners to provide an Energy Performance Certificate (EPC) when they construct, sell, lease or modify a building. They must also ensure that air conditioning systems with an output of greater than 250kW have received an energy inspection by 4th January 2009.

Only accredited companies can provide EPCs. By complying with legislation and following the recommendations supplied with the EPC on how to improve energy efficiency, building owner's can reduce energy bills and cut carbon emissions.

From 1st October 2008, public authorities and institutions occupying buildings with a floor area over 1000m2 and visited by a large number of the public must put on view a Display Energy Certificate (DEC). DECs show the actual energy usage of a building, the Operational Rating, and help the public to understand the energy efficiency of a building.

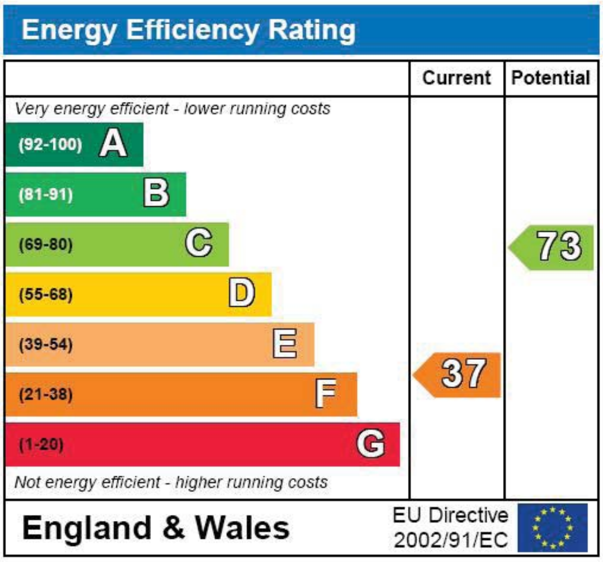
A DEC is always accompanied by an Advisory Report that lists cost effective measures to improve the energy rating of the building. DECs are valid for one year whilst the Advisory Report is valid for seven years.

There are significant differences between an EPC and a DEC. The EPC, which is required by the Building Control Body before they can provide the Completion Certificate, is a predictive assessment of how the building performs against the Building Regulations Part L. However, Part L does not take account of all the energy consumed in a building, so neither does the EPC. The EPC relates to the 'regulated' energy loads, which are those addressed by Part L. The DEC reports the actual meter readings taken after 12 or more months of building operation, so the DEC includes both the 'regulated' loads addressed by Part L and the 'unregulated' loads not addressed by Part L.

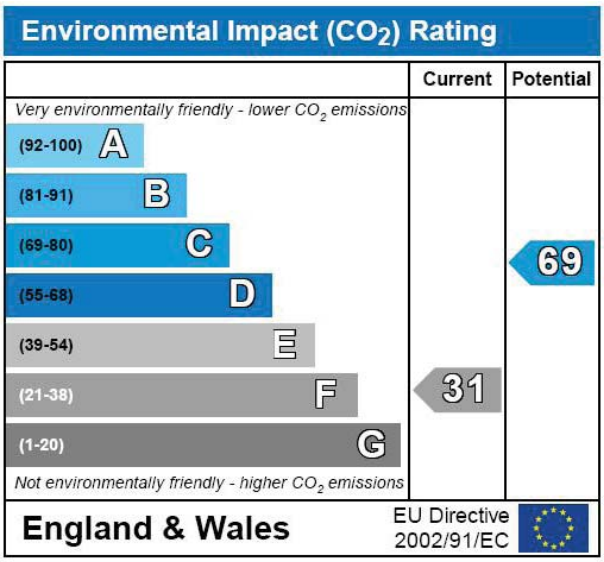
For homes this detail is not significant as the 'unregulated' loads, for example energy used by white goods, are relatively small. However, for buildings such as schools, offices or hospitals, the unregulated loads can actually be greater than the loads considered by Part L. This should be kept in mind the next time a high-profile building appears with A or B rated EPC, but only a D or E rated DEC.

Further information about EPCs is available at www.epc.direct.gov.uk and DECs at http://www.communities.gov.uk/publications/planningandbuilding/displayenergycertificates

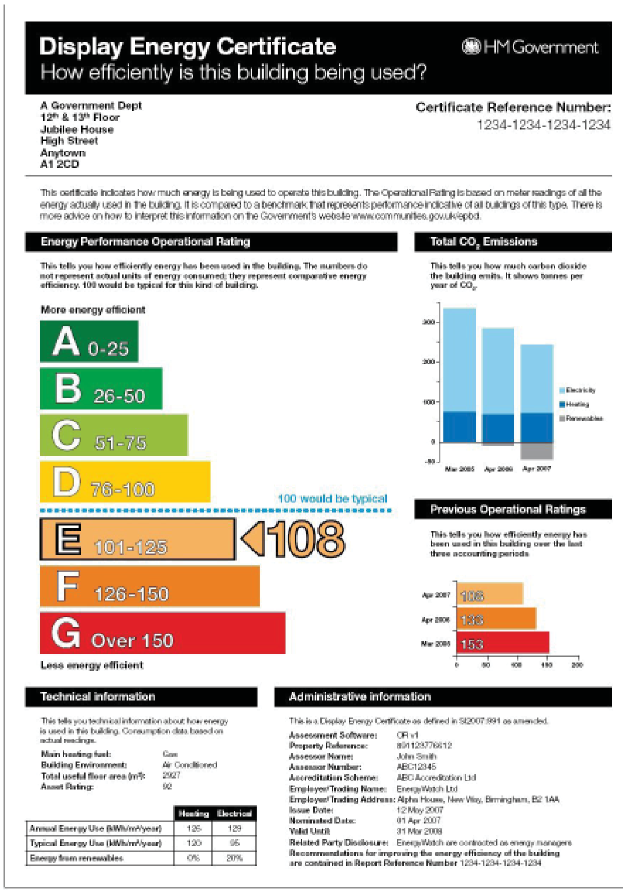
Energy efficiency ratings



The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills will be.



The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating the less impact it has on the environment.



Principles of energy and climate change

Building Regulations and Zero Carbon Homes

Building Regulations - Part L 2006

Government had initially set out its policy for new homes to be 'zero carbon' from 2016, and an ambition that new public sector non-domestic buildings would be zero carbon from 2018 and all other non-domestic buildings by 2019. 'Zero carbon' in this context related to both regulated and unregulated loads and sources of carbon emission assocaited with the building- i.e. both the building fabric and heating and lighting systems, and any other services or appliances fitted within it.

The progression towards zero carbon buildings was to be delivered by revisions to Building Regulations Part L. The 2010 revision was approved in October 2010; however, schemes registered before this date and that start construction before October 2011 can comply with Part L 2006.

However, in March 2011 the Government revised the scope of 'zero carbon' for new homes from 2016. The calculation of unregulated loads of new homes from 2106 were removed from the energy performance and carbon calculations. Only the regulated loads associated with new buildings - building fabric, heating and lighting systems assessed under Building Regulations Part L - will be taken into account from 2016 onwards.

The 2006 issue of Part L ‘Conservation of Fuel and Power’ contained a number of significant changes to the required performance of buildings and to the information that must be submitted to Building Control.

The standard accounted for energy improvements of between 23.5 –28% dependent on services strategy on the 2002 Building Regulations in all new buildings. The following requirements were also introduced:

- pressure testing
- elimination of overheating from excessive solar gains
- provision of information on the efficient operation of the building

In addition, there are requirements for wider improvements when work is carried out on existing buildings. In domestic buildings this involves the upgrade of whole elements (e.g. external walls) where work is being carried out to a part of that element. In non-domestic buildings, energy improvements to building services and the incorporation of renewable energy technologies are required, where feasible.

Building Regulations - Part L 2010

The 2010 issue of Building Regulations Part L goes further than the 2006 version in a number of areas, such as:

- The maximum U-values allowable have been improved for fabric elements such as walls, windows, roofs, etc

- An interim submission to the Building Control Body is required for the building ‘as designed’, in addition to the submission on practical completion for the building ‘as constructed’

Principles of energy and climate change

Building Regulations and Zero Carbon Homes

Building Regulations - Part L 2010 (cont'd)

- The Building Control Body must be provided with a checklist of key features, which will assist them to assess the approach taken to compliance
- The requirement for 'consequential improvements' remains in place for existing non-domestic buildings (Part L2B), although these are yet to be introduced for work undertaken on existing homes (Part L1B). Consequential improvements are energy efficiency improvements that are required to be made on projects where the building services requirement is being increased. Improvements that payback within 15 years should be implemented.

Further information on Building Regulations Part L can be found at www.planningportal.gov.uk/buildingregulations/approveddocuments/partl/.

Code for Sustainable Homes and BREEAM

Code for Sustainable Homes

In December 2006, the Government published the Code for Sustainable Homes, which outlines national standards for measuring sustainable design and construction in new housing development. At the heart of the Code are energy and water considerations. The Code has been updated for 2010 to take account of, among other things, the 2010 revision of Building Regulations Part L.

The transitional arrangements are summarised below:

- Where evidence shows that all dwellings are eligible to be assessed against Part L 2006, it will be possible to register developments indefinitely against the May 2009 V2 version of the Code.

- For Code schemes registered before 11th December 2010, it was possible to select to register the scheme under either the May 2009 V2 or the 2010 versions of the Code.

- For all Code schemes registered after 11th December 2010, it is necessary to register against the 2010 version of the Code, unless they are being assessed against Part L 2006 (see first bullet point).

The Code awards points for carbon improvements above Building Regulations Part L. It also encourages energy efficient improvements to internal and external lighting and Ecolabelled white goods. Code compliance has been required for new social housing developments, which must meet Code level 3 as a minimum since April 2008. From 1st May 2008 it has been mandatory for all new homes to be rated against the Code. A Code Certificate must be included within the Home Information Pack (HIP).

Further information on the Code is available at www.planningportal.gov.uk/uploads/code_for_sustainable_homes_techguide.pdf.

Principles of energy and climate change

Code for Sustainable Homes and BREEAM (cont'd)

BREEAM

BREEAM (the Building Research Establishment Environmental Assessment Methodology) is a commonly used environmental certification scheme in the UK. BREEAM also awards points for carbon improvements above Part L and for the introduction of low carbon or renewable energy technologies.

It is not mandatory for non-domestic buildings to have a BREEAM rating, although public sector buildings often require a BREEAM rating to be obtained for funding purposes. Additionally, many local planning departments stipulate BREEAM ratings in planning policy to enforce higher sustainability standards for buildings.

The Green Deal and the Energy Services Directive

The Green Deal

The Green Deal is a forthcoming initiative to support the implementation of energy efficiency measures to the UK's existing building stock (households and businesses) without requiring the owners/occupiers to provide any of the upfront costs.

This programme will be backed by a finance mechanism where the long-term financial benefits from the reduction in energy consumption are shared between the building owner/occupant and the private sector party that funds the efficiency upgrade.

More information on the Green Deal can be found on DECC's website: www.decc.gov.uk/en/content/cms/tackling/green_deal/green_deal.aspx.

Energy Services Directive

The Energy Services Directive, effective in the UK from 17 May 2008, aims to enhance the cost effective improvement of energy end use efficiency. Article 5 requires public sector organisations to lead by example and take up cost effective energy efficiency improvements that generate the largest savings in the shortest space of time.

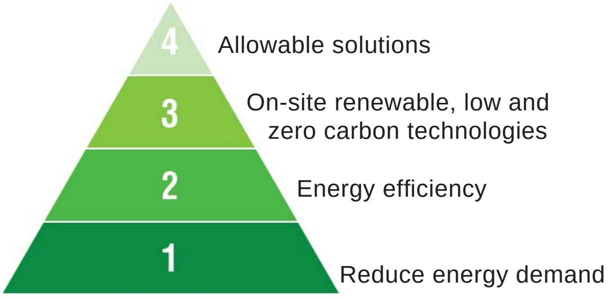
Further information is available at www.decc.gov.uk/en/content/cms/what_we_do/consumers/saving_energy/esdirective/esdirective.aspx.

Principles of sustainable energy management

the energy hierarchy

The purpose of the energy hierarchy is to provide a principled approach to designing a building with sustainable energy performance in mind. The hierarchy is being embedded into policy and practice through DCLG's ongoing work on Low and Zero Carbon buildings, Building Regulations, and through planning policy. T here are many possible sustainable energy solutions available to building designers and developers, as well as property and facility managers. Some are applicable in all development types and others are specific to particular development sectors, locations or style of architecture. Further details are provided in the solutions section of this module.

The diagram below illustrates the stepped approached to designing for sustainable energy management that should be used within new build projects and refurbishments.



Following the energy hierarchy is one of the most effective ways in which to reduce the environmental impacts of buildings. Measures are listed below:

1. Reduce energy demand

Reduce the quantity of energy required for heating, lighting and cooling via fabric efficiency and passive design:

- insulation better than the Part L maximum values for walls, roof, floor, windows and doors
- air-leakage level better than the Part L maximum
- enhanced insulation of pipes, ducts and vessels
- solar control glass and/or shading louvres
- use natural environmental systems instead of artificial systems, such as passive solar gains, natural ventilation and natural daylighting

2. Energy efficiency

Use energy required to provide occupant comfort and safety efficiently:

- Energy efficient services, appliances and controls, such as

  - high efficiency condensing boilers
  - high efficiency chillers
  - underfloor heating
  - chilled beams
  - pumps and fans with variable speed motors (DC or EC)
  - pipework and ductwork with larger diameters
  - efficient controls systems

- Low-energy lighting, such as:

  - CFL (compact fluorescent lighting)
  - LED (light emitting diode) bulbs
  - natural daylight and presence detection controls

- Energy efficient white goods:

  - fridge
  - freezer
  - washing machine
  - tumble-dryer
  - dishwasher

Principles of sustainable energy management

the energy hierarchy (cont'd)

3. On-site renewable, low and zero carbon technologies

Replace or minimise the use of finite and polluting fossil fuels:

- Low or zero carbon (LZC) micro-generation technologies, to provide as much energy as is technically and economically feasible:
  - combined heat and power
  - biomass boiler
  - heat pumps (either ground source or air source)
  - solar water heating
  - solar photovoltaic panels
  - wind turbines
  - small hydro power

- Purchase all remaining electricity requirements on a Green Energy Tariff (electricity generated from off-site renewable energy) that supports the development of new large-scale renewable energy generation and infrastructure

4. Allowable solutions

If a building consumes fossil-fuel for heat and power, it may still be classified as 'zero carbon' if the same quantity of resulting CO2 emissions are offset elsewhere. The offsetting solutions are categorised as 'allowable solutions'. The following solutions may be considered as allowable solutions:

- Reducing the energy consumption of other buildings elsewhere
- Investment in macro-scale energy solutions, such as a district heating network or wind farm
- Payment into a community investment fund

Benefits of Energy Management

Integrating the principles of the energy hierarchy into the design of new development and refurbishment schemes, and implementing the various energy efficiency, low and zero carbon energy solutions, can deliver significant benefits to occupants, property owners and the wider community. These include:

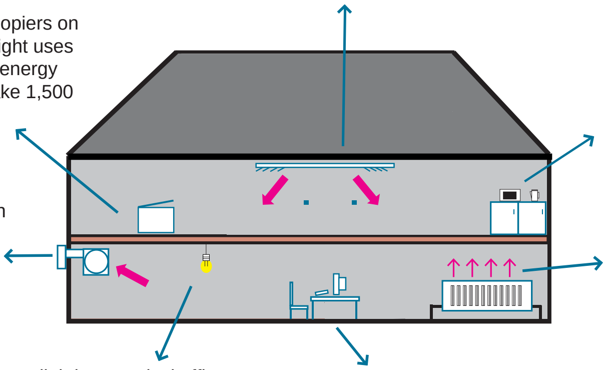
- social and economic benefits:
  - reduced fuel bills as less energy is required to keep homes warm and cool.
  - opportunities to generate income via Feed in Tariffs and the Renewable Heat Incentive
  - healthier and more comfortable home environment
  - increased energy security, both locally and nationally
  - reduced maintenance bills (e.g. if natural ventilation is pursued instead of mechanical ventilation)
  - reduced incidence of energy poverty and prevention of underheating of homes, in particular those of vulnerable people
  - job creation as the green technology and construction industries grow
  - mitigation of longer term risks to social and economic wellbeing associated with climate change
  - awareness raising and educational value from highly visual technologies

- environmental benefits:
  - reduced building related carbon dioxide and other atmospheric emissions
  - reduced emmissions from tradtional energy supply and generation networks
  - gas, oil, coal and fossil fuel generated electricity.
  - better management of (and less reliance on) finite fossil fuel resource
  - cross benefits in terms of adaptation, improved local air quality and architectural innovation

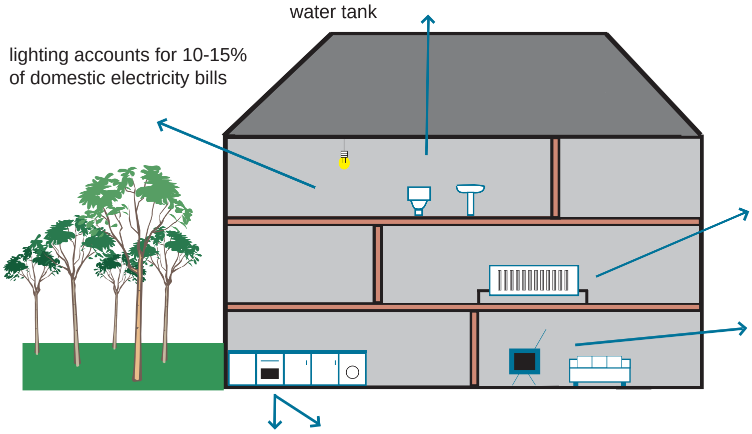
Principles of sustainable energy management

Energy Demand in Buildings

Office



House



Solutions

Solutions are presented in accordance with the stepped approach taken in the energy hierarchy. There are many solutions available within each step and their appropriateness and applicability will vary according the development type, nature and scale; likely building occupants; site constraints; and the technical capability of the solutions themselves.

When designing for sustainable energy management it is important that issues and opportunities are identified at the outset as part of an on-going discussion between client, architect/designer and the planning authority.

reducing demand and energy efficiency

This section describes many of the energy efficiency solutions that address the first steps on the energy hierarchy. The applicability of these solutions depends on the type of project; in particular, whether it is a new building or a refurbishment. Specific attention is drawn to considerations relevant to the residential, commercial, educational, health and industrial sectors.

Building design

In the case of new buildings, energy issues should be given consideration at the early stages of design (ideally at project inception) to enable the best technical and economic solutions to be achieved. These measures are inf l uenced by decisions made throughout the design process. Cost implications are variable. In many cases, these design choices can lower capital costs through reducing building service requirements.

In addition, these passiveenergy saving measures typically require little or no maintenance and last throughout the lifespan of the building with no energy input.

At an early design stage there are many opportunities to develop an integrated approach to energy use and savings, including the determination of the physical form and characteristics of the building. Consideration should be given to the following:

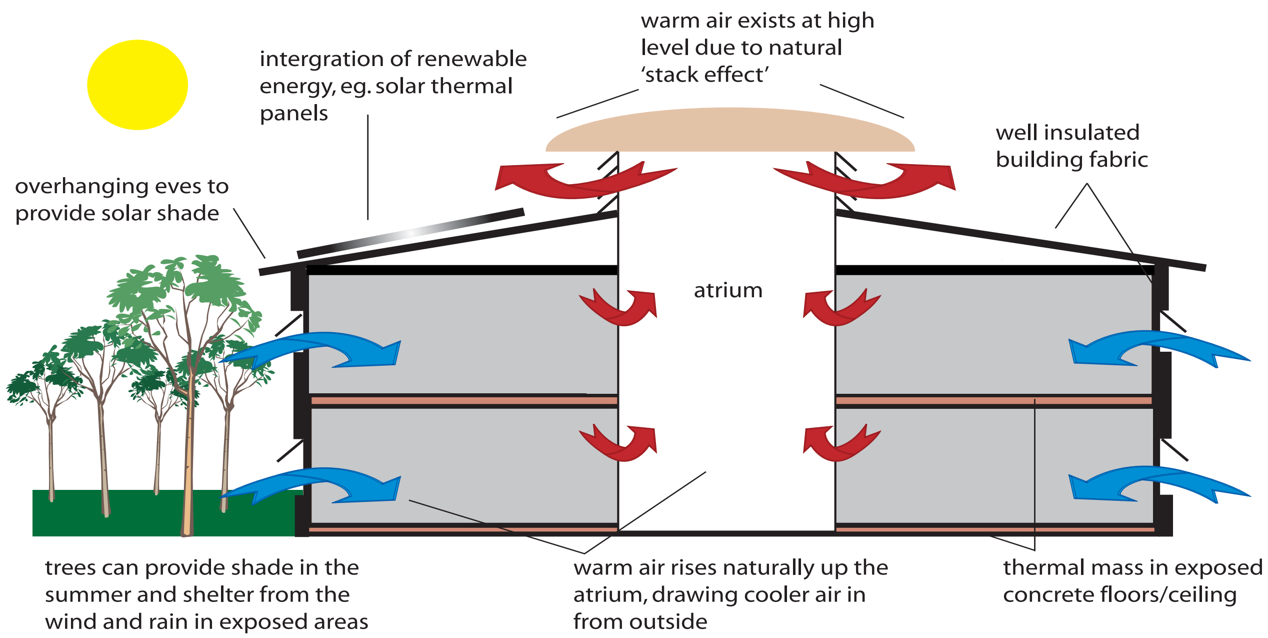
- orientation - sun path around the site, prevailing wind direction and the need for clear views
- reducing the amount of exposed external area compared with enclosed internal volume
- incorporation of atria, courtyards or sunspaces can reduce energy consumption in deep plan buildings
- thermal mass should be fully considered and included or excluded as appropriate, to correspond with activity and occupancy patterns
- landscape design can influence the microclimate (and reduce energy demand) by providing shelter from driving rain and wind
- the ratio of glazing to solid material in the external walls can be optimised to provide benefits from natural light and useful solar gains, whilst avoiding excessive heat losses or gains

Where appropriate and possible, these passive solutions should also be applied to refurbishment projects.

Solutions

reducing demand and energy efficiency (cont'd)

Energy Efficient Design



Solutions

reducing demand and energy efficiency (cont'd)

The materials used in the construction of a building heavily influence its energy performance, in both new build and refurbishment projects.

Insulating the building fabric to a high standard is an effective way of reducing energy use and is also a cost effective solution. U-Values listed in Building Regulations should be considered as a minimum standard and should always be improved on as far as is technically and commercially practicable.

U-Values

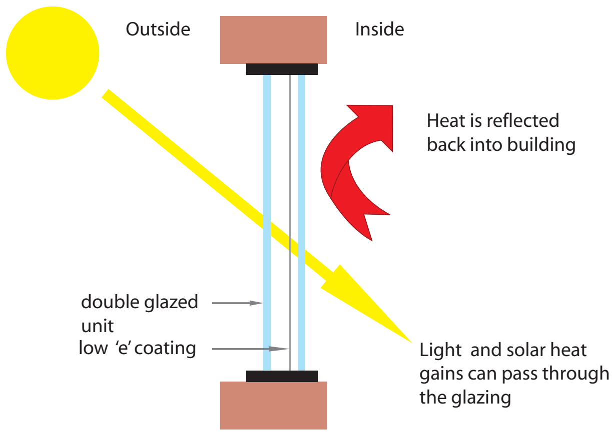
The rate of heat loss through a building element, such as a wall, roof or floor, is termed a "U-Value".

The U-Value is the rate of heat transfer through a building element, subject to the difference between internal and external temperatures. The lower the U-Value, the slower the heat loss occurs, which results in a more energy efficient building.

Previous and current Building Regulations Part L maximum U-Values are given in the table below.

Thermal element	2006	2010
Walls	0.3	0.28
Floors	0.22	0.22
Windows	1.8	1.6
Doors (50% glazed)	2.2	1.8
Door (other)	3.0	1.8
Pitched roof (insulated at ceiling level)	0.16	0.16
Pitched roof (insulated at rafter level)	0.2	0.18
Flat roof	0.2	0.18

The specification of glazing should be carefully considered. Part L 2010 has been updated to correspond with good practice standards (a maximum U-value of 2.0 W/m2K for domestic and 2.2 W/m2K for non-domestic windows). Low-e coatings are commonplace and best practice U-values of 1.4 W/m2K or less are possible using argon gas fills or triple glazing. These are gradually appearing on the UK market.



Energy Efficient Glazing

- low 'e' coating – this is a thin film of metal oxides or semiconductors placed directly onto a pane of glass to reduce heat transfer. In a double glazed unit, the film is applied to the outer surface of the inner pane to reflect heat back into the room. There is virtually no associated visual impact and solar energy still passes into the building.
- argon filled cavity - it is possible to use gases other than air in the cavity of double glazed units. Argon is a typical alternative, which reduces heat transfer due to the properties of the gas.
- solar control glazing, which helps to prevent excessive solar gain, is an options that is also now available from all major window manufacturers.

Solutions

reducing demand and energy efficiency (cont'd)

Air tightness

The majority of heat loss from a building historically occurred via conduction through the walls, roof, windows etc. However, Part L has improved the U-values of new buildings sufficiently such that the heat lost via air movement has become an important area to consider. Warm and cold air moves around a building through both controlled means (ventilation design) and uncontrolled means (infiltration leakage). Infiltration is generally undesirable as it disturbs the ventilation strategy and results in excess heat loss in winter.

Careful detailing of the building fabric and junctions between building elements such as windows and external walls reduces heat losses from air leakage. Targets for air leakage rates should be specified at the design stage and verified during construction through pressure testing, which gives the opportunity to address any problem areas.

Part L 2010 includes a maximum permissible air-leakage rate (for both domestic and non-domestic) of 10 cubic metres of air every hour for every square metre of internal floor area (m3/m2/hr) when tested at an internal air pressure of 50 Pascals (which is achieved using fan blowers). Mandatory testing results evidence that many buildings perform significantly better than this figure, with leakage rates of 5m3/m2/hr@50Pa or less being commonplace.

Reducing air-leakage to 3m3/m2/hr@50Pa or less might introduce the need for mechanical ventilation, to ensure there is adequate ventilation at all times of year. Building Regulations Part F (ventilation) is therefore being updated in alignment with the air-leakage limits in Part L.

Mechanical ventilation is often regarded as an energy intensive solution; however, using mechanical ventilation with heat recovery (MVHR) in a very air-tight building with relatively low cooling loads can provide a very energy efficient solution. For instance, 'PassivHaus' buildings in Europe have completely avoided the need and cost of a conventional heating system by being extremely efficient and installing MVHR. The increase in capital costs can be a few percentage points and it is claimed this can payback many times over within the lifespan of the building. The trade-off is the reliance on the mechanical ventilation system for heat and ventilation throughout the year.

Passive design and solutions

To achieve their energy efficiency benefits, passive solutions for ventilation, heating and cooling usually need to be applied in a controlled manner.

In particular, the controlled use of daylighting, natural ventilation and passive heating and cooling can create a low energy building with reduced environmental impacts, whilst still achieving comfortable conditions for occupants. The following solutions can help achieve this:

Passive solar design is the capture of useful solar gains (heat) to offset heating energy requirements. Atria and sun spaces are typical examples of this approach.

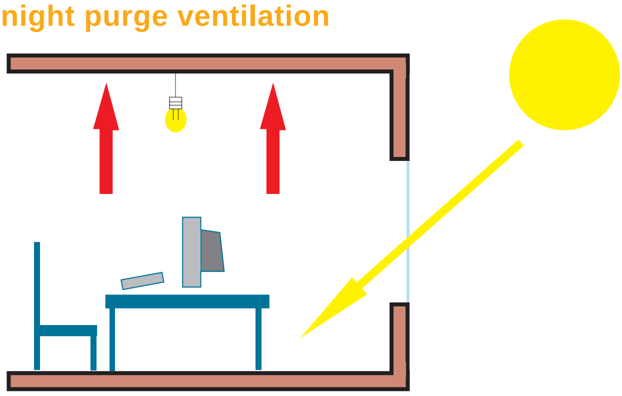
Passive cooling techniques save energy, but also avoid the use of environmentally damaging refrigerants. The most simple and economic approach is the use of night purge ventilation in buildings with exposed thermal mass.

Solutions

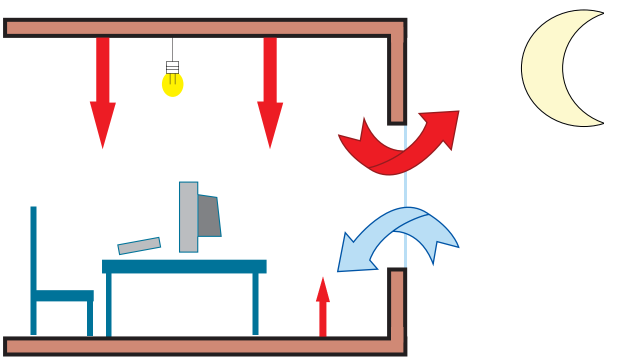
reducing demand and energy efficiency (cont'd)

However, this is not appropriate for every building and alternatives include the use of absorption cooling from waste heat, surface or ground water cooling, ground coupled air cooling, displacement ventilation, and evaporative cooling.

night purge ventilation

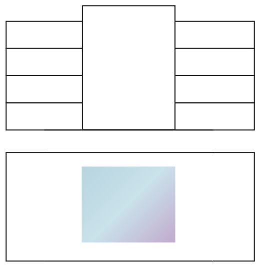


Daytime:
During the day, heat gains from occupants, activities and solar energy are stored in the thermal mass of exposed concrete, stone or brick in the walls, floor and ceilings. This cools the space during the day without using energy.

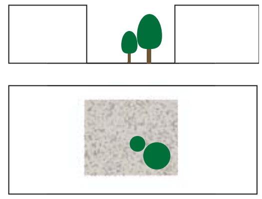


Night time:
At night, the heat that has built up during the day is released from the building fabric and leaves the space through an open window or vent. The space is then cool for the start of the next day. In winter, the vents can be closed and the heat retained.

atria and courtyards



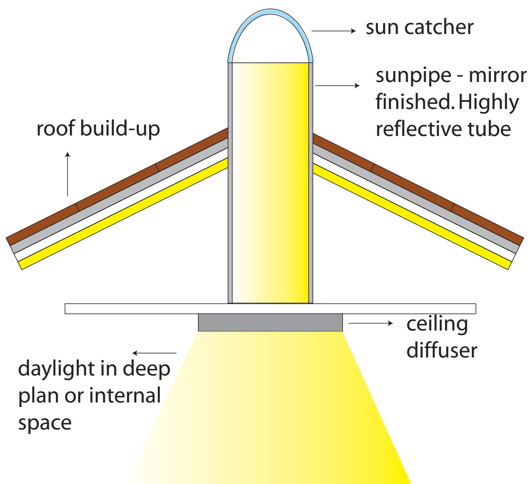
Enclosed glass volume, can be used to bring daylight and natural ventilation into the centre of deep plan buildings.



Void in the middle of a building, or group of buildings, which is open to the elements.

natural lighting

The use of natural light rather than artificial systems can offer significant energy savings. In addition to atria and courtyards, techniques to bring light further into deep plan buildings include sun pipes and solar reflectors. These can be either included during construction or can be retrofitted.

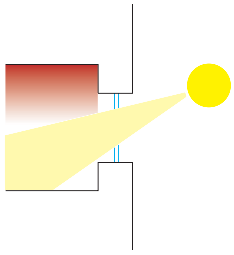


Natural ventilation can be used in situations where the external conditions are free from excessive noise or poor air quality and where the intended use of the space allows. In narrow plan buildings, a typical approach is to use openable windows. In larger spaces, additional measures would be required, for example the use of a 'stack effect' system.

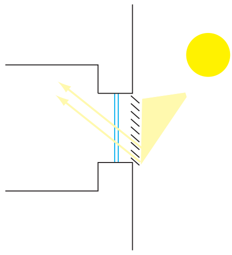
Solutions

reducing demand and energy efficiency (cont'd)

Optimisation of glazed areas - balancing daylight against heat gains and losses



Uncontrolled solar gains can result in overheating.



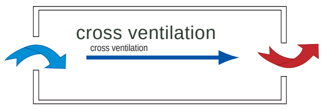
The use of solar shading (shown) or solar control glazing allows diffused light into the space and keeps excessive heat gains out

narrow floor plates (to facilitate natural ventilation)

narrow floor plates: opening on single side

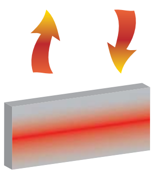
maximum depth of 7m for effective natural ventilation via an opening on one side of the space.

narrow floor plates: openings on opposite sides

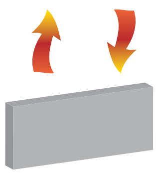


maximum depth of 15m for effective natural ventilation via openings on opposite sides of the space.

thermal mass



Materials such as concrete, brick and stone absorb heat, can help prevent a building from overheating.



Stored heat is released later when required.

Building Services or Active Solutions

Building services equipment, such as boilers, air handling units and lighting systems use energy to provide comfortable internal conditions for building occupants. Where it has been determined that mechanical services are required to provide comfortable internal conditions, efficient plant should always be specified.

Minimum boiler efficiencies are recommended in the compliance guideline documents that accompany Part L: the 'Domestic Building Services Compliance Guide' and the 'Non-Domestic Building Services Compliance Guide'. Both of which are available for download from the Planning Portal.

It should be remembered that the recommendations in these documents are for the minimum acceptable performance and should be bettered where possible. For instance, boilers with an operating efficiency of over 90% are readily available at no or minimal additional cost. The official boiler efficiency database is available on the sedbuk website.

For refurbishment projects, a building services survey will identify services that are underperforming or nearing the end of their life cycle. The opportunity to upgrade them with the most efficient replacements should always be assessed, particularly as making replacements during the refurbishment will almost always be more cost-effective than returning in future years. 'Easy wins' that pay back in a short timeframe, such as additional insulation to existing pipes and ducts or the upgrade of lighting ballasts, should not be overlooked in favour of 'big ticket items' such as new boilers or renewable energy.

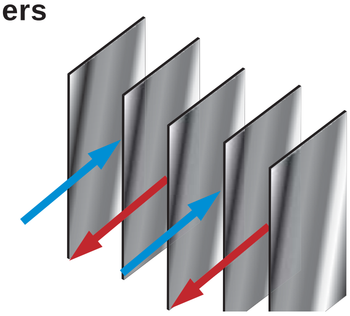
Solutions

reducing demand and energy efficiency (cont'd)

If mechanical ventilation is being used then energy efficient fans should be specified. The building services compliance guides (referenced above) contain minimum performance values for Specific Fan Power, which should be bettered where possible. n air-tight buildings, the use of heat recovery should be investigated, in the form of plate heat exchangers, thermal wheels, or run-around coils, depending on the space availability and ventilation requirements. Note that using heat recovery in buildings that are not air-tight can lead to an increase in energy consumption. Ideally the building services designer would model the fan and seasonal energy consumption under several realistic scenarios.

plate heat exchangers

Air (or water) moving in opposite directions is separated by thin sheets of metal, which allow heat transfer. In this way, heat can be recovered from the exhaust air and used to pre-heat incoming air.



The use of air conditioning and comfort cooling should be restricted to those areas where it is strictly necessary.

Artificial lighting systems for use internally and externally should be as energy efficient as possible. Low energy light bulbs are widely available and use only 20% of the energy of standard bulbs, and can therefore offer significant energy and maintenance/ replacement savings.

For refurbishment projects, services should be upgraded wherever possible. If costs are prohibitive, then more economic measures could be implemented, such as insulation of pipes and ductwork.

Building management systems/controls

The use of an appropriate control system can significantly reduce energy wastage. For example, sensors can be used to detect when there is sufficient daylight in a space and can dim or switch off the artificial lights in response. Variable speed controls on pumps and fans can save a significant amount of energy. This allows building services to use only the energy that is required, rather than continuously operating at full capacity.

A BMS (Building Management System) is a sophisticated network of sensors and controls for the building services. A BMS can be programmed for optimum operation and minimal energy use. BMA are typically installed on larger projects.

Use of a BMS facilitates energy monitoring and can highlight areas of excessive use where savings could be made. In smaller buildings, a simpler approach could be to take regular readings of utility meters and any submeters. However, a benefit of having a BMS is that it frees up time that might otherwise be spent taking meter readings, so more time can allocated to the analysis of the data and to developing a plan for making improvements.

Many of these systems can be retrofitted, although this is not a reason to exclude them at the design and construction stage.

Consideration should be given to the maintenance implications of installing controls and sensors. In a few instances, the additional maintenance and replacement costs associated with e.g. additional sensors and motorised controls (such as daylight controlled blinds) can be greater than the cost savings arising from reduced energy consumption.

Solutions

reducing demand and energy efficiency (cont'd)

refurbishment projects

For refurbishment projects, a building survey will identify services that are underperforming or nearing the end of their life cycle. The opportunity to upgrade them with the most efficient replacements should always be assessed, particularly as making replacements during the refurbishment will almost always be more cost-effective than returning in future years. 'Easy wins' that pay back in a short timeframe should not be overlooked in favour of 'big ticket items' such as new boilers, windows or renewable energy. Easy wins include:

- draught proofing of windows, doors and service penetrations
- insulation to hot or chilled water pipework
- extra lagging to any hot water storage vessels
- sealing of ductwork leakage
- replacement of AC pumps and fans with variable speed DC/EC motors
- upgrade of burners in an existing boiler
- upgrade of light fittings (might also require new ballasts)

renewable and low carbon energy solutions

The use of cost-effective renewable or low carbon (RLC) energy sources reduces the use of conventional energy and associated greenhouse gas emissions. The suitability of renewable energy technologies varies from project to project and is dependent on site factors, location and funding availability. The Hertfordshire Renwwable and Low Carbon Study provided a high level analysis of the feasibility and appropriateness of a range of RLC technology solutions across Hertfordshire, including the solutions presented below. A copy of the RLC study is available to download at www.hertsdirect.org/docs/pdf/h/renewablecarbonreport2010.pdf.

Funding streams for RLC solutions

Increasing the use of renewable energy is important for Government to achieve its national and international targets. Various financial incentives have been recently introduced to enable renewable and low carbon solutions to compete on an economic basis with conventional fossil fuels. These include:

- Energy efficiency grants – discounts on wall and loft insulation and better boilers and controls. Developers and tax-paying building occupiers can gain cash flow discounts on energy efficiency products using Enhanced Capital Allowances (ECA). Existing building owners in Hertfordshire can benefit from the HEEP scheme. www.heepgrant.org/

- Feed In Tariffs (FIT) – incentives for low carbon electricity generation from micro-technologies such as photovoltaic panels and micro-CHP. The utility company pays the consumer for electricity generated. www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/feedin_tariff/feedin_tariff.aspx

- Renewable Heat Incentive (RHI) – to be introduced in late 2011 to incentivise low carbon heat generation from micro-technologies such as solar thermal, biomass boilers and ground source heat pumps. www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/policy/incentive/incentive.aspx

- Renewable Obligation Certificates (ROCs) – tailored towards large energy installations such as wind farms and biomass power plants. The options above are more appropriate for building projects. www.ofgem.gov.uk/Sustainability/Environment/RenewablObl/Pages/RenewablObl.aspx

Solutions

renewable and low carbon energy solutions (cont'd)

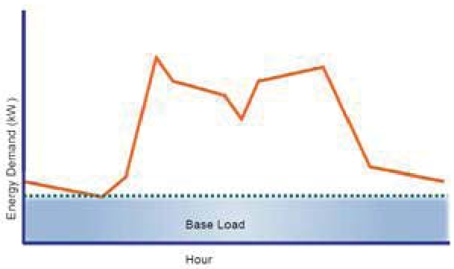
In addition to the consideration of technical and economic feasibility on projects, it is vital to address planning issues associated with the installation, including local environmental and visual impacts.

The following gives an overview of available RLC technologies:

Combined Heat and Power (CHP)

Both electricity and thermal energy (for space heating and/or hot water) are produced from a single energy source, which is typically natural gas. Although not a renewable energy technology, this can be a very efficient use of fuel for some buildings and reduces their overall carbon emissions.

This technology is most efficient when sized to operate at a thermal 'base load'. Both CHP and Biomass boilers perform best when sized to meet the thermal base load. The thermal base load is the amount of heat continuously required by the building. This is illustrated in the following graph showing a generic demand profile:



The base load is that below the dotted line. Peak energy demands result from increased activity and heat requirement throughout the day. Peak demands are typically met by using conventional gas boilers.

Additional systems meet the peaks of demand. This technology is best suited to buildings where there is a heat demand that matches electrical demand, such as process industries, swimming pools, community heating systems and hospitals. Possible variations on the basic system include the addition of absorption chillers, or the use of biomass as a fuel source, although it should be noted that these options will impact on the economics of the system.

Solar thermal

Solar collectors or solar thermal panels generate hot water using the thermal energy of sunlight which is used to offset conventional energy use for provision of hot water for showers and taps. This technology is well established, reliable and typically provides reasonable economic paybacks.

Panels are ideally applied to south facing roofs pitched at 30-45 degrees and can be freestanding or integrated into the roof, with pipework leading into the building and connected to a storage tank with a back-up heating supply.

Solutions

renewable and low carbon energy solutions (cont'd)

Solar photovoltaics

Photovoltaic (PV) panels or tiles convert solar energy into electricity and are available in a variety of styles, colours and materials. Panels can be freestanding, or can be integrated into the south facing facades or roofs of buildings. Systems are best elevated at 30-45 degrees from horizontal. It is also possible to manufacture the PV cells into glass laminates providing the dual benefits renewable electricity and solar shading to internal spaces.

Source: Kawneer

PV tiles are a relatively new form of the technology and have been designed to match the colour and appearance of conventional slate tiles. They therefore can be a good solution to use on buildings within Conservation Areas.

Source: inhabitat.com

The installation of photovoltaic panels has been boosted by the Feed In Tariff for small scale electricity generation and the Green Deal in coming years.

The FIT dramatically reduces the payback period of photovoltaic panels and has enabled very interesting options to emerge such as free PV using third-party finance. The applicability of these options depends on who actually owns the panels once installed.

Wind turbines

Turbines generate electricity from wind and are available in a variety of sizes and scales. Suitable sites must be exposed and have an average wind speed of at least 6 metres per second for a large portion of the year.

Source: Quiet Revolution

There are various options for the configuration of turbines. Small scale models can be roof mounted. Typically they have a rated output of around 1.5kW. Alternatively, small scale freestanding models are available at rated outputs of 15-250kW. These range in size up to industrial scale models that can be seen on wind farms at rated outputs of 2-7 MW.

Turbines are categorised as either horizontal or vertical axis, which relates to the axis the blades rotate around. Horizontal axis turbines are more powerful for their size, although some people consider vertical axis turbines to be more aesthetically pleasing.

When considering wind turbines of any scale it is crucial to consider the difference between the rated power output and the annual average output.

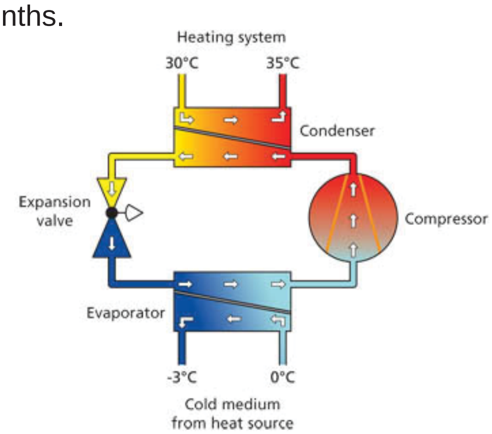
Solutions

renewable and low carbon energy solutions (cont'd)

The rated output is the maximum possible output under perfect wind conditions, which rarely occur during the year. The ratio between this maximum output and the average output over the year is called the 'utilisation factor', which typically ranges between 20-30% for a commercial wind farm. Small scale turbines in an inappropriate location without strong winds have been found to have utilisation factors of less than 10%.

Ground Source Heat Pumps (GSHP) and Air Source Heat Pumps (ASHP)

Heat pumps convert low grade thermal energy from a constant temperature source to higher grade energy that can be used for space heating or hot water (see diagram below). GSHP draw upon low grade thermal energy from the ground or an aquifer and ASHP draw low grade thermal energy from the air outside a building. Both GSHP and ASHP are available in different sizes, for both domestic heating and commercial premises, and the process can be reversed to provide cooling during summer months.



Source: grenergy.co.uk

GHSPs are better suited to new build applications as their efficiency is highest when supplying low temperature distribution systems such as underfloor heating. The use of GSHP is restricted to sites with enough land to either lay pipework in long trenches or with access to a suitable body of water such as a lake or aquifer.

Source: GroundwaterUK.co.uk

The high 'coefficient of performance' or COP of a heat pump means it is an energy efficient technology – for each unit of electricity used to operate the heat pump, around four units of heating energy is produced via a GSHP and 2-3 units of heating energy via an ASHP. The average COP over the course of a year is known as the Seasonal Performance Factor. The CoP of GSHP over a year may gradually reduce if the thermal energy of the heat source (the ground or body of water) is not sufficiently 'recharged' naturally or managed.

Biomass

The burning of energy crops in a biomass boiler to provide heating and hot water is considered to be a 'carbon neutral' process, as the amount of CO2 released during combustion is equivalent to that which is absorbed during the growing cycle of the crops.

Source: building.co.uk

Solutions

renewable and low carbon energy solutions (cont'd)

Biomass fuel can be delivered in the form of either woodchips or pellets. Pellets contain much more energy within them, so a smaller volume needs to be stored between each delivery. Pellets can also be pumped like a fuel between the delivery lorry and the storage hopper, which makes deliveries quicker and more straight-forward. Automated systems feed the fuel through to the combustion chamber from a hopper, which needs to be refilled on a regular basis. On domestic scale systems, this is typically once per week, but depends on the system size and energy demand. Ash also has to be removed approximately once every month.

Both wood pellets and wood chip require space for storage, with woodchips requiring a larger storage volume, and delivery. It is therefore important to consider the storage and delivery access arrangements, for both new build and retrofit projects, early in the design stage if a biomass boiler is to be used.

Although it is always desirable to grow the biomass crops locally, crops are almost always grown by a separate company who sell the crop via fuels agents on the open market. Installers of biomass boilers can advise on local options. The carbon and ecological footprint associated with the cultivation and transportation of biomass fuel is something that should therefore be considered before opting for a biomass solution.

If considering this technology on an urban site, care should also be taken to ensure that the specified equipment meets the requirements of any designated smoke control zone.

District heating networks

The circumstances of new development may make it difficult to utilise on-site RLC solutions to achieve carbon savings.

Therefore, when seeking to achieve low or zero carbon developments, it may be necessary to consider off-site solutions or 'allowable' solutions. A recognised and widely used off-site solution in the UK and Europe is district heating networks.

District heating is an alternative method of supplying heat to buildings, using a network of super insulated pipes to deliver heat to multiple buildings from a central heat source. Heat is generated in an energy centre and then pumped through underground pipes to the building. Building systems are usually connected to the network via a heat exchanger (also known as a heat interface unit (HIU)), which replaces individual boilers for space heating and hot water.

Whilst there is some amount of thermal loss from the heat distribution infrastructure, the aggregation of small heat loads from individual buildings into a single large load allows the use of large scale heat technologies, including the capture of waste heat from industrial processes or power generation, or other large scale heat generation technologies which are not viable at a smaller scale. Of particular interest is combined heat and power (CHP) technologies.

Did you know?

A Department of Trade and Industry commissioned a survey into public attitudes towards renewables in 2006 and found that 85% of the general public support the use of renewable energy. 81% are in favour of wind power and just over three fifths would be happy to live within 5km of a wind farm development.

Solutions

sector specific issues

Different types of buildings have individual requirements in terms of energy use. Some points for consideration are listed below.

residential

Passive systems, such as natural ventilation and daylighting are traditional solutions for domestic buildings. Passive solar design can be particularly effective, with south facing sun spaces giving free energy and pleasant living conditions (note these are not the same as glazed conservatories). These must be design appropriately to avoid excessive solar gain and overheating .

An alternative low energy approach which is emerging from the in fl uence of Scandinavian design is the construction of an extremely well insulated and air tight building with a mechanical ventilation system incorporating ef fi cient heat recovery. This building design is sometime referred to as PassivHaus - www.passivhaus.org.uk

Small scale renewables can be appropriate. Technologies which lend themselves to this particular sector include solar thermal and photovoltaic panels, and biomass boilers. Micro Combined Heat and Power (Micro CHP) units for domestic use are gradually emerging onto the market.

Historic and Listed Buildings also present specific issues and circumstances that need to be taken into account when seeking to implement energy efficient and sustainable solutions.

Listed Buildings and buildings within Conservation Areas are subject to tighter planning controls than the rest of the housing stock in regards to changes to facade and the fabric of the building. Specific guidance on how to achieve energy efficient refurbishment or renovation, and the use of sustainable solutions within historic and listed buildings can be accessed at the links below:

Construction Industry Publications
www.cip-books.com/product-details.aspx?productID=2061

English Heritage publication "Energy conservation in traditional buildings" available at www.english-heritage.org.uk/professional/advice/advice-by-topic/climate-change/energy-conservation/

English Heritage advice on Renewable Energy in historic areas is available at www.english-heritage.org.uk/professional/advice/advice-by-topic/climate-change/renewable-energy/

commercial

Although natural ventilation is typically the preferred choice, it is not always appropriate in commercial developments. If the site is noisy, has poor air quality or high internal heat gains from intensive use of IT or other equipment, it may be more appropriate to seal the building and use a mechanical ventilation system. In this case, measures for energy ef fi ciency should be adopted, such as free cooling or heat recovery.

Solutions

sector specific issues (cont'd)

The use of daylight should be promoted and could be combined with control systems to switch off electric lighting when not required. This is typically a significant form of energy consumption in commercial buildings.

Atria can be particularly effective in this sector and can be used to bring natural light in and encourage air movement in deep plan spaces.

Renewable and low carbon energy technologies can be suitable, although biomass boilers for heat or Combined Heat and Power do not tend to be suitable for most commercial developments due to their intermittent occupancy and relatively low heat demand.

As mentioned previously, it can be beneficial to reduce unregulated energy consumption in operation. IT and media equipment constitutes an increasing proportion of 'unregulated' energy loads, particularly in IT-rich environments such as offices and schools. IT equipment requires electricity to operate and releases waste heat, which can contribute to rooms overheating and becoming uncomfortable, or lead to the use of air-conditioning that requires even more energy to be consumed.

The procurement of efficient IT equipment reduces the energy consumed to run IT devices and helps to avoid the use of air-conditioning. Efficient IT features include:

- Low-energy flat screen displays (LED displays are emerging on the market)
- Thin client devices and virtual desktop management
- Power saving measures and procedures, such as automatic hibernation mode or night-time power-down
- Behaviour change campaigns, such as stickers/posters to encourage 'switch off your PC for lunch'
- Hosting IT server activities at an offsite 'green data centre', whose energy efficiency will be measured as a Power Usage Effectiveness

Education

Passive measures are typically desirable in primary and secondary schools. The activities in further and higher education buildings can require a more intensive services strategy; again efficient equipment should be specified.

Controls systems that turn lights off in unoccupied classrooms, corridors and toilets should be incorporated.

The use of renewable and low carbon energy technologies can be particularly appropriate in education buildings, to raise awareness of energy issues. There are several examples of schools with small scale wind turbines in Hertfordshire and across the UK. It should however be remembered that even educational installations should only go ahead if they will generate a meaningful quantity of energy. The educational benefits can backfire if the energy meters show that little energy is being generated for the money spent on the installation. Furthermore, the visible installation of renewable energy causes some people to consume more energy than they would do otherwise, on the premise that since it is 'free' green energy it can be wasted. This is one example of what is termed the 'rebound effect'.

Health

Renewable and low carbon energy technologies can be particularly appropriate for hospital buildings.

Solutions

sector specific issues (cont'd)

A large roof space is typically available for installations of solar thermal or photovoltaic panels.

Combined heat and power systems lend themselves to this type of building, as there is a high and constant energy demand for both electricity and heat. Ground source heating/ cooling can also be effective where site conditions permit.

Industrial

The approach to energy efficiency on industrial buildings very much depends on the activities being carried out. For example, there may be processes on site which generate waste heat, which could be reclaimed and used to heat other areas of the building.

Large industrial buildings may benefit from using radiant heating rather than convective or warm air heating.

Did you know?

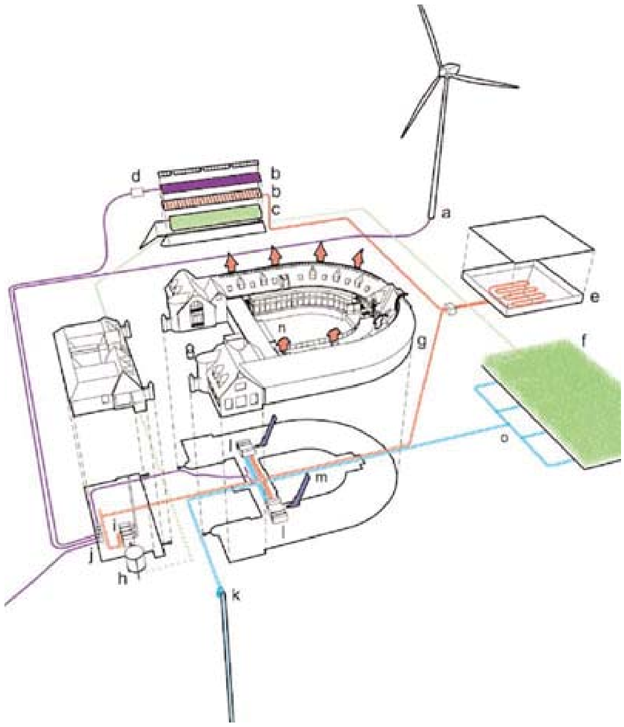
The Enhanced Capital Allowance Scheme encourages businesses to invest in energy saving measures.

Further information can be found at: eca.gov.uk

Building integrated energy efficient and renewable technologies

introduction

Beaufort Court at Kings Langley is the headquarters of RES (Renewable Energy Systems) Group, who converted the original 1930s poultry farm to 2,665m^2 of sustainable office accommodation in 2003. The site originally supplied eggs to the nearby Ovaltine factory, but fell into disrepair after production ceased in the 1960s. The farm originally comprised a horseshoe shaped barn, a coach house and seven hectares of land. The original buildings have been retained and the ground floor has been extended into the courtyard using steel a frame with a green roof.



description

A number of integrated energy efficient and renewable technologies have been incorporated to meet all energy requirements on site, with no associated emissions.

passive solar - Large windows and rooflights are used throughout the development. Deciduous trees have been planted to take advantage of passive solar energy while avoiding overheating.

solar energy - 54m^2 of hybrid photovoltaic solar thermal panels and 116m^2 of solar thermal panels provide both heat and electricity to the offices.

underground heat store - Excess heat in summer is moved to the underground store, which consists of 1,400m^3 of water covered by a floating insulated lid. From autumn through to spring, the stored heat is used to pre-heat the air supplied to the offices via the mechanical ventilation system.

wind turbine - A 225 kW 50m high wind turbine produces twice the annual amount of electricity required on the site, with the excess exported to the National Grid.

borehole cooling - Water is taken from an aquifer via a 75m borehole and is first used to cool the ventilation air supply. The water is then circulated through chilled beams in the offices, before finally being used to irrigate the biomass crops.

biomass - Energy crops are grown and harvested on site to fuel the 100kW biomass boiler.

Cont...

project team

- Renewable Energy Systems (RES)
- Studio E Architects
- Max Fordham LLP
- Esbensen Consulting Engineers
- Shell Solar Energy B.V.
- Netherlands Energy Research Foundation (ECN)

further information

- www.beaufortcourt.com

Environmental benefits
zero carbon emissions
100% on site generation of energy needs

Application
refer to key

Cost
Not available

Other considerations
Not available

Building integrated energy efficiency

introduction

Roche UK's new office complex brings together 1200 employees on a single site in Welwyn Garden City, Hertfordshire. It provides 21,800m^2 of modern work space, named 'Hexagon Place' to reflect the company's hexagonal brand. It has been designed to the highest environmental standards, in particular to keep CO_2 emissions to around 26% below current Building Regulation (2002) limits.

description

From the outset, the company specified a building with a low environmental footprint. The project team used a wide range of established and cutting edge sustainable technologies in its design. These include:

thermal zoning - The building is split into a number of separately controlled thermal zones which can be individually adjusted using the automated Building Management System (BMS).

high performance cladding - Sustainably certified (Forestry Stewardship Council) oak timber cladding, blocks unwanted heat gain in the summer and minimises energy loss in winter.

building air-tightness - The whole building was tested for air tightness by the BRE, and significantly beat (current) industry standards. This will offer potentially huge energy savings over the life cycle of the building.

borehole cooling - 120m deep boreholes

reject the buildings' unwanted heat gains into the underground aquifer providing near free cooling. Combined with environmentally friendly ammonia and propane chillers, the cooling system for the site has a very low global warming potential.

water minimisation - Flow regulators and a leak detection system reduce water consumption.

sub-metering - A number of sub meters around the building help monitor and manage water and energy inputs in strategic areas.

Roche also endorses a green transport policy to further reduce CO_2 emissions, by encouraging staff to use sustainable methods of travel. The facility achieved a BREEAM score of 10 out of 10 and an 'Excellent' rating.

project team

Building Design Partnership (BDP)
Roche

further information

welwyn.corporate_affairs@roche.com

Environmental benefits

BREEAM Excellent reating
CO_2 emissions 26% lower than 2002 Building Regulation limits
Low global warming potential
Reduced water consumption

Cost

c £75m

Application

refer to key

Other considerations

Not available

Low cost energy saving measures

introduction

Francis Combe School is a secondary school attended by 718 students. It was built in the 1950s and has a system-built structure with a number of wings that are one, two and three storeys in height.

The school was approached by the School Standards and Curriculum Division of Hertfordshire County Council to apply for the School Energy grant. The school Standards and Curriculum Division identified a number of improvements and new energy saving opportunities that would be suitable for the school and reported on approximate costs and annual savings.

description

Energy saving measures installed include new boiler controls, thermostatic radiator valves, electronic room thermostats, replacement of electronic space heating and low energy lighting.

Anticipated savings per year are 177,856 kWh or 10.96 tonnes of carbon. This equates to £1,550 or 6.5% of the total fuel bill. The payback time is 4.8 years.

project team

Francis Combe School
Hertfordshire County Council

further information

www.est.org.uk
www.franciscombe.herts.sch.uk

Environmental benefits

improved operational energy efficiency

Cost

total cost of measures was £7,438, with a School Energy grant of £3,000 and a cost to the school of £4,438.
6.5% reduced fuel bill

Application

refer to key

Other considerations

Not available

On-site renewable energy generation

introduction

The Ford Dagenham Diesel Centre is a £325 million investment manufacturing unit for diesel engines at Dagenham in Essex. The facility was opened in 2003 and was constructed on a 500 acre site. Ford came to the conclusion that there was a good business case for creating London's first wind park as part of the regeneration of Dagenham, generating 100% cost-effective 'green' electricity to help power the facility's Clean Room Assembly Hall.

description

Ford consulted with the British Wind Energy Association (BWEA) and worked with Ecotricity (wind power company) as project partners. Ecotricity carried out the feasibility study and environmental assessments and produced the planning application. This work included consulting with local communities, the local airport and the Royal Society for the Protection of Birds.

The installation included two 1.8MW wind turbines located on different sides of the site. The turbines generate an annual electricity output of 6.7GWh, which is sufficient to meet 100% of the electricity needs of the Centre. German super-quiet E66 Enercon turbines were installed, with a hub height of 85m and a blade length of 35m.

The turbines were funded through a 'Merchant Wind Power' arrangement , where Ecotricity meets the capital costs, installation and maintenance of the turbines and Ford has a contract to buy the electricity produced.

The two wind turbines will result in annual emissions savings of:

- Carbon dioxide: 5,762 tonnes
- Sulpher dioxide: 67 tonnes
- Nitrogen oxide: 20 tonnes

project team

Ford Motor Company
Ecotricity

further information

www.ecotricity.co.uk
www.est.org.uk/practicalhelp

Environmental benefits

100% on-site generation of energy needs

Cost

Electricity was supplied to Ford at a reduced rate. This was possible for the following reasons:
- distribution costs were cut
- Ford was a guaranteed purchaser of green electricity
- exemption from the Climate Change Levy

Application

refer to key

Other considerations

Not available

Low-tech energy efficient housing

introduction

Gallions Ecopark is an affordable housing scheme of 39 houses at Thamesmead, developed by Gallions Housing Association. The homes contain a combination of cost effective and practical energy efficiency design solutions that are easy to use and maintain.

The aim was to show that energy efficient sustainable housing need not be high-tech and can be built within realistic budgets. The houses achieved an EcoHomes Excellent rating and a SAP rating of 100.

description

Energy efficiency measures include:

- low U-value materials, e.g. double glazed, argon filled windows of 1.1W/m2K
- roof mounted solar collectors
- internal and external energy efficient lighting
- underfloor heating and mechanical ventilation in a few homes
- a high level of air tightness
- sunspaces behind south facing elevations for a few homes

Monitoring was achieved through installing a set of meters including humidity meters, electricity meters, heat metering (of the solar panels and gas boiler) and water meters. Monitoring has shown the following:

- all homes showed a reduction in gas consumption, the homes with the south facing sun space achieving the highest reduction of 32%

- the airtightness levels outperformed Building Regulation specifications

project team

Gallions Housing Association
Wilmot Dixon
PRP Architects and Project Services
Fulcrum Consulting

further information

www.gallionsecopark.co.uk
www.gallionsha.co.uk

Environmental benefits

overall energy consumption is 26% lower than a standard terraced house and is EcoHomes Excellent

Application

refer to key

Cost

Not available

Other considerations

Not available

Building integrated energy efficiency

introduction

Construction of Great Notley Primary School in Essex was completed in 1999. The building has since won awards for an innovative approach to low energy design.

The £1.2 million development relies heavily on the use of passive energy systems throughout. The environmental impacts of the school are further reduced by the extensive use of recycled materials and sustainable materials such as timber cladding and a green roof.

description

The building form has been designed to allow all spaces to be day lit and naturally ventilated. The roof design incorporates clerestorey windows which enhance both air movement and light in the classrooms and assembly areas.

The façade design includes solar shading devices such as brise soleil and large overhangs to minimise overheating, thereby avoiding the need for cooling.

The external envelope has been designed to include a high level of insulation within a breathing wall construction. This results in low heat losses and a reduced energy requirement for heating the school.

The sedum roof also provides a high level of insulation in the roof and in addition provides thermal mass to modulate any heat gains from internal activities, or associated with the daylighting strategy.

project team

Essex County Council
Alford Hall Monaghan Morris
Atelier Ten

further information

www.atelierten.com/ourwork/greatNotley.asp

Environmental benefits

high levels of natural light
energy consumption comparable with 2006 Building Regulations

Cost

Not available

Application

refer to key

Other considerations

Not available

Building integrated renewable energy

introduction

Co-operative Insurance Services (CIS), the insurance sector within Co-operative Financial Services (CFS), is based in a 13-storey building on Portland Street in Manchester, which was originally constructed in 1962.

As part of an internal environmental policy and an awareness of climate change impacts, CIS decided to retro-fit micro wind turbines on the roof of the building to provide a small part of the electricity demand.

description

CIS installed 19 turbines on the roof of their headquarters building. This is the largest ever commercial application of micro-wind turbines in the UK. The wind turbines will produce 44,000kWh of renewable energy each year, which is equivalent to 3% of the annual energy demand of the building.

Each of the turbines has a height of approximately 3m and is rated at 1kW. The wind speed on the roof of the 13 storey building is higher and less turbulent than at ground level, which results in ideal operating conditions for the turbines. Under these conditions, the payback on each of the £2,500 turbines is expected to be 4 – 5 years.

CIS has also recently started to reclad a tower in at their headquarters building with solar panels. This will be Europe's largest vertical solar array, with all three sides of the 25 storey building's service tower clad in energy generating solar panels. 7,244 solar photovoltaic panels, designed to convert daylight into electricity, will create 180,000 units of renewable electricity each year. This is enough energy to make 9,000,000 cups of tea.

project team

Co-operative Insurance Services
Windsave

further information

www.cis.co.uk
www.windsave.com

Environmental benefits

3% on-site renewable energy generation

Application

refer to key

Cost

£2,500 per turbine
4-5 year payback

Other considerations

Not available

Building integrated energy efficiency and renewable technologies

Case study - Kingsmead Primary School, Northwich, Cheshire

introduction

Kingsmead Primary School in Cheshire opened in 2004 and provides places for 150 pupils within a new housing development. Sustainable design issues were taken into account throughout the design and construction process, which has resulted in a low energy building and a positive learning environment for the pupils.

description

The principles of the energy hierarchy (be lean, be green and be clean) were observed in the building design. Energy demand has been reduced through the orientation and siting of the building. It has also been reduced through the use of passive energy systems such as daylighting and natural ventilation and a super-insulated building envelope.

‘Green’ energy technologies have been adopted as follows:

solar photovoltaics- A 5 kW peak system is expected to supply 15% of the school’s annual electricity demand.

solar water heating- Solar panels are mounted on an A-frame on the south facing roof. The water heated by the system will be stored in a low-pressure heat store, before being heated further by the biomass system.

biomass- The biomass boiler meets around 60% of the heat demand of the school. The fuel supply consists of waste woodchip from a local source.

The use of these renewable energy systems has resulted in a reduction of annual emissions by approximately 5 tonnes of CO_2 each year.

project team

Cheshire County Council
Willmott Dixon
White Design Architects
Mander Strucutral Design
Arup Engineering

further information

www.est.org.uk/practicalhelp
www.cheshirerenewables.org.uk/schools.htm
www.white-design.co.uk

Environmental benefits

60% heat demand met by renewable energy
15% power demand met by renewable energy

Application

refer to key

Cost

Not available

Other considerations

Not available

Building integrated energy efficient and renewable technologies

introduction

The Devonshire Building is a flagship environmental building for the University of Newcastle and is home to laboratories and office spaces for the University's multidisciplinary Environmental and e-Science Research Centre.

From the outset of the project it was decided that the building should demonstrate and achieve the highest possible environmental and sustainable design targets. The building has high quality finishes and has an annual energy demand approximately 30% lower than the UK best practice targets at the time of construction in 2004. It was the first university laboratory building to achieve a BREEAM Excellent rating.

description

Within the building, there are a number of different spaces, ranging from the closely controlled laboratories to a central atrium with passive environmental controls. The following measures have been incorporated to reduce the energy load of the building:

façade engineering - The façade is highly glazed, which enhances the availability of daylight in the building. To avoid overheating and an excessive cooling load, motorised shading has been included.

heating and cooling - Cooling is provided via an active beam system, using free cooling from a thermal water storage tank within the ground via a series of plate heat exchangers. Heat from the office spaces and cold rooms is rejected into a 40,000 litre geothermal water tank. A conventional chiller is provided as a back-up and the heating plant is fully condensing and utilises low water temperatures to maximise heat recovery.

lighting - Movement and daylight sensors are used in the lighting controls to minimise waste.

natural ventilation - The office areas have automatically controlled openable windows for ventilation and for night purge cooling.

photovoltaic panels: - 184m^2 of PV cells have been installed on the roof and have a peak output of 25kW.

BEMS (Building Energy Management System) - A fully functional, graphics driven BEMS has been provided to facilitate fully automatic control of the building and its systems.

project team

University of Newcastle Upon Tyne
The Dewjo'c Partnership
WSP
White Young Green
Shepherd Engineering Services

further information

www.greenspec.co.uk/html/design/imgbank/devonshire.html
www.heepi.org.uk/buildings/buildings_resources.htm
www.battlemccarthy.com/projects/education/devonshire.html
www.estates.ncl.ac.uk/projects/devonshire/index.php

Environmental benefits

BREEAM Excellent
30% lower energy consumption than construction best practice at 2004

Application

refer to key

Cost

Not available

Other considerations

Not available

Ultra low energy housing

introduction

The Hockerton housing project is the first earth-covered, self-sufficient housing development. Self-built by the occupants, who are committed to living in a way that is environmentally sensitive, the development has no need for space heating and uses less than 25% of the energy of a conventional house.

description

The Hockerton development consists of a terrace of five ultra-low-energy houses incorporating a range of energy saving measures that have completely eliminated the need for space heating. The most important features are:

building orientation - The orientation of the houses allows for maximum winter solar gain, as they have a south-facing conservatory running the full width of the dwellings.

building fabric - Concrete is used extensively, which provides thermal mass to absorb and release solar heat gains. The houses are wrapped in 300mm insulation and have triple glazing to minimise heat losses. An earth covering to the north further reduces heat losses.

space heating and hot water - Space heating is provided purely through the passive solar arrangement, using large areas of south facing glazing and thermal mass. Domestic hot water is provided by an air-to-water heat pump located in the conservatory, which is connected to a storage cylinder.

ventilation - In summer, houses are ventilated through a large opening light in each bay, adjacent to a corresponding light in the conservatory roof. In winter, air is extracted from the bathroom, kitchen and utility room. This is passed through a heat exchanger to warm incoming fresh air.

renewable energy - The development has two wind turbines, which together are capable of generating 10kW of power and are estimated to produce 24,000 kWh annually.

project team

Robert & Brenda Vale
Occupants of Hockerton Housing Project

further information

www.bbc.co.uk/nottingham/360/where_to_go/hockerton_housing_project/tour_04.shtml

www.hockerton.demon.co.uk/virtualtour/VT-BB-CRN.html

Environmental benefits

energy consumption is less than 25% of that of a conventional house

Application

refer to key

Cost

Not available

Other considerations

Not available

Healthcare combined heat and power

introduction

The Western General Hospital cares for more than 150,000 patients every year and it provides specialist acute health care. It has 800 acute beds and 34 day beds.

description

The Hospital has an Energy Services Agreement with Scottish and Southern Energy Plc who owns, operates and maintains the energy plant and equipment. This plant and equipment provides all the heat and power required by the hospital. To implement this, Scottish and Southern Energy has installed new boilers and a Combined Heat and Power (CHP) system to generate electricity, steam and hot water efficiently.

Hospitals generally have large continuous heat and power demands and CHP is an ideal solution. A gas fired reciprocating engine CHP was installed after the current and projected heat and power loads were evaluated. The CHP system generates approximately 1MW of electricity which is fed into the main supply to the Hospital's high voltage ring main. The system is sized to match the site's base load and can therefore be run at full output all year around.

Waste heat is recovered from the engine cooling and lubrication systems and is used to generate hot water at approximately 90°C. This is supplied to the hospital plant rooms, providing heating and domestic hot water.

The on-site generation of hot water, steam and electrical power allows a system efficiency of approximately 77% to be achieved. This is a

significant improvement over traditional grid imports and boiler operation, and produces primary energy savings of more than 30%. The system generates approximately 7.8GWh of electricity annually, producing a net carbon saving of approximately 800 tonnes / annum.

project team

Western General Hospital
Scottish and Southern Energy Plc
Cadogan Consultants

further information

www.scottish-southern.co.uk
www.actionenergy.org.uk
www.chpa.co.uk

Environmental benefits

30% energy savings

Application

refer to key

Cost

Not available

Other considerations

Not available

Further information and references

1	Part L Building Regulations: Conservation of Fuel and Power DCLG (Department for Communities and Local Government) Eland House Bressenden Place London SW1E 5DU Telephone: 020 7944 4400	www.communities.gov.uk
2	Planning Policy Statement 22: Renewable Energy DCLG Eland House Bressenden Place London SW1E 5DU Telephone: 020 7944 4400	www.communities.gov.uk
3	Hertfordshire WasteAware Telephone: 08457 425000	www.wasteaware.org.uk
4	Energy White Paper: Our energy future – creating a low carbon economy Department for Trade and Industry Response Centre 1 Victoria Street London SW1H 0ET Telephone: 020 7215 5000	www.dti.gov.uk/energy/whitepaper/ourenergyfuture.pdf
5	The Carbon Trust – extensive database of best practice guidance and information on grants and loans (non domestic buildings) 3 Clement's Inn London WC2A 2AZ Telephone: 0800 085 2005	www.thecarbontrust.co.uk
6	The Energy Savings Trust – extensive database of best practice guidance and information on grants and loans (domestic buildings) 21 Dartmouth Street London SW1H 9BP Telephone: 020 7222 0101	www.est.org.uk

Further information and references

7 Hertfordshire Renewable Energy Strategy
Environment Department
Hertfordshire County Council
County Hall
Pegs Lane
Hertford SG13 8DQ
Telephone: 01438 737555
www.hertsdirect.org/yrccouncil/hcc/env/plan/hres/

8 London Energy Partnership: Integrating renewable energy into new developments: Toolkit for planners, developers and consultants
Greater London Authority
City Hall
The Queen's Walk
London SE1 2AA
Telephone: 020 7983 4000
www.london.gov.uk/mayor/environment/energy/docs/renewables_toolkit.pdf

9 Green Consumer Guide - energy efficient white goods database
www.greenconsumerguide.com/whitegoods.php

10 Building Services Research Information Service
BSRIA
Old Bracknell Lane West
Bracknell
Berkshire RG12 7AH
Telephone: 01344 465600
www.bsria.co.uk

11 Construction Industry Research & Information Association
CIRIA
Classic House
174-180 Old Street
London EC1V 9BP
Telephone: 020 7549 3300
www.ciria.org.uk

12 Royal Institute of British Architects
RIBA
66 Portland Place
London W1B 1AD
Telephone: 020 7580 5533
www.riba.org/go/RIBA/Home.html

Further information and references

13	Chartered Institute of Building Services Engineers CIBSE 222 Balham High Road Balham London SW12 9BS Telephone: 020 8675 5211	www.cibse.org
14	Building Research Establishment BRE Garston Watford WD25 9XX Telephone: 01923 664000	www.bre.co.uk
15	Climate Change Levy	www.defra.gov.uk
16	Association for the Conservation of Energy	www.ukace.org
17	British Wind Energy Association	www.bwea.com
18	Low Carbon Building Programme	www.est.org.uk/housingbuildings/funding/lowcarbonbuildings
19	Combined Heat and Power Association	www.chpa.co.uk
20	Combined Heat and Power Quality Assurance	www.chpqa.com
21	National Energy Foundation	www.nef.org.uk
22	Code for Sustainable Homes DCLG Eland House Bressenden Place London SW1E 5DU	www.communities.gov.uk
23	Building a Greener Future DCLG Eland House Bressenden Place London SW1E 5DU	www.communities.gov.uk