Sustainability
Simple steps to better homes
Achieving a premium for green homes

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The benefits of ‘going green’ are clear from an environmental perspective. The earth’s resources are limited and we are using more than the earth can regenerate. In 2016 we used around 1.6 times the earth’s resources. However, there is evidence and research to suggest this is not necessarily the case: in the UK, research conducted by housebuilder Redrow found that 63% of home buyers want to purchase a green, environmentally friendly home, and 82% would pay more for a home that allows them to fulfil this ambition to ‘go green’.

The study found that more than 25% of buyers would pay at least a 6% premium for a home with sustainable features. Further, a recent UK report by the Department of Energy and Climate Change (DECC) found that making energy saving improvements to a home ‘could increase its value by 14% on average and up to 38% in some regions’.

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Energy

According to the Department for Business, Energy & Industrial Strategy (BEIS) the domestic (residential) sector currently accounts for 29% of all the UK’s annual energy consumption. Reducing our use of power and fuel in the residential sector will help drive a sustainable lifestyle and help meet our environmental targets and energy conservation.

Since 1970 there has been a 7.4% increase in domestic energy consumption across the UK. However, this has come at the same time as a 16% increase in population. Domestic energy consumption has therefore actually declined on a per capita basis. BEIS suggests that a reduction in energy consumption since the 1970s has come from some key changes within households, including the reduction of hot water tanks in homes, the increased use of more efficient boilers, double glazing, cavity wall insulation (73% of all homes have cavity wall insulation in 2015 compared with just 4% in 1976) and loft insulation (98% of all homes with a loft have loft insulation). All of these small measures have helped energy conservation over the last four decades. However, since 2008 there has been a noticeable and marked decrease in domestic consumption, down 18.6% from 2008’s figure. This decline is probably attributable to more energy efficient appliances and white goods, together with the decreased use of such goods on account of high energy prices. However, the simple fact is that many analysts don’t fully understand why domestic energy consumption has decreased by such a large amount.

The declining use of domestic energy consumption over time has been largely helped by households becoming more educated, aware and indeed more financially conscious about the high cost of energy (by some estimates the cost of fuel bills are the motivation behind 95% of people’s support for lower carbon housing).

Given that space and water heating account for over 80% of energy consumption, it is appropriate to examine the ways in which we can make efficiencies in this area.

Small-scale home improvements affecting the fabric of a home can be one of the most effective ways of reducing energy consumption.

Heat loss is one of the biggest contributors to energy consumption; about 35% of the heat escapes through the walls and gaps in and around windows and doors and a further 10% is typically lost through the floor. Thus insulating underfloor should be considered. 25% of heat loss can also occur through the roof, so insulating a loft is also crucial. In the same vein, the insulation of cavity wall space prevents convection and heat loss through the walls and inevitably leads to greater energy conservation and future cost savings. Lastly, windows are also part of the home’s thermal envelope and suitably insulating them as well as solid wall (as opposed to cavity wall) is important. Installing double or even triple glazed windows can prevent energy loss, although it can sometimes be costly and doesn’t always supply a high return on investment. Sometimes simply draught-proofing the window or door gaps can produce good, quick-win results against heat loss. The most effective method for ensuring against and minimising heat loss in a home is by concentrating on the design of the envelope or fabric of the building. This is discussed in more detail in ‘Fabric First’ on page 9.

Replacing and upgrading a boiler to a more energy efficient standard or hanging thick curtains to further insulate against draughts are also ways in which the end user may easily consume less energy.

However, these types of improvements have already reached the peak of the energy efficiency they are now able to achieve and most users who can do this, will have already done so, particularly given the recent rises in fuel prices and a drive to reduce these costs.
Solar Energy

The use of the sun is another way in which the built environment can harness the natural environment, creating and conserving energy in a sustainable way. Orienting a house or development such that it has maximum exposure to sunlight in the winter (providing solar gains) and minimal exposure in the summer (attention to shading during building design) is one such way that the sun’s energy can be used effectively. Good sun exposure also naturally reduces the need for artificial lighting.

Solar panels on roofs are another way of utilising the sun’s energy to maximum benefit. A photovoltaic system employs solar panels (solar PV) which convert sunlight to energy without producing pollution. The amount of power output of solar PVs is dependent upon direct sunlight unless a tracking system is used whereby the panels can adjust their position in line with the sun’s direct rays. Because of some concerns about the aesthetic appearance of solar panels, new technologies have recently been developed whereby roof tiles now have solar panels (solar PV) which convert sunlight to energy without requiring the grid whereas most solar technology currently requires some form of grid back-up. Both Tesla and Daimler (Mercedes Benz) have announced the production of such battery packs for home-use and indeed Daimler are in the process of building a large manufacturing facility in Germany for the sole-purpose of producing these lithium-ion batteries for home and car use.

As solar energy and solar panels are widely used, the cost savings have been extensively researched. One such study for the US Department of Energy looked at 23,000 home sales across eight states over a 12 year period. They found that 4,000 of those homes sold had installed solar PV systems for which buyers paid a premium of around $15,000 (USD) compared with a similar home without a solar panel system. A further study conducted in California found that the presence of a solar system led to a premium over comparable homes without a solar PV system, averaging around $5.50 per wattage or a premium of approximately $17,000 for a 3,100 watt solar PV system.

Other ‘low carbon’ heating technologies include air source heat pumps and ground source heat pumps. An air source heat pump absorbs heat (energy) from outside a building and releases it inside the building as hot air, water-filled radiators, underfloor heating, etc. They can be used as a space heater or cooler using the same system. Meanwhile a ground source heat pump (or geothermal heat pump) transfer heat (energy) from the ground and transfers it back into a building. Both types of heat pumps have higher capital costs than conventional heating and cooling systems, but they save on annual fuel bills and ongoing operation costs. There is however some controversy over whether these types of systems are in fact any more energy efficient than a traditional gas-boiler system. Heat pumps contain fluorocarbons (refrigerants) which contribute to global warming as carbon emissions.

Water

Application of a rainwater harvesting system in an urban setting has many advantages including reducing demand on the mains supply and enabling groundwater levels to be sustained. However, they can also help to mitigate flooding and generally provide water during times of restriction and drought. Rainwater harvesting systems are becoming much more common in many rain-deprived areas and in Santa Fe, New Mexico USA a rainwater harvesting system is mandatory in all new dwellings.

The installation of a green roof can not only insulate the building (against energy loss and outside noise), but also reduce storm-water runoff and the absorption of rainwater. Particularly in heavily built-up urban areas, green roofs can form part of an effective sustainable drainage solution by reducing run-off at peak times, and lessening the need for underground drainage at site boundary level. In the summer, it has been found that a green roof can retain between 70-80% of rainwater.

A green roof system may however require an overall design rethink: if the scheme involves heavy mechanical and electrical elements situated on or within the roof, they will need to be relocated or rethought altogether. Nevertheless, including a green roof in any new development can also enhance amenity value. In an increasingly built-up and dense urban environment there is less available space for gardens or places to enjoy open space. Therefore in order to provide outdoor green space in accessible areas this is increasingly becoming the roof space.

There are of course other areas within the home to make simple water efficiencies. Water efficient taps, toilets, and shower heads have been on the market for some time, and indeed the take-up for such products is high among modern homeowners and builders alike. The initial cost outlay for such items compared with the environmental benefit and long-term financial savings more than makes up for the small nuisance of changing to new fixtures. Most modern new builds will come with these already installed.

Finally, greywater recycling is something which is also now being more and more considered as part of a home design. Used water is captured and reused in other ways, such as irrigation or garden watering. However, it is still unclear whether the energy employed in installing and using these systems outweighs the environmental benefit.

The development of rechargeable lithium-ion battery packs for in-home use will boost the usage of solar energy.

These batteries, mounted to a wall, can store electricity generated from solar panels and tiles thus taking the home even further into the realms of ‘off-grid’, with little to no reliance on traditional electricity coming into the home. The battery can power a household entirely without requiring the grid whereas most solar technology currently requires some form of grid back-up. Both Tesla and Daimler (Mercedes Benz) have announced the production of such battery packs for home-use and indeed Daimler are in the process of building a large manufacturing facility in Germany for the sole-purpose of producing these lithium-ion batteries for home and car use.
Building materials

The various types of material used in building new homes or retrofitting a property are also an important component to working towards a green property. This includes the use of low environmental impact or environmentally friendly materials such as reclaimed timber, recycled plastic and glass or natural products such as bamboo, cork, straw, linsen and linoleum. The benefit of the latter in that they are also rapidly renewable resources and can be used for such things as flooring and cabinetry.

Rapidly renewable resources are non-petroleum based and have harvest cycles under 10 years.

The local sourcing of building materials has a much lower environmental impact than sourcing from areas where transportation of the goods becomes an environmental concern. While locally sourcing some materials is not always possible, it may be worth researching nearby recycled materials. The use of recycled materials also goes a long way to reducing our environmental impact and reduces landfill capacity. The consideration of the life cycle of materials and products used in the building and their impact on the environment is also becoming increasingly important. Life Cycle Assessment (LCA) is a method to evaluate this life cycle ‘from cradle to grave’ and attempts to identify the environmental effects of products during their lifetime. This approach to building raises awareness of products which are being used and what their wider impact on the environment is, during the entire life of the building.

The use of non-toxic finishes, paints, floor finishes and adhesives are a further component of a ‘green’ home. These types of finishes are not only better for the environment but better for the end-user’s health and well-being, not to mention the health and well-being of those who are installing and working with the materials. While there has been a move towards safer, less toxic paints over the last forty years, most paint is still based on petrochemical solvents. Nevertheless it is possible to find and source those which are not based on petrochemical solvents.

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A fabric-first approach to building design involves using materials and design to maximise the performance of a building. Construction methods and materials used should aim to:

- Maximise air tightness
- Create high levels of insulation
- Make good use of natural light and solar gain
- Use the building’s thermal mass to advantage

Air tightness – the fewer gaps in the building’s envelope then the less heat is lost to the outside world. Prefabricated systems which are built off-site (closed panel timber frame and structural insulated panels, etc.) are the most preferred method as the risk of workmanship errors is minimised. With high levels of air tightness, a building will need a mechanical ventilation system, as discussed earlier.

Insulation – the more insulation you can incorporate into the structure than the more heat will be retained. This includes insulating the roof, floors and walls, while also installing double and triple glazing to the windows. It is important to note here that overheating can become an issue if ventilation is not properly addressed. This can be overcome by using such systems as a mechanical ventilation heat recovery unit (addressed earlier).

Natural light – This includes orienting the building in such a way that you are optimising the sunshine to warm up the house during the winter, and equally provide shading during the summer months. The use of roof lights and sun pipes can also reduce the need for artificial lighting.

Thermal mass – A building’s materials, such as brick and concrete, can absorb warmth provided by the sun during the day and then release it into the home during the right time. Used correctly, this type of thermal store can reduce energy consumption greatly.

One of the fundamental attractions of this type of design, apart from low energy loss and the resultant low energy bills, is the fact that it doesn’t overly rely on technical elements or design. In other words, this type of system can’t really ‘break’ and is not difficult for the end-user to employ or work with. That is why those techniques are now being used more and more in the social housing or housing association new build sector – users do not need much training or guidance on how to use the green elements meaning that a change of tenant or resident will not compromise the green design or mechanics.

Highly sustainable buildings designed using a fabric-first approach aim towards a ‘Passivhaus’ standard. While this is often difficult to achieve, it is considered the gold standard for highly efficient green homes and is becoming more widely used here in the UK and worldwide.

“By focusing on the building fabric we’ve really solved a lot of the problems before they’ve arisen.” Alan Clarke, Passivehaus services engineer.
Operations and maintenance

The operations and maintenance of a sustainable green home are not as easily measurable or identifiable as many of the systems and issues we have discussed above but they are no less important. The maintenance of a system, how easy it is to use, preserve, fix and repair are nearly as important as implementing the measures in the first instance. Education and training for the end user are of utmost importance. The home owner or user needs to know how everything works for all techniques and systems to run properly, smoothly and to their utmost efficiency. Some renewable technologies and their control interfaces are incredibly complex and complicated to use. Air source heat pumps for example need detailed written instructions by the installer for the user, as well as being shown in detail how to use the system and to check that it is working properly. Solar panels require regular upkeep and general cleaning in order to work optimally. These types of maintenance and complexity issues can sometimes lead the end-user to giving up on the technology and turning it off. In contrast however, new technologies such as smart apps and app-based control interfaces are attempting to address these over-complicated issues and are much simpler to use.

The longevity of materials used throughout the building are another consideration in the ongoing maintenance and operational longevity of the techniques and products. Low-toxin, environmentally friendly products are the only way to ensure that the running of the building is efficient and not threatening the fully sustainable aspects of it.

Indoor air quality

Insulation improves energy efficiencies, but it can mean a building is less well ventilated. So it is necessary to have a system that provides fresh air. For example, a mechanical ventilation heat recovery (MVHR) system provides good indoor air quality by removing moisture and stale air along with odours and pollutants and replaces them with fresh outdoor air.

Indoor air quality is also affected by pollutants within the house. Using less toxic paints, varnishes, finishes and sealers (discussed above) has been to improve indoor air quality. Since paint fumes and associated toxins (volatile organic compounds / VOCs) continue to be released over many years, the use of more natural paint will greatly increase indoor air quality. Paints labelled as ‘zero VOC’ are now more commonly available and should be included in the design of a green home.
Passivhaus is a standard of highly efficient building design that was developed in Germany in the early 1990s. It is generally accepted as the highest level of sustainable building and the world's best insulation technology. The standard approaches energy conservation and sustainability using a fabric-first approach. The Passivhaus standard can be applied to residential, commercial, industrial and public buildings. They are built with meticulous attention to detail and rigorous design and construction principals developed by the Passivhaus Institute. The exceptionally high standards of air tightness and thermal insulation are some of the key elements leading to a Passivhaus certification.

The crucial element of a Passivhaus is that by using a fabric-first approach and minimising the need for highly-complicated renewable energy systems, it doesn’t require the end-user to have complex behaviour change or training. A Passivhaus can’t really ‘break’ in the way technology can.

A Passivhaus building is built in such a way that the heating requirement is reduced to the point where a traditional heating system may no longer be needed. Cooling is also minimised by using the same principals and through shading, the use of vegetation. As well as being energy efficient, Passivhaus also provides excellent indoor air quality through air infiltration systems by supplying fresh air which is filtered and post-heated by using a mechanical ventilation and heat recovery unit. All of this means that energy consumption compared to existing homes can be reduced by nearly 90%, translating into very low energy bills.

It is estimated that there are some 30,000 Passivhaus homes worldwide, although the number may in fact be much higher than this. Achieving a Passivhaus Certificate can be an expensive process and therefore some owners of Passivhaus-builds may have built to the standard but not had them certified as a result of high cost implications. Nevertheless, there are many Passivhaus examples across the UK including single-family homes and multi-housing schemes.

Due to the incredibly low energy costs required in a Passivhaus and the resulting low household heating bills, these buildings are being increasingly seen as effective way of ensuring residents do not fall into fuel-poverty. This in turn means that tenants are less likely to have rent arrears and financial complaints meaning that Passivhaus is a good standard for the Build to Rent sector. In the UK, Housing Associations have been one of the main builders of multi-unit Passivhaus buildings. One of London's largest Passivhaus scheme was commissioned by Circle Housing and built by Climate Energy Homes. The 51 unit development located in Rainham, Havering is one of the largest Passivhaus social housing developments in the UK. The key aim of the development was to provide truly sustainable and affordable homes. The result was a development using the Passivhaus Standard with the aim of slashing occupier energy bills by upwards of 70%.

For more information on the Passivhaus standard, definition and criteria, see the following resources:

- Passivhaus Trust (UK) passivhaustrust.org.uk
- Passive House Institute (Germany) passivehouse.com
- International Passive House Association passivehouse-international.org
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