Knowledge File - Sustainability in Building Refurbishment
Lessons from BREEAM applied to refurbishment

Introduction

"Low Carbon Refurbishment of Buildings", published in June 2008, by the Carbon Trust, describes a number of energy reduction drivers for refurbishment schemes over and above legislative requirements. Such as:

- Reduced cost of operating facilities
- Reduced risks due to energy costs
- Better comfort, satisfaction & productivity of staff
- Recruiting & retaining quality staff by demonstrating Corporate Social Responsibility policies in action
- Sales & marketing benefits

But it is important to remember that sustainability is **NOT** just about reducing carbon emissions. It is about the resolution of the environmental, social & economic challenges facing a design, whether it is a refurbishment or a new build project.

Measurement

It is possible to measure the sustainability of developments both at a portfolio level & a building level.

At the portfolio level BRE's **BREEAM Management & Operation** Scheme is still being used for Offices & Retail schemes. BRE is going to launch their new **BREEAM in Use** scheme in March 2009 which will be able to evaluate all non-domestic commercial buildings to support Corporate Social Responsibility & ISO14001 requirements of companies. It will provide, either for individual buildings or whole property portfolios, Asset Ratings, Operating Ratings (covering the operation of buildings) & also assess the way occupiers manage their activities within buildings.

At the building level, all of the BRE's BREEAM 2008 schemes can be used for a range of commercial building types being refurbished as for new build. Such as:

- BREEAM Offices
- BREEAM Retail
- BREEAM Industrial
- BREEAM Bespoke (for use with major mixed use scheme or for a building type not covered by an existing scheme)

For residential developments the BREEAM **Code for Sustainable Homes** is available for developments in England. BREEAM **EcoHomes** still operates elsewhere.

There have been a number of changes to the BREEAM process with the introduction of BREEAM 2008 in August 2008. Only an Interim Certificate will now be issued at the Design Stage, with the Final Certificate only being issued after a Post Construction Review. In addition to being able to award a Pass (with a score of 30%), Good (45%), Very Good (55%) and Excellent (70%) Ratings, an Outstanding Rating can now be awarded if a score of 85% is achieved. This has been introduced to recognise exemplar projects within the industry.

BREEAM 2008 is now divided into 9 sections and the weighting of each section has been revised as indicated in the Table below:

	Weighting %	Fit Out weightings %	2006 weightings %
Management	12	13	15
Health & Wellbeing	15	17	15
Energy	19	21	
Transport	8	9	25
Water	6	7	5
Materials	12.5	14	
Waste	7.5	8	10
Land Use & Ecology	10	N/A	15
Pollution	10	11	15

BREEAM 2008 also requires mandatory standards to be achieved in some in some credits if a particular rating is to be achieved. In some developments it might only be possible to satisfy these requirements by tenants carrying out the work or activity. As such these requirements might have to be passed on to tenants in their leases. Advice of the appointed BREEAM assessor should be sought at an early stage of the project to assess the implications of this.

BREEAM have also introduced Innovation Credits. Each innovation credit will be worth 1% on the BREEAM score, with a maximum of ten innovation credits being able to be awarded. An Innovation Credit can be awarded when the described 'exemplary performance' level is achieved in certain credits. Alternatively it is possible to make an application to BRE Global to have a particular building feature, system or process recognised as 'innovative'. If the application is successful an Innovation Credit will be awarded.

Sustainable design aspects of refurbishment

A summary of possible sustainability design aspects that might be incorporated into refurbishment projects, are described below:

Land Use & Ecology in Refurbishment
It is possible to increase the ecological value of refurbishment projects, with devices such as bird or bat boxes & by incorporating Living Roofs into the design. Living Roofs come in variety of types from Extensive Roofs (less than 100mm thick, with thin soil & no irrigation - usually sedum or brown roofs), Simple Intensive Roofs (between 100 & 500mm thick - usually grasses or herbaceous plants which can create a high biodiversity impact) or Intensive Roofs (usually roof gardens)

When considering using Living Roofs assess whether the existing roof can take the additional loads & check its construction does not comprise existing weathering details. The Trelleborg Green 'grid' roof system uses plastic planting trays, which allows a Living Roof to be easily installed on existing roofs & moved if necessary.

Transport in Refurbishment
BREEAM assesses a developments proximity to available public transport & local amenities (such as grocers shop etc.) & while a refurbishment project's site location is fixed, Travel Plans can be developed which are structured to the needs of a particular site to include a package of measures to encourage greater use of non-car modes of transport.

Adequate space needs to be allowed to provide cycle storage for between 5 & 10% of the building's occupants (depending on size of building), although this number can be reduce by 50% in city centres. An additional BREEAM credit is available if showers plus either changing facilities or drying space for wet cloths is provided for cyclists. Credits are also available for providing car parking below local authority's planning standards

Health & Wellbeing in Refurbishment
Thermal comfort needs to be addressed by checking that the refurbished building conforms to the thermal comfort requirements of Table 1.5 of CIBSE Guide A: Environmental Design, which may require a dynamic thermal simulation to be undertaken by a service engineer. The potential for natural ventilation can be addressed through the provision of openable windows to provide adaptive opportunities for occupants. Replacement windows could provide a range of ventilation opportunities, with small opening lights at the top of windows for night time ventilation, large openings in the middle to provide the maximum amount of ventilation & small openings at the bottom to provide additional ventilation close to the window.

Visual comfort can be addressed by providing adequate daylight levels, views out of windows or into atria from workstations & the prevention of glare. It is important to understand both the opportunities & constraints of existing windows, as windows (of the same area) will provide different daylight values depending on shape & location.

Occupant health issues can be addressed through the use of low volatile organic compound paints or stains, wood based products & floorings with low levels of formaldehyde, wall coverings with low formaldehyde & vinyl chloride monomer content & avoiding microbial contamination in water & humidification systems.

Energy in Refurbishment
BREEAM has shifted it's assessment of energy from using the Building CO_2 Emission's Rate to assessing the Energy Performance Certificate Carbon Index.

Energy Performance Certificates (EPC) are defined by the calculation of a Carbon Index (CI) - defined as the Building's CO_2 Emission rate (derived for Building Regulations) divided by a Standard CO_2 Emissions Rate (based on a mixed-mode ventilation strategy) multiplied by 50. So a Building Regulation compliant mixed-mode ventilation building would be expected to achieve a CI of 50 (on the borders of EPC Bands B & C). A Building Regulation compliant air conditioned building a CI of around 66 (mid Band C) and a compliant naturally ventilated building a CI around 44 (mid Band B). The 1st EPC issued in early 2008 was for Swan House in London, a 1980's office, and it achieved a Band E rating. Since then around 500 large commercial premises have had EPCs completed with an average score in Band C.

How it is possible to achieve a better EPC for a refurbishment project?
One approach would be to adopt an energy hierarchy approach to design, which:

- First - reduce energy demand by reducing thermal losses, reducing thermal gains & maximising passive cooling opportunities

- Second - improve the energy efficiency of installed equipment
- Third - investigate the use low or zero carbon energy generating technologies

Energy demand can be reduced by reducing thermal losses by investigating the following strategies:

- As 75% UK buildings were constructed prior to 1980, increasing insulation levels in roofs & walls will reduce thermal losses. While additional insulation to roofs & cavities walls can be fairly straight forward, adding insulation to solid external walls can have its difficulties. If you add the insulation to the inside face of walls there is a danger of interstitial condensation occurring within the fabric & lettable areas could be reduced. Fixing insulation to the outside face of walls changes the appearance of buildings and could create planning difficulties. Innovative materials such as the Micronal Smartboard panels might offer insulation solutions to solid walled buildings.
- Replacing existing windows with new energy efficient windows which can reduce the rate of heat loss by up to a third of old single glazed windows.
- Reducing uncontrolled ventilation losses. Old 'leaky' buildings can have a rate of uncontrolled air leakage which is the same as it's fresh air requirements and twice that of a Building Regulation compliant building or four times that of a reasonably air tight building. Old buildings can be tested to determine air leakage rates & smoke testing used to locate air gaps in the building envelope. These can be filled or draught lobbies/ proofing added to reduce uncontrolled ventilation.
- It might be possible to reduce space heating energy by up to 50% by reducing thermal losses.

Energy demand can be reduced by reducing thermal gains by investigating strategies to turn off equipment when not required/ auto standby or by locating equipment together in one space so it can be treat differently. Increasing efficiencies of lighting installations & turning off lights when not required will also reduce internal heat gains. Reducing thermal solar gains from glazing also needs to be investigated by:

- Establishing the nature of the problem - studies have shown that where the percentage of glazing in offices starts to exceed 50-60% of the facade then total energy demand will increase
- Do you need to prevent over heating in summer?
- Is one side of building overheating?
- Are the running costs of cooling higher than expected?
- Is glare the problem?

Reduce demand by maximising the benefits of passive cooling by investigating the possibilities for:

- Exposing thermal mass to absorbed heat gains, by either removing ceilings or providing ceilings with sufficient voids to allow the mass to work. This can reduce office temperatures by between 2 & 3^0C, but night time purging of the absorbed heat is required.
- Use a natural ventilation strategy if appropriate – either wind or stack driven.

Improve the energy efficiency of the heating, ventilation & air conditioning plant to reduce demand for energy by investigating:

- New condensing boilers - +90% efficiency
- Insulating pipe work etc. to prevent distribution losses on heating systems
- Localise hot water generation
- Effective control of dampers for minimum fresh air & free cooling
- Heat recovery from exhaust air

- Variable speed fans to minimise power needs
- Minimise losses from ductwork
- Appropriate zoning & controls to avoid systems running when not required
- Using energy efficient lighting systems which can reduce lighting energy by down to 20% of old inefficient systems

The use of low or zero carbon technologies needs to be considered by investigating the options available:

- **Wind** can have limited use in urban areas due to turbulence created by other buildings & noise from large horizontal axis turbines means they need to be located away from residential areas. Large horizontal axis turbines might be suitable for large industrial or retail parks with suitable wind conditions. There are series doubts about the efficiencies of very small horizontal axis wind turbines as they can be badly affected by turbulence. Alternatively vertical axis turbines, such as Quite Revolution's QR5 turbine, could be used as they are not affected as much by wind turbulence.
- **Solar – Photvoltaic panels** can be located on either roofs or facades, ideally facing within 20^0 of south. It is important to check whether there is any possibility of overshadowing from adjoining buildings as they could seriously affect their output. It is also possible to use PVs for non-building energy uses such as street lighting or car park control machines etc.
- **Solar thermal hot water** panels could provide 50-60% of annual hot water demand, although this will be small in comparison to amount of energy used by offices & retail units. STHW panels can be either evacuative tubes (which are more efficient) or flat panels. They need to face within 20^0 of south with an ideal pitch of 30^0 & over shadowing by adjoining buildings should be avoided as it will affect their output.
- **Biomass boilers** for space heating & hot water are generally larger than gas boilers of equivalent output. Quite a large space will be required for fuel storage, along with access for large fuel delivery vehicles. Fuel is usually either wood chip or wood pellet, with the energy density of wood pellets 3.5 times that of wood chips so storage requirements could be reduced. Another consideration is to check whether the fuel supply chain is secure for the long term.
- **Ground source heating & cooling** is low carbon energy generation which uses one unit of grid electricity to create 5 units of heating etc. by using the stored heat/ coolth in the ground. Either horizontal ground loops or if vertical loops in piles can be used to transfer this stored energy, but it is important to check if there is enough land available to accommodate the length of the horizontal loops of if vertical piles are being used is access available for drilling rigs.
- **Combined heat & power** plant could provide both electricity & heating for a development, if there are sufficient operating hours & a spread of loads available for economic use. CHP produces between one to one & a half units of heat for each unit of electricity & even if the fuel used to power the CHP is gas CO_2 emissions will be approximately70% of traditional supply options. Emissions can be reduced further by using a biomass CHP. The same constraints as for biomass boilers apply and the use of biomass CHP is limited within the UK.
- Linking onto an existing local decentralised energy network might be an alternative to providing new CHP plant – if not now but in the future. Such a network exists in central Woking & the London Climate Change Agency is aiming develop networks within London. These might be driven by hydrogen fuel cell CHP plant. One operates in Woking operates using a hydrogen fuel

cell which can continue supplying electricity, in the event of a grid failure, without disconnecting any customers.

The ability to monitor energy consumption is vital to understanding any operational energy inefficiencies that might occur. This requires a strategy which provides sub-meters for each sub-meter each floor or sub-tenancy of a building & for each substantial energy use (e.g. space heating, hot water, lighting & small power at each floor level, cooling systems & humidification plant). CIBSE TM39: Building Energy Metering can be used to develop this strategy.

Materials in Refurbishment

It is not always obvious which building element has the biggest environmental impact. In office building floor finishes have the biggest environmental impact, over its 60 year life, because they are replaced so frequently. Obtaining information on the embodied energy of materials can be fraught with difficulties. A more effective approach to reducing the environmental impact of materials is to use BRE's Green Guide to Specification (www.thegreenguide.org.uk) to specify A/ A+ Rated construction elements.

In refurbishments there are opportunities to both re-use of facades & structure. BREEAM credits are awarded when at least 50% of a final façade (by area) is re-used & at least 80% of the re-used façade (by volume) comprises in-situ material. Similarly when at least 80% of the existing primary structure re-used & the re-used structure comprises at least 50% of the final structural volume.

Investigate the responsible sourcing of materials by specifying suppliers who have certified environmental management systems & ensuring all timber products are legally sourced from certified sustainable sources – FSC, PEFC etc. All insulation materials (both building fabric & services) should be non-ozone depleting, with a global warming potential of less than 5 & be responsibly sourced. Design all internal partitions to BS 5234 Part 2.

Water in Refurbishment

Water consumption can be reduced by using low volume dual flush WCs, low flush or waterless urinals, taps with restricted flows & low flow volume showers. It can be reduced further by adopting rainwater or grey water recycling strategies. An integrated grey water recycling management system is available from Ecoplay which can be used for residential or hotel schemes to recycle bath & shower water for use in toilets.

A pulsed water meter, linked to a building energy management system, allows water consumption to be monitored. Sanitary water supply shut off devices & major leak protection provision prevent water being wasted when leaks occur.

Waste in Refurbishment

Construction is the single largest source of waste (90 million tonnes) in the UK, with 12% of materials delivered to sites going into skips unused. The introduction of Site Waste Management Plans, for all projects over £300,000, is part of a government strategy to reduce construction waste by 50% by2012. On line templates for developing SWMPs are available from both WRAP (http://www.wrap.org.uk/construction/index.html) & BRE (http://www.smartwaste.co.uk/). BREEAM credits are awarded where targets are set (in m^3 of waste generated per $100m^2$ of gross internal area) for reducing site waste.

BRE operates a number of site waster monitoring schemes through its SMARTWaste – e.g.. SMARTStart+ or SMARTAudit

Waste can also be reduced by using recycled aggregates as part of the mix for any new concrete structures. WRAP operates an on-line service to source recycled aggregates. In addition facilities should be provided on site (or off site if space is not available) for recyclable construction waste into separate waste streams. Also allow sufficient space in the design to assist building occupants to recycle operational waste, in different waste streams.

Pollution in Refurbishment

The use of refrigerants in cooling systems with a global warming potential of less than 5 (e.g. butane/ propane/ CO_2) will reduce a refurbishment project's impact on climate change. Where normal refrigerants are used provide leak detection & refrigerant recovery system. Pollution can be reduced by using low nitrogen oxide burning boilers & boilers emitting between 70 – 100mg/kWh (at 0% excess O2) are common.

The risk of flooding can be reduced if surface water run-off is reduced through attenuation or the use of sustainable drainage schemes. Potential pollution from roof mounted plant areas needs to be considered to minimise possible pollution to water course. Night time light pollution can be avoided by ensuring external lighting is fitted with auto switch-off controls between 23.00 – 07.00. & undertake a noise impact assessment to avoid noise pollution.

Management in Refurbishment

The sustainability of the construction process will be improved if main contractors participate in the Considerate Constructors scheme. The current average score of participating sites is currently 30, so require your contractor to achieve a score of between 32 & 35.5. Reduce the impact of the construction process by monitoring site CO_2 & water consumption, monitor site generated transport CO_2 (which can be difficult), adopting best site practice in relation to air (dust) & water pollution, requiring the contractor to operate an environmental purchasing policy, use contractors with certified environmental management systems & use sustainably sourced site timber.

Appoint independent commissioning agents to monitor commissioning & require seasonal commissioning to be adopted during the first year of occupation. A Builders Use Guide should be developed to provide information to both the facilities manager & building occupiers on how to operate their building efficiently.

Impact of Sustainability on Investment Portfolios

There has been much debate of late on what the impact of improving the sustainability of new & existing building will have on property rents and values. This has especially been true in relation to the discussion on the impact of Energy Performance Certificates. On the one hand a survey undertaken by Sustainable Building at the end of 2007 found that 65% of those surveyed considered that improving the energy efficiency of existing buildings would add a high or moderate premium to rental or sale price over next 5 to 10 years. On the other hand Mikes Keeping, a Partner in King Sturge, commented that while there was currently no evidence to suggest that more energy efficient buildings would command higher rents, there is an expectation amongst investors that energy inefficiency would lead to 'price chipping' during rental negotiations'. There is, however, some evidence from a recent survey by the CoStar Group which found that in the United States LEED

rated buildings were more sort after by tenants and investors, and they were also achieving higher rents.