Government Historic Estates Unit Annual Seminar

CUTTING DOWN ON CARBON

IMPROVING THE ENERGY EFFICIENCY OF HISTORIC BUILDINGS

Building Research Establishment, Garston
9 October 2007

ENGLISH HERITAGE

RESUMÉ OF PRESENTATIONS

GHEU's eleventh annual conservation seminar was held at the Building Research Establishment (BRE) at Garston near Watford on 9 October 2007. The theme was 'Cutting down on carbon: improving the energy efficiency of historic buildings'. Over 90 delegates attended the one-day seminar, representing a wide range of government departments and agencies, plus a variety of other public bodies.

The proceedings were introduced by **Philip Davies**, South Territory Director at English Heritage, who highlighted the ambitious targets that government has set for improving energy efficiency on its own estate. The targets on energy require that the central government office estate be carbon neutral by 2012. By 2020, departments are expected to reduce carbon emissions by 30% while increasing energy efficiency by 30%, relative to 1999/2000 levels. He predicted that many proposals for alterations to historic buildings can be expected, related to conserving or generating energy; he emphasised the importance of English Heritage's *Conservation Principles* in assessing these proposals.

In his welcome to delegates, **Dr Peter Bonfield**, BRE's Chief Executive, emphasised the social aspects of the changes that are being called for. He referred to the very high level of enquiries that BRE is receiving from public corporations regarding research and innovation in the field of sustainability.

Other presentations focussed on various aspects of energy use, ranging from the regulatory framework to practical measures to improve energy efficiency. The contents of the individual presentations are summarised below. Copies of speakers' Powerpoint presentations may be obtained from GHEU.

SPEAKERS

Chris Wood, English Heritage
English Heritage's response to climate change

Chris Wood reviewed past models of climate change by the UK Climate Impact Programme, based at Oxford University, the Tyndall Centre and the Hadley Centre, part of the Meteorological Office culminating in the 2002 DEFRA briefing report, *Climate change scenarios for the United Kingdom*. This should be read against the background of the Kyoto Protocol, and the *Stern review: the economics of climate change* and *Climate change 2007* – the latest report of the UN Inter Governmental Panel on Climate Change.

Domestic buildings (dwellings) are a major producer of carbon emissions. Haringey Council has produced an interactive heat-loss map study (http://www.seeit.co.uk/haringey/Map.cfm). The calculations in the current Home Information Packs are prejudiced against old buildings of traditional construction. The 40% house project (www.40percent.org.uk), which excluded buildings in conservation areas, anticipates a substantial increase in rates of demolition in order to achieve a 60% saving in CO_2 emissions by 2050. However, some of their assumptions can be challenged. The favourable performance of traditional buildings, and the fact that 24% of all UK waste is building waste, calls into question some of the assumptions of the Pathfinder housing

renewal programme. EH has published interim guidance on Part L: *Building Regulations and Historic Buildings* (2004), which aims to balance the needs of energy conservation with those of building conservation.

A major EH initiative is the hosting of a climate change summit on 24-25 January 2008 at the Royal Society, London. A new website, 'Climate Change and Your Home' is also being launched, aimed at homeowners of traditional (but not necessarily designated) buildings, showing how energy consumption can be reduced.

Other web-based EH guidance notes include *Micro wind generation* and *Energy conservation in traditional buildings*.

Tim Yates, BRE
Energy conservation measures & standards for non-domestic buildings

Tim Yates gave a brief overview of available guidance on energy conservation for non-domestic buildings before focussing on the key requirement of understanding how buildings work and the variety of analytical techniques required including pressure testing. There is a need to follow building regulations, but certain relaxations can be applicable to 'historic buildings' and the building regulations encourage advice to be sought from the local conservation officer.

Energy-saving case studies included Norton Park, Edinburgh, the Treasury Building, London, and the Royal Borough of Kensington and Chelsea Flagship project involving a five-storey Victorian terraced house at 36 Beaufort Gardens, (http://www.rbkc.gov.uk/flagshiphome/general/), which demonstrated how older buildings can make a positive contribution to low carbon use.
The BRE's current stable block project was also considered. Tim Yates ended with a checklist of refurbishment strategies and examined the role of renewables in reducing carbon emissions, while warning that simple energy off-sets cannot be a long term solution.

Discussion

Mike Brown (London Borough of Enfield/IHBC) asked: if we can expect warmer winters, should the focus over the next 20 years be on introducing more cooling in buildings?
Tim Yates: New buildings are currently being designed for summer cooling. But six times more energy is expended in cooling a building by one degree than heating it by one degree. Here, the good thermal mass of traditional buildings is an advantage over some modern construction.
Phil Ogley: Cautioned that some models of climate change suggest we will not necessarily have warmer winters.

Jane Anderson, BRE
Energy use and building fabric: operational and embodied impacts

Jane Anderson spoke about research recently conducted by BRE on carbon emissions arising from operational and embodied impacts. This has shown that in 2000 the manufacture and transport of building materials accounted for 10% of UK CO_2 emissions. A logical approach is Life Cycle Assessment (LCA), a 'cradle-to-grave' assessment of environmental impact which considers pollution and toxicity as well. The performance of a conventional Victorian terraced house was

assessed in work commissioned by English Heritage. It was found that building a typical Victorian terraced house from materials manufactured today has an impact of 32¾ tons of CO_2. By contrast, a house of identical layout, but of contemporary construction with cavity walls and satisfying current building regulations, generates 40 tons of CO_2. This difference is largely explained by the use of Portland cement in the mortars used to construct the latter house, this product being burnt at much higher temperatures than traditional building limes.

Regarding operational impacts, a late Victorian house of 111.8 sq m was shown to generate 11.8 tonnes of CO_2 per year. It is known that refurbishment to upgrade performance can dramatically reduce energy use but comparative data is not available.

BRE has also studied refurbishment of offices in contrast to new-build and has found that refurbishment is always environmentally better than redevelopment (provided that air-conditioning is not used), and is always cheaper.

Chris Wood, English Heritage
New guidance in relation to Building Regulations Part L

Chris Wood said that 46% of all UK carbon emissions are from buildings, 26% of the total coming from dwellings. Even fitting a replacement window in an existing building requires consent under the Building Regulations. Satisfying current standards requires replacement glazing to be double-glazed and of low emissivity glass within frames that resist cold-bridging, though *repairs* are not controlled.

Mindful of the potentially adverse effect of stricter thermal performance standards on the historic environment, EH published formal guidance: *Building Regulations and Historic Buildings* in 2002 (revised 2004). The current Part L (in force since April 2006) grants exemptions in respect of Listed Buildings, Buildings within Conservation Areas, Scheduled Monuments and churches. This is not blanket exemption; improvements to thermal performance of buildings in these groups are encouraged 'where that is practically possible'. The Regulations embody Approved Documents L1A – L2B. Approved Document L1B (conservation of fuel and power in existing dwellings) refers to second-tier advice, part of which is the EH guidance noted above which is currently being revised. In the near future there will be more than 30 related guidance notes on the EH website, most of which have already been drafted. They are arranged in four sections:

- Background
- Elements
- Building types
- Case studies

Pressure testing is now mandatory for new buildings under the Building Regulations. Historic Scotland (with Glasgow Caledonian University) is undertaking research into the performance (and potential upgrading) of traditional sash windows; EH plans to collaborate in this work. Retro-fitting energy conservation measures to a modernist 1930s detached house cut its annual fuel bill from £800 to £300 (though the works would not be adequate to satisfy current Part L requirements). The next stage in EH's process will be to consider the further raising of targets, with the likely introduction of consequential improvements in the next revision of the Regulations.

Phil Ogley, Oxley Conservation
Making it happen: putting energy efficiency measures in place

Phil Ogley concentrated on practical considerations following the explanations of principles and rules that were set up by the previous speakers. 'Listening to the building' must be the starting point: understanding its construction, modification and use. Performance is also crucial: intended performance, possible changes in the intended use and performance in use. For example, damage can be caused by well-intentioned but unsuitable repairs.

In understanding thermal performance it is important not to rely on preconceptions; for example, a brickmaker's late-Victorian terraced house in Leamington Spa passed the permeability test set by the 2002 Part L of the Building Regulations. Data logging is crucial; humidity and temperature trackers in a range of rooms throughout the building give a basis for targeted action. Supplementary qualitative information can be gained from a fan pressurisation test (compulsory for new-build under Part L 2006). Images taken by a thermographic camera identify cold bridging. Analysis of use patterns, surveys of user experiences and comparison with similar buildings can all add valuable information.

Small changes can sometimes result in improved performance: altering use patterns, correcting any maintenance backlog (eg cleaning windows and light fittings), repairing windows and doors, improving controls (eg programmable thermostats, thermostatic radiator valves), upgrading artificial lighting and portable appliances.

Lastly, the thermal performance of the upgraded building should be monitored.

It may also be important to 'think outside the building'. Where there is a complex of buildings, a combined heat & power system (CHP) may be both desirable and practicable (under consideration for 'Albertopolis' in South Kensington).

Geoff Rich, Feilden Clegg Bradley
Energy efficiency and office design: key issues in new build and re-use

Geoff Rich is an accredited conservation architect with Feilden Clegg Bradley Studios LLP, a practice which has a strong interest in sustainability. His talk looked at energy conservation both in the construction (ie choice of materials) and in the design of buildings, and also at active and passive energy usage once the building is occupied. He described four office schemes: two as new build and two as conversions of existing buildings. The first was the prestigious new national HQ, 'Heelis', for the National Trust at Swindon. This 700sq m building, which opened in 2005, is lit by industrial-style rooflights on the north-facing roof pitches, with solar panels on the opposing south-facing roof slopes. The interior is cooled naturally, relying on the thermal mass of brick walls and the concrete ceiling/floor sandwich to absorb heat, aided by manually or automatically triggered ventilation. The design makes references to the industrial history of the site.

Feilden Clegg Bradley were also responsible for the New Environmental Office at the BRE (1997). The two conversion projects that were presented were the Greenpeace HQ in Islington, re-using a 1900s warehouse, and the Grade II-listed mid-nineteenth century former brewery in Bath, now the local office of the practice. A fascinating analysis of the carbon footprint produced by their 60-person office in Bath and 40-person office in London was given, showing how all office activities, including travel, need to be taken into consideration.

David Drewe, English Heritage
Energy benchmarking

David Drewe explained how English Heritage has carried out energy benchmarking to enable the assessment of energy levels, in response to DCMS's request in 2002 to reduce the organisation's carbon footprint.

EH has over 400 sites, with a mixture of historic and non-historic buildings. Current annual energy spend is approx £1 million, or 18 million kW per year.

EH collaborated with the Carbon Trust who advised on the brief, nominated appropriate consultants and audited results to produce a benchmark for future comparison. Phase 1 looked at offices and phase 2 at the historic estate.

A complete survey of all EH offices and non-historic sites was carried out in 2004 and reports completed in 2005, using the Energy Conservation Group ECG 019 guidance to show the current situation and provide recommendations to improve performance. This approach worked well for all non-historic buildings except the archive stores at Swindon which have particular requirements and which need separate assessment.

Because a large number of EH's historic sites have little or no energy use, it was decided to look at just the largest 18 sites in detail. However, even for these, when assessed using the ECG 019 guidance, the historic sites tended to gain a Grade A certificate which would not be useful to mark any improvement.

The energy use at the 18 sites was therefore recorded, broken down into lighting, heating, hot water and power expenditure, and potential improvements were identified in order to create a unique energy 'indicator' for future comparison.

Jon Wallsgrove, Ministry of Justice
Energy usage in older buildings

Jon Wallsgrove set out the detailed study of the energy usage and energy efficiency of a cross-section of law courts and associated buildings which seems to confirm the inherent energy efficiency of traditionally-constructed pre-war public buildings.

There are approx 800 buildings in the Court Service portfolio: courts, office buildings and judges' lodgings of varying ages; 20% are listed. The study looked in detail at 33% of the estate, chosen to reflect the overall portfolio in terms of age, size, type and usage. Annual energy use was analysed and the data was then sorted by various different categories.

The results confirmed that the construction type indicated by date band was of primary importance in affecting energy efficiency. Pre-1900 buildings were generally the most energy-efficient per sq m. This group provided a datum of 0%. Their performance was approached only by those of the 1990s and 2000s at around 8% over datum. Those of the 1940s and 1950s were 45% over datum, by far the worst performers, and those of 1960s also generally poor at 35% over. Buildings dating from 1970s-1980s and 1900s-1930s were around 20% and 25% over datum respectively.

Pre-1900 buildings are the most efficient due to high mass construction, with natural lighting and ventilation, and are therefore recommended for retention on this basis alone, regardless of their individual historic value.

Buildings dating between 1900 -1939 suffer poorer energy efficiency due to lighter construction techniques, and can probably be improved with additional insulation. Those of 1970-1989 giving similarly poor results, tend to rely heavily on artificial lighting, heating and air conditioning with internalised planning.

Buildings of the 1940s and 1950s (5% of the portfolio) are by far the worst group for energy efficiency, and are also the most difficult to upgrade. Those of the 1960s are almost as poor, but significantly also form 25% of the portfolio, making a major impact on overall statistics.

On these results, recommendations have been made that pre-1900 buildings should be prioritised for retention, and updated as required, and that buildings of the 1940s, 1950s and 1960s should be prioritised for disposal.

Energy improvements recommended for pre-1900 and pre-war buildings, and for inclusion in briefs for any new buildings include:

- Openable windows and natural ventilation systems
- Natural lighting (eg rooflights)
- More efficient heating systems and sophisticated services control systems
- Exploitation of passive solar gain
- Use of shutters and curtains for solar shading and night-time insulation

The study showed that pre-1900 and pre-war court buildings are more energy efficient than all but the most recent modern buildings. A similar case may be made for other public buildings.

Questions

Elizabeth Moore (GHEU) asked Phil Ogley to explain in more detail exactly how the fan pressure testing worked. PO explained that the fan is set up, in an open doorway or window and the space around fully sealed. The fan is then operated to regularise air pressure within the building to be just above or below the external air pressure to allow the identification of air leakage positions.

Chris Daniell asked for further information on Energy Performance Certificates. David Drewe confirmed that EPCs, which are graded A-G, are required under Article 7 of the EU Energy Performance in Buildings Directive and that all public buildings will be required to have one on display from April 2008. The system software and accreditation procedure are still under discussion. More information can be found on the Carbon Trust website.

Malcolm Porter asked Jon Wallsgrove whether the management and occupancy of the buildings assessed had been taken into account in the survey. JW agreed that this would obviously have an effect on individual buildings but said that the survey had not tried to capture this information since the variation was constant across all ages of building.

WEB LINKS RELATED TO ENERGY CONSERVATION

2007 *Meeting the energy challenge: a White Paper on energy,* Department of Trade & Industry
www.dti.gov.uk/energy/whitepaper/page39534.html

Planning and climate change, draft Planning Policy Statement (PPS), Communities and Local Government
www.communities.gov.uk/archived/publications/planningandbuilding/consultationplanningpolicy

Transforming existing buildings: the Green Challenge final report, RICS
www.rics.org/Property/Commercialproperty/transformingexistingbuildings.htm

EH guidance on Home Information Packs and traditional buildings
www.english-heritage.org.uk/server/show/ConWebDoc.11600

EH guidance note on energy conservation in traditional buildings
www.helm.org.uk/upload/pdf/EnergyConservation.pdf

EH guidance note on micro wind generation and traditional buildings
www.helm.org.uk/upload/pdf/MicroWind.pdf

2006 *Sustainable refurbishment of Victorian housing,* Tim Yates, BRE Trust
www.brebookshop.com/details.jsp?id=224138

Code for sustainable homes, Communities and Local Government
www.planningportal.gov.uk/uploads/code_for_sust_homes.pdf

Building a greener future, Communities and Local Government
www.communities.gov.uk/publications/planningandbuilding/building-a-greener

Stern review: the economics of climate change, HM Treasury
www.hm-treasury.gov.uk/Independent_Reviews/independent_reviews_index.cfm

Climate change and the historic environment, English Heritage
www.helm.org.uk/server/show/nav.9256

Sustainable operations on the government estate
www.sustainable-development.gov.uk/government/estates/index.htm#targetsco2

2005 EH guidance note on wind energy and the historic environment
www.helm.org.uk/upload/pdf/Wind_Energy_(final).pdf