

CIOB

BUILDINGS UNDER REFURBISHMENT AND RETROFIT

5.0

CARBON ACTION 2050 WHITE PAPERS FROM THE CHARTERED INSTITUTE OF BUILDING

APRIL 2011

RÉSUMÉ

THE UK'S EXISTING STOCK OF BUILDINGS

The UK Government has placed special emphasis on the retrofitting and refurbishment of the UK's existing domestic and non-domestic buildings, as this approach is deemed to hold the greatest potential for reducing CO₂ emissions in the short to medium term.

Reliable data on where and how to act is regarded as paramount for the decarbonising process to both proceed and succeed. In order to plan and apply the actions required, it is viewed as essential to measure what is happening in the present and to continually re-measure in order to provide feedback for further actions. Improvement of data collection, the range of data collected, reporting, distribution and use are considered to be essential factors for bringing about the changes required.

There are nearly 30 million buildings (domestic and non-domestic) in the UK. Approximately 28 million of these (including 25 millions homes) are required to be retrofitted by the end of 2050 if the carbon targets are to be met. Up to 85% of housing that will exist in 2050 has already been built.¹ The energy used to heat, light and run domestic buildings alone accounts for 27% of **all** bad UK CO₂ emissions.² It has been calculated that Britain has the oldest domestic stock in the developed world, i.e. some 8.5 million properties that are over 60 years old (Pre-1944: 38%, 1945-1984: 46%, 1985 onwards: 16%).

There are approximately 1.8 million non-domestic buildings in the UK. These are currently responsible for roughly 18% of the country's total CO₂ emissions.² Three-quarters of the non-domestic building stock are more than 25 years old, while nearly one-third are over 70 years old (pre-1940: 31%, 1940-1985: 46%, 1985 onwards: 23%).³

¹ Existing Homes Alliance, 2010

² UK Green Building Council, 2009

³ Building Research Establishment (BRE), 2010

FIRST THINGS FIRST

While refurbishment and retrofitting measures afford the opportunity to improve the energy efficiency of existing buildings, the various benefits that can be accrued from good building-maintenance and repairs must be a chief consideration. Good maintenance and repair work not only helps to minimise energy wastage and living discomfort, but also increases the durability and longevity of a building's fabric, yielding further long-term benefits in terms of the retention of embodied/capital carbon. Conversely, poor maintenance and repair work results in a reduced carbon investment – best practice repair and maintenance is essential to both reduce this risk and to achieve the carbon reduction targets.

5.0

INTRODUCTION

In the UK, approximately 45% of all carbon emissions come from the use and operation of existing buildings.² In 2050, it is estimated that up to 85% of the buildings lived in and occupied will be those that exist today. This highlights the potential impact that existing buildings, as opposed to any proposed new buildings, have in meeting the Government's carbon-reduction targets.

Existing buildings have already produced carbon during their construction, known as embodied/capital carbon, in which case there is a very strong argument for ensuring that they last for as long as possible. Refurbishment and retrofit have the added advantage of maximising the use of embodied/capital carbon, while rendering the building as energy-efficient as possible.

Energy-efficiency should not constitute the sole focus of retrofit and refurbishment; the work must also be considered in a sustainable context to ensure the embodied carbon in the original construction is not unduly compromised. Retrofit and refurbishment is also a carbon-generating activity in itself and its impact should be considered in relation to the total lifespan (whole life) of a building.

Retaining embodied carbon and minimising the possibility of carbon-generating building repair commands an understanding of the affect that retrofit and refurbishment could have on existing building-fabric, and most significantly, understanding that well-informed maintenance and repair should be the first option sought in making existing buildings sustainable.

In addition to reducing carbon emissions, well-designed and executed refurbishment and retrofit work comes with added benefits, not least the 'sense of place' that is maintained for the people who live, work in, or use the buildings otherwise.

POLICY CONTEXT

The *Kyoto Protocol* (1997) was a watershed event and led to the *European Energy Performance of Buildings Directive* in 2002. In time, UK Government legislation was brought into place, which in practical terms has been the major force behind carbon-reduction policy. The *Climate Change Act* of 2008, with its five-year 'carbon budgeting system', committed the UK Government to delivering a 30% reduction in carbon emissions by 2020 and 80% by 2050, i.e. from a 1990 baseline. In response to this, the Department of Energy & Climate Change (DECC) produced their *Low Carbon Transition Plan* in 2009 that sets out the parameters for compliance with the *Climate Change Act*. For the construction industry, a joint government-industry initiative – The Strategic Forum for Construction (SFfC) – has produced a *Strategy for Sustainable Construction* (BERR 2008) as a way forward for delivering change in the sustainability of the construction sector. From here, it is the Government's vision that UK construction industry firmly establishes itself as a world leader in sustainable design and build practices. It is recognised that the construction industry must take the lead for the successful delivery of the *Low Carbon Transition Plan*, rather than following it (IGT 2010). In 2010, the IGT published their *Emerging Findings* (IGT 2010[a]) and *Final Report* (IGT 2010[b]) in which a series of propositions for actions by stakeholders have been advanced.

This *Climate Change Act* (2008) has resulted in numerous initiatives and regulation that affects the UK's existing-building stock. This includes *Building Regulations Part L* which is aimed at improving the energy performance of buildings and Energy Performance Certificates (EPC) ratings as part of the EU's *Energy Performance of Buildings Directive*. There has, however, been an emphasis on reducing energy consumption that promotes retrofitting without issues that properly consider sustainability issues, but latterly that situation has changed a little.

The latest Part L *Building Regulations* has sensibly considered the sustainability effects of retrofitting traditional (i.e. solid wall) buildings, known as breathable buildings, most of which were built before 1919. Approved Document LIB: *Conservation of Fuel and Power in Existing buildings* and Approved Document L2B: *Conservation of Fuel and Power in Existing Buildings Other than Dwellings* were published in April 2010 and came into effect on the 1st October 2010. A 'special consideration' can now be granted where works would impinge on a building's ability to breathe, thus possibly causing long-term decay problems (further details can be found here: <http://www.greensteps.co.uk/tmp/assets/1163178050906.pdf>). It will require building owners and their advisors to make a case for special consideration.

⁴ Chartered Institution of Building Service Engineers (CIBSE), 2010

⁵ Existing Homes Alliance, 2010

The same regulations also provide 'exemptions' for listed buildings, buildings within conservation areas and scheduled monuments where their character or appearance is unacceptably impaired. In England, English Heritage has published guidance (further details can be found here: <http://www.english-heritage.org.uk/publications/energy-efficiency-historic-buildings-part/>)

The vast majority of buildings will have to comply with these regulations and government initiatives such as 'Warm Front' and 'Decent Homes' standard promote almost wholesale retrofit in order to achieve greater energy-efficiency. In order to comply with Government's carbon-emissions reduction targets, an average of approximately 12,000 UK homes need to be retrofitted every week between now and 2050 (i.e. approximately 1 home per minute).^{4,5} A number of issues relating to this are discussed further below.

SCOPE

In-scope – Here we describe an holistic approach to retrofit and refurbishment concerning sustainability, with carbon-emissions reduction as a product of sustainability. It will cover the main issues which are well-publicised, but will also highlight lesser-known issues that have not been the subject of widespread coverage.

Out-of-scope – are the specific products used in retrofit, their means of installation, costs, energy consumption and savings-data including Government financial-incentives schemes (e.g. Green Deal/Pay-as-You-Save) and the like. It should be noted, however, that this is not a comprehensive description of all issues.

BEST PRACTICE GUIDANCE

A general description of sustainable retrofit and refurbishment

In the context of carbon reduction, retrofit and refurbishment is about making buildings more thermally efficient and sustainable. It principally concerns improving the insulation of the building envelope, which focuses on:

- Walls: insulation of cavities or on external/internal surfaces.
- Roofs: usually loft insulation (virgin and top-up).
- Doors: usually draught-proofing, but can include additional/replacement doors.
- Windows: very often includes replacement of old windows with double or triple-glazed units, but can include draught-proofing existing windows and/or the installation of secondary glazing.
- Floors: insulation.

It also focuses on energy use by buildings systems (operational carbon):

- Lighting: new controls, occupancy sensors, LED, fibre optic and other low-energy technologies. Other options principally for non-dwellings include: maximise daylight with motorised external louvers and light shelves.
- Tanks and pipes: lagging.
- Boilers: replacement with high-efficiency condensing boilers, new controls, boiler-burner replacement with higher-efficiency models, connection to low-carbon community heating systems.
- Chiller-plant improvements: upgrade of plant, pumps, piping and controls which all relate to non-dwellings.
- Controls and Building-Management Systems: installation of a building-management system, upgrade to include digital controls and greater number of sensors, which all relate to non-dwellings.
- Air conditioning: upgrade and provide passive replacement in areas of building where possible, which all usually relate to non-dwellings.
- Renewable Energy Systems: photovoltaics, solar thermal hot water, solar ventilation pre-heating, passive solar heating, wind energy, retrieved-methane powered plant installations, wood and organic-waste power-sourced heating or power plant, replacing traditional air conditioning with air-source (ASHP) or ground-source heat pumps (GSHPs), micro-hydro power. This array of options will usually be applicable to non-dwellings.
- Water conservation: low-flow water fittings and shower heads, low-flow plumbing equipment, water-efficient irrigation, greywater systems and rainwater harvesting.
- Electrical peak saving: thermal-energy storage, on-site electricity generation. The latter is usually applicable to non-dwellings only.

- Advanced metering systems: smart metering, half-hour metering.
- Distributed Generation: Combined-Heat-and-Power (CHP), Combined-Cooling-Heating-and-Power (CCHP), fuel-cell technology, micro turbines. Not so long ago these options would be confined to non-dwellings only, but CHPs can now be installed in dwellings.

The above describes the most common ingredients of retrofit and low-carbon refurbishment. It should be realised however, that in an integrated way, it must also focus on keeping buildings in good repair. It will be a package of measures that will take items from that listed above, combined with knowledge-based building maintenance that will produce sustainable retrofit and refurbishment.

Low-carbon refurbishment also entails deciding on the most environmentally suitable employment of spaces within buildings.

Process

The elements of what retrofit and low-carbon refurbishment, as described above, can contain promotes an approach that focuses on selecting the options available. This can lead to decisions which may not be the most beneficial. All options have a multitude of advantages and disadvantages covering issues that range from practicalities and payback to well-informed embodied/capital carbon data and potential technical problems relating to the original building fabric and the health of occupants. Some of these issues will be explored further below.

In a generic sense, the options available must be listed and understood. Advantages and disadvantages must be worked out and a conclusion reached. From the outset, however, the building must be understood in terms of its condition and performance in-use (operation) and options for retrofit and refurbishment must consider the effects on both these aspects.

Lastly, the simple and least expensive options may provide some of the best results, and should be considered in the first instance.

Sustainability

Sustainability must entail ensuring that buildings last for as long as possible with minimum carbon-generating work being necessary throughout their lifespan, whilst at the same time being as energy-efficient as is realistically possible. Ultimately, this is a balancing act that requires a great deal of understanding in order to attain the most beneficial solution. Existing buildings already have an investment of embodied/capital carbon and securing this investment is part of the equation in finding that balance.

The materials and components used in retrofit and refurbishment are also part of this equation. There are a number of guides that help with retrofit and refurbishment, but there is also disagreement on many issues. For example, given the quantity of carbon used to produce it (i.e. carbon heavy), should cement be classified with a high environmental rating? The answer is very complex, but needs to be addressed if such guides are to have a meaningful use.

Building Maintenance and Repair

Proper building-maintenance is an essential requirement if buildings are to be sustained. This involves repair, but the majority of this work involves periodic activities such as clearing rainwater gutters, checking and clearing blocked drains, making sure that under-floor vents are kept clear. Click <http://www.english-heritage.org.uk/your-property/looking-after-your-property/maintenance-and-repair/maintenance-checklist/> for further details.

In order for maintenance and repair to be sustainable it must be undertaken properly. This means using compatible materials in repair with the appropriate skills used. Where traditional buildings are concerned, this means using traditional building materials and skills.

Understanding Buildings is Critical

Refurbishment may be necessary for many reasons, but retrofit, as we currently understand it, is an activity that is necessary to provide a building with components or accessories not fitted during initial construction to make it more sustainable and energy-efficient.

The starting point for both refurbishment and retrofit is to understand the building in terms of both condition and performance during use (operation). This should entail a consideration of the current and future intended uses of space within the building. This activity is commonly understood to be a building pathological investigation, which is something that goes beyond a building survey or inspection undertaken at a particular point in time.

A building pathological investigation will ensure that problems related to the condition of a building and its uses are better understood. This will require establishing the true cause of problems and ensuring those problems are treated, not just their symptoms. This is the only approach that ensures sustainable treatment. Common examples of misunderstood treatment include: chemical damp-proof courses, where the presence or source of dampness has not been properly identified and understood, is likely to result in the root-cause of the problem being allowed to remain and fester. Another is the re-pointing of lime-mortar joints using a cement-based mortar; this can lead to further deterioration of the building. Whilst understanding the cause of problems is critical, taking action to alleviate these problems is equally important. For further information click <http://www.spab.org.uk/advice/technical-q-as/>

Is retrofit necessary?

It has been estimated that we spend 90% of our time indoors, with most of this time spent at home. With approximately 30% of the UK's energy consumption used by homes and about 57% of this energy use attributed to space heating, the need for a focus on energy conservation is clearly evident.

Making buildings more fuel-efficient with the optimum type of heating and lighting will save energy and therefore reduce carbon emissions. Each type, however, will have different financial payback periods.

Heat-loss from each element of a building will vary according to the type of building and its construction, but it is in the order of the following for solid-wall buildings:

- roofs 15%;
- walls 35%;
- ground floors 15%;
- windows 10%;
- doors 15%.

This information relates to the financial payback of elements of retrofit. For example, windows could take 97.6 years. This would suggest that replacement windows should not be a priority and this is explored later. Insulating solid walls may have a payback of only seven years. There are, however, risks to contend with and these are likewise explored later.

There are numerous options for making buildings more thermally efficient and less draughty. However, at present there is insufficient understanding of existing thermal-performance. Studies have indicated that the energy-efficiency of buildings have been underestimated when considering RdSAP estimates compared with actual performance. Assumed published U-values of solid walls compared to *in situ* test data betrays a wide range of differences and studies that highlight the comparisons of buildings of different construction types and ages, also highlight this point. This would suggest that many buildings, and in particular those that are known as hard-to-treat (HTT), such as traditional solid-wall buildings, are more efficient than currently realised. This strongly suggests that they do not require increased thermal insulation to the degree that is often proposed.

Common retrofit and refurbishment solutions may not always provide the most cost-effective or energy-efficient measures. For example, research has indicated that there are numerous options available to reduce energy-loss through window openings which do not involve replacing existing windows with new UPVC double-glazed units. For example, the installation of secondary glazing, which would leave the original window intact, thus retaining embodied

carbon and alleviating the cost of a new window. Click http://www.historic-scotland.gov.uk/gcu-technical-_thermal-efficiency-traditional-windows.pdf for further information.

Retrofit and Refurbishment Risks

Internal building-environmental conditions affect the building and occupants in different ways and certain forms of retrofit and refurbishment can have varying effects. Traditional buildings, for example, rely on air-circulation to disperse any moisture that evaporates from the building's fabric, and too little air-circulation can have detrimental effects on the health of occupants.

There are many parts of the British Isles that are susceptible to heavy rainfall to the degree that cavity-wall insulation is likely to result in penetrating dampness. This will no doubt result in occupants turning up the heating to dry-out the damp walls, thus increasing carbon output (operational carbon) in the process. This is the type of scenario that could occur and should be avoided.

There are a substantial number of hard-to-treat (HTT) buildings in the UK. In England, HTT homes equate to 9.2 million dwellings and solid-wall homes account for 72% of this stock, of which 5 million in England are known as traditional buildings.

Traditional buildings have solid walls which breathe. They absorb moisture and this must be allowed to evaporate. Inhibiting this process can cause serious decay which itself has the potential to reduce the lifespan of existing building-fabric, thus necessitating carbon-generating remedial work. Wall insulation can also affect the performance of existing building-fabric. For example, the installation of internal wall-insulation will isolate the original wall from the effects of warm interiors. This will reduce the thermal performance of the original wall and also result in it remaining damp and cold for longer periods of time, thus increasing the risk of frost damage (cryoturbation) and that possibly caused by invasive vegetation (floralurbation). This is further exacerbated if a building is not kept in good external repair.

Penetrating dampness and rising dampness are also problems that must be understood, particularly where traditional buildings are concerned. Interstitial condensation is another risk. This could affect any timber elements in the structure of a building possibly resulting in dry rot, wet rot, infestation or the appearance of invasive species. It could also severely affect the quality of the internal environment potentially leading to ill health, often termed 'sick building syndrome'.

Insufficient research has been undertaken into many of these issues, which is possibly the biggest risk of all. The consequences of getting things wrong are severe in terms

of the performance of the buildings, the health of occupants, along with the waste of time and substantial amounts of money.

The benefits of retrofit and refurbishment may not be achieved if the design (and in particular the detailing), methods deployed and the standard of work is not satisfactory. This will require the correct skills and expertise with a proper knowledge of existing buildings. Before work is undertaken, it must be ensured that the causes of any dampness are treated and the building permitted to dry out. Otherwise, enclosing spaces that are damp could result in a host of serious problems.

Consider the use of buildings

Refurbishment projects should be used as an opportunity to ascertain the optimum use for each space. This can result in minimising the need for heating and forced-ventilation and maximise the feasibility for passive-controlled internal environments. The analysis will usually form part of a building pathological investigation involving environmental monitoring of internal spaces that indicates the suitability of each space for a given use.

Internal wall-insulation will reduce the space within a building and this may lead to a decision to use external wall-insulation, which can present different problems.

Aesthetics

External wall-insulation can detrimentally affect the appearance of buildings. Where listed buildings (statutory/local), scheduled monuments and buildings situated within conservation areas are concerned, it is very unlikely that this will be permissible under present UK planning policy and legislation. Even if buildings do not fall within these categories, external insulation can have a detrimental effect on the building and external environment generally. This could present a problem, as an alternative solution would be to install internal wall-insulation which will reduce internal space and be comparatively expensive due to the need to remove and reinstall elements such as kitchen and/or bathroom fittings. Building regulations can of course exempt statutory-listed buildings, scheduled monuments and buildings within conservation areas and give special consideration to traditional buildings with breathable structures.

Very often, buildings will receive interior wall-insulation at the front and exterior wall-insulation at the rear and sides which often have exteriors that are less ornate. This also reduces the need to remove and re-install kitchens and bathrooms, which are usually situated in the rear areas.

Pros and cons of Retrofit and Refurbishment

The advantages of retrofit include:

- Rendering buildings more suitable for existing use, or an intended use;
- Rendering buildings more energy-efficient, thus lowering related carbon emissions (operational carbon);
- Greater sustainable use of embodied-carbon investment (capital carbon).

The disadvantages include:

- Costly and inconvenient;
- Possibly reducing the internal space if internal wall-insulation is installed;
- Not all risks are understood at this stage – it is possible that retrofit could result in greater carbon-emissions if it results in deterioration of the existing building-fabric;
- Simple and least expensive options do not seem to be given priority;
- Does not always focus on the basics of keeping buildings in good repair to make them last for as long as possible;
- If a building becomes flooded, wall insulation will no doubt have to be removed in order to allow the original building-fabric to dry out;
- Unforeseen harm to heritage assets, possibly caused by the application of untested methods/technologies or arising from cumulative impacts. Potential harm to archaeological burial environments (e.g. trenching for GSHPs).

THE BIG HITTERS...

- Take carbon out of energy generation.
- Keep buildings in good repair – particularly concerning water/moisture ingress.
- Do the simple, easiest and least expensive things first – it does not always entail spending a lot of money.
- Expertise amongst many product manufacturers is very good – but sound independent expertise is key to well-informed refurbishment and retrofit.
- More research is required, particularly concerning wall insulation and the affect on existing building-fabric.
- Training & education to have the understanding and maintaining of buildings set as the foundation for all other taught activities and issues.
- Well-informed and balanced promotion and debate of retrofit and refurbishment that covers risks as well as benefits. Most current information focuses on energy-reduction and does not even mention any risks.
- Reassessment of current understanding on the thermal qualities of buildings based upon the latest on-site analysis – this particularly concerns solid-wall buildings.

CASE STUDIES

A number of ongoing research initiatives are exploring the approaches and methods for green-refurbishment or retrofitting existing buildings. Until a greater understanding of the short-, medium-, and long-term effects of green-refurbishment and retrofit are known, including cumulative impacts, considerable caution is warranted. Where uncertainty and risk prevail, the adoption of basic principles of good building maintenance, possibly combined with simple and easily reversible 'greening' measures, is regarded as a relatively low-risk approach to be taken (Edwards & Townsend 2010).

A number of projects are being/have been monitored by key stakeholder organisations in the UK:

British Research Establishment (BRE):

<http://www.bre.co.uk/podpage.jsp?id=2426>

Constructing Excellence:

<http://www.constructingexcellence.org.uk/resources/demonstrationprojects/>

Energy Technologies Institute (ETI):

<http://www.energytechnologies.co.uk/Home/Technology-Programmes/Buildings.aspx>

Prince's Regeneration Trust (PRT):

<http://www.princes-regeneration.org/sustainableheritage/case-studies/>

Sustainable Development Commission (SDC):

<http://www.sd-commission.org.uk/pages/built-environment.html>

Technology Strategy Board (TSB):

<http://www.innovateuk.org/competitions/retrofit-for-the-future.ashx>

UK Green Building Council (UKGBC):

<http://www.ukgbc.org/site/media/index?id=889>

USEFUL REFERENCES AND FURTHER GUIDANCE

TEXTS

- BIS & DECC, 2009. *The UK Low Carbon Industrial Strategy*. Department for Business, Innovation and Skills and Department of Energy and Climate Change.
- CE, 2009. *Never Waste a Good Crisis: A Review of Progress Since Rethinking Construction and Thoughts for Our Future* by Andrew Wolstenholme. London: Constructing Excellence.
- CE, 2010. Chapter 4: Sustainability, In, *Clients' Commitments Best Practice Guide*. London: Constructing Excellence (Construction Clients' Group).
- Charles, P. and Connolly, S. (eds), 2005. *Environmental Good Practice Site Guide*. Second Edition. London: CIRIA.
- DECC, 2009. *The UK Low Carbon Transition Plan*. Department of Energy & Climate Change. Norwich: The Stationery Office.
- Edwards, J. and Townsend, A., 2010. We're Cool: Carbon Reduction and Built Heritage Can Coexist. *Construction Research and Innovation* (CRI) Vol. 1 (4), 36-37.
- Green, A., 2010. *Taking the Measure of a Low Carbon Industry*. Construction Manager (CM) May 2010, 41-44.
- IGT, 2010(a). *Low Carbon Construction: Emerging Findings*. Innovation & Growth Team. Department for Business, Innovation & Skills.
- King, D., 2010. The Great Zero-Carbon Skills Gap. *Construction Research and Innovation* (CRI) Vol. 1 (1), 24-29.
- Ryan, C., 2011. *Traditional Construction for a Sustainable Future*. Abingdon: Spon Press.
- IGT, 2010(b). *Low Carbon Construction: Final Report*. Innovation & Growth Team. Department for Business, Innovation & Skills.
- PRT, 2010. *The Green Guide for Historic Buildings: How to Improve the Environmental Performance of Listed and Historic Buildings*. The Prince's Regeneration Trust. Norwich: The Stationery Office (for The Prince's Regeneration Trust).
- SFFC & BIS, 2009. *Strategy for Sustainable Construction: Progress Report*. September 2009. Strategic Forum for Construction & HM Government (Department for Business, Innovation and Skills).
- SFFC & CT, 2010. *Carbon: Reducing the Footprint of the Construction Process. An Action Plan to Reduce Carbon Emissions*. Prepared by Joan Ko on behalf of the Strategic Forum for Construction and the Carbon Trust. London: Construction Products Association.
- Smith, K., 2010. A Little Ticking Time Bomb. *Construction Research and Innovation* (CRI) Vol. 1 (3), 14-19.
- Wilkinson, G., 2010. *The Next Milestone on the Road to Zero Carbon*. Construction Manager October 2010, 35-38.

WEBSITES

General:

- Act on CO₂ Campaign – www.direct.gov.uk/actonco2
- Association for the Conservation of Energy (ACE) – www.ukace.org
- Chartered Institute of Building (CIOB) – www.ciob.org
- Society for the Environment (SocEnv) – www.socenv.org.uk
- Biomass Energy Centre – www.biomassenergycentre.org.uk
- British Hydropower Association – www.british-hydro.org
- British Wind Energy Association (BWEA) – www.bwea.com
- Building Research Establishment (BRE) – www.bre.co.uk
- Building Services Research and Information Association (BSRIA) – www.bsria.co.uk
- Building Control Northern Ireland – www.buildingcontrol-ni.com
- Carbon Trust – www.carbontrust.co.uk
- Centre for Alternative Technology (Machynlleth, Wales) – www.cat.org.uk
- Changeworks – www.changeworks.org.uk
- Chartered Institution of Building Services Engineers (CIBSE) – www.cibse.org
- Combined Heat & Power Association (CHPA) – www.chpa.co.uk
- Committee on Climate Change – www.theccc.org.uk
- Community Sustainability Energy Programme (CSEP) – www.communitysustainable.org.uk
- Constructing Excellence – www.constructingexcellence.org.uk
- Construction Industry Research and Information Association (CIRIA) – www.ciria.org
- Construction Products Association (CPA) – www.constructionproducts.org.uk
- Crichton Carbon Centre – www.carboncentre.org
- Department for Communities and Local Government (DCLG) – www.communities.gov.uk
- Department for Environment, Food & Rural Affairs (DEFRA) – www.defra.gov.uk
- Department of Energy and Climate Change (DECC) – www.decc.gov.uk
- Enact Energy – www.enactenergy.co.uk
- Energy Efficiency Partnership for Homes – www.eeph.org.uk
- Energy Networks Association (ENA) – www.energynetworks.org
- Energy Saving Trust – www.energysavingtrust.org.uk
- Environment Agency – www.environment-agency.gov.uk/
- Envirowise – www.envirowise.gov.uk
- European Solar Thermal Industry Federation (ESTIF) – www.estif.org
- Flood Support Microsite (AVIVA) – www.floodresilienthome.com

- Generation Homes – www.generationhomes.org.uk
- Gentoo Group – www.gentooigroup.com
- Green Electricity – www.greenelectricity.org
- Green Grants Machine – www.greengrantsmachine.co.uk
- Ground Source Heat Pump Association (GSHPA) – www.gshp.org.uk
- Intergovernmental Panel on Climate Change (IPCC) – www.ipcc.ch
- Local Government Association – www.lga.gov.uk
- Low Carbon Buildings Programme (Phase 1) – www.lowcarbonbuildings.org.uk
- Low Carbon Buildings Programme (Phase 2) – www.lowcarbonbuildingsphase2.org.uk
- Micropower Council – www.micropower.co.uk
- National Energy Action (NEA) – www.nea.org.uk
- Natural England – www.naturalengland.org.uk
- Northern Ireland Environment Agency – www.ni-environment.gov.uk
- Northern Ireland Planning Service – www.planningni.gov.uk
- One Planet Products – www.oneplanetproducts.com
- Planning Portal – www.planningportal.gov.uk
- Real Assurance Scheme – www.realassurance.org.uk
- Salix Finance – www.salixfinance.co.uk
- Scottish Government (for planning and building standards) – www.scotland.gov.uk
- Sustainable Development Commission (SDC) – www.sd-commission.org.uk
- Sustainable Energy Academy (SEA) – www.sustainable-energyacademy.org.uk
- Triodos Bank – www.triodos.co.uk
- UK Climate Impacts Programme (UKCIP) – www.ukcip.org.uk
- UK Solar Energy Society (UK-ISES) – www.uk-ises.org
- Unity Trust Bank – www.unity.co.uk
- T-Zero – www.tzero.org.uk
- Warm Front – www.warmfront.co.uk
- Warm Homes Scheme – www.warm-homes.com
- Water Footprint Network (WFN) – www.waterfootprint.org
- Wolseley Sustainable Building Center – www.wolseleysbc.co.uk
- Zero Carbon Hub – www.zerocarbonhub.org

Websites specifically useful for retrofit and refurbishment:

- Boiler Efficiency Database (SEDBUK) – www.boilers.org.uk
- Building Research Housing Group (BRHG) – www.brhg.org.uk
- Climate Change Act (2008) – www.opsi.gov.uk
- Climate Change & Your Home (English Heritage) – www.climatechangeandyourhome.org.uk

- Energy Performance Certificates – <http://epc.direct.gov.uk>
- Energy Saving Trust – www.energysavingtrust.org.uk
- Department of Energy & Climate Change (DECC) – www.decc.gov.uk
- Existing Homes Alliance – www.existinghomesalliance.org.uk
- Feed-in tariffs – www.fitariffs.co.uk
- Generation Homes – www.generationhomes.org.uk
- Good Homes Alliance – www.goodhomes.org.uk
- Great British Refurb Campaign – www.greatbritishrefurb.co.uk
- Green Book Live – www.greenbooklive.com
- Historic Scotland – www.historic-scotland.gov.uk
- Low Carbon Construction (IGT *Emerging Findings & Final Report*) – www.bis.gov.uk/constructionigt
- Microgeneration Certification Scheme (MCS) – www.microgenerationcertification.org
- National Energy Foundation – www.nef.org.uk
- Old Home SuperHome (Sustainable Energy Academy) – www.sustainable-energyacademy.org.uk
- Renewable Energy Association (REA) – www.r-e-a.net
- Renewable Energy Centre – www.therenewableenergycentre.co.uk
- Renewable Heat Incentive (RHI) Scheme – www.decc.gov.uk
- Solar Trade Association – www.solar-trade.org.uk
- UK Green Building Council (UKGBC) – www.ukgbc.org
- WUFI building performance simulation software – www.wufi-pro.com/

Websites useful for sustainability for good quality building care:

- Cadw – www.cadw.wales.gov.uk
- English Heritage – www.english-heritage.org.uk
- Georgian Group – www.georgiangroup.org.uk
- Historic Scotland – www.historic-scotland.gov.uk
- Institute of Historic Building Conservation (IHBC) – www.ihbc.org.uk
- National Trust – www.nationaltrust.org.uk
- Prince's Foundation for the Built Environment – www.princes-foundation.org
- Prince's Regeneration Trust – www.princes-regeneration.org
- Shrinking the Footprint (Church of England) – www.shrinkingthefootprint.cofe.anglican.org
- Society for the Protection of Ancient Buildings (SPAB) – www.spab.org.uk
- Theatres Trust – www.theatrestrust.org.uk
- Twentieth Century Society – www.c20society.org.uk
- Victorian Society – www.victoriansociety.org.uk

KEY ACTION POINTS

ACTION	BY WHOM?	“COULD”, “SHOULD”, OR “MUST”	IS THIS ACTION MEASURABLE? IF SO, HOW?
<p>1) Creation of a <i>Knowledge Network</i> for the acquisition, dissemination and use of information and data (i.e. Smart Data) relating to the retrofitting and refurbishment of the UK's extant building stock, to include data from 'before' and 'after' measurement, and feedback from ongoing monitoring tools. Consideration should be given to the historic environment.</p>	<p>DCLG</p>	<p>Must</p>	<p>Metric: KgCO₂ e/m²/yr.</p> <p>Sector feedback from the use of monitoring tools, e.g. DEC's & EPC's.</p>
<p>2) Develop a <i>Comprehensive Strategy</i> (as part of a <i>Government Strategic Framework</i>) for the retrofit/refurbishment of the UK's domestic and non-domestic building stock.</p>	<p>DCLG DECC CIC/CIOB</p>	<p>Must</p>	<p>Metric: Not Applicable.</p> <p>Procure data relating to the number of domestic and non-domestic buildings refurbished/retrofitted – for domestic buildings this should include information relating to 'measures based', 'whole house', 'whole street' 'neighbourhood' and district-scale measures.</p>
<p>3) Develop and implement a range of mechanisms or 'levers' (regulation, fiscal reward, fiscal penalty, information/education), to incentivise owners and/or occupiers to improve the energy efficiency of their buildings (i.e. insulation and building systems), to include the development of Energy Management Plans.</p>	<p>DECC Green Deal</p>	<p>Must</p>	<p>Metric: KgCO₂ e/m²/yr.</p> <p>Kwh metering of energy use and use of monitoring tools, e.g. DEC's & EPC's.</p> <p>Procure data relating to consumer buy-in (i.e. quantify measures by type and their geographical distribution) to incentive mechanisms e.g. Green Deal/ Pay-as-You-Save, Low-Cost Loans.</p> <p>Procure data from the measures implemented (i.e. to monitor the success, or lack of, of 'greening' measures through the capture of building-performance data).</p> <p>Procure data on levels of penalties issued.</p>
<p>4) Extension of use and more effective management building-performance tools.</p>	<p>DCLG</p>	<p>Must</p>	<p>Metric: KgCO₂ e/m²/yr.</p> <p>EPC's, DEC's, CE-TC350, SAP, S-BEM, CEEQUAL, BREEAM, LEED, Cradle to Cradle, Carbon Profiling, Local Carbon Frameworks.</p> <p>Procure data relating to consumer buy-in (i.e. quantify measures by type and their geographical distribution).</p> <p>Procure data from the measures implemented (i.e. to monitor the success, or lack of, of 'greening' measures through the capture of building-performance data).</p> <p>Procure data on levels of penalties issued.</p> <p>Procure data on levels of accreditation for good and best practice.</p> <p>Anticipated impact: Global.</p>

KEY ACTION POINTS CONT.

ACTION	BY WHOM?	"COULD", "SHOULD", OR "MUST"	IS THIS ACTION MEASURABLE? IF SO, HOW?
<p>5) Develop an education & skills programme for the entire property and construction supply-chain in relation to all aspects of the refurbishment and retrofit market, to include conservation and heritage issues.</p>	<p>SSC HE & FE Sectors Educational establishments</p>	<p>Must</p>	<p>Metric: Not Applicable.</p> <p>Procurement of data from education providers and sector bodies (education and construction) relating to levels of provision.</p> <p>Procure data from education providers and sector bodies (education and construction) relating to uptake of provision.</p> <p>Procure data from education providers and sector bodies relating to success/completion rates.</p> <p>Procure data from funding bodies in relation to R&D.</p> <p>Anticipated impact: Global.</p>
<p>6) Revision of the Building Regulations to introduce more rigorous requirements for works to existing buildings and the revision of the application and parameters of monitoring tools (e.g. DECs). Introduction of guidance equivalent to the <i>Code for Sustainable Homes</i> for refurbishment and retrofitting work.</p>	<p>DECC DCLG</p>	<p>Must</p>	<p>Metric: KgCO₂ e/m²/yr.</p> <p>Sector feedback from the use of monitoring tools, e.g. DECs & EPCs.</p> <p>Procure data from industry bodies relating to measured effects of revised regulations, to be used as feedback for informing future revisions.</p> <p>Anticipated impact: National.</p>

John Edwards FCIQB & Andrew Townsend MCIQB, March 2011