Management guide CTV038

Low Carbon Refurbishment of Buildings

A guide to achieving carbon savings from refurbishment of non-domestic buildings

Contents

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Executive summary

Non-domestic buildings are responsible for nearly a fifth of all UK carbon emissions. Significant cuts in emissions from non-domestic buildings are therefore likely to be essential as part of the UK's commitment to reduce carbon emissions by at least 60% by 2050.

It is estimated that 60% of the buildings that will be standing in 2050 have already been built. Although there has been much recent focus on measures to reduce the emissions from new buildings, the existing building stock remains largely untouched and many refurbishment projects miss opportunities to reduce emissions and deliver low carbon buildings.

Refurbishment covers a wide range of activities, from relatively minor works to very significant changes to the fabric or internal layout of a building. In order to understand the challenges and opportunities presented by refurbishment projects, the Carbon Trust has engaged with 10 typical commercial and public sector building refurbishments, working with each from initial concept through to successful completion and ongoing operations.

Encouragingly, our experience has shown that delivering a low carbon refurbishment doesn't require significant increases in complexity, or adoption of high risk or unproven technical solutions. On the contrary, nearly all refurbishments offer opportunities to reduce carbon emissions beyond the standards set by building regulations. However, conventional refurbishment projects often miss the opportunities available, leading to unintentional and unnecessary increases in energy use and associated emissions.

This guide is aimed at those who wish to ensure that a planned refurbishment delivers carbon savings, in addition to meeting its other objectives. It provides clear, practical guidance based on real world experience. The guide is structured around a roadmap for the refurbishment process, identifying the key intervention points during the preparation, design, construction and use phases of the project.

A key common factor in successful low carbon refurbishments is a corporate commitment to cutting carbon emissions, coupled with effective project management to ensure that this is translated into targets and approaches which ensure the low carbon objectives are met. This guide includes advice on translating the vision into the design brief, setting targets, appointing contractors, monitoring progress and making sure the refurbished building is commissioned and operated as intended.

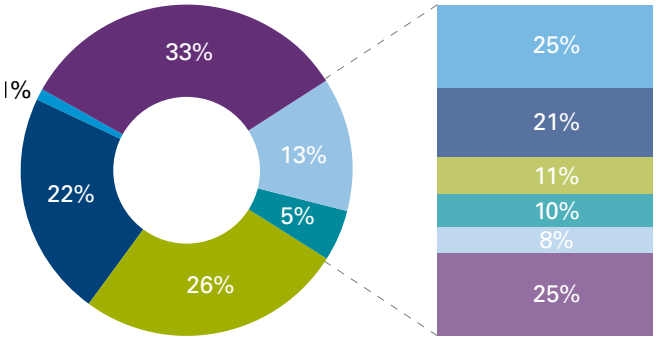
This guide is intended to help you deliver building refurbishments that reduce operating costs, improve comfort levels, increase occupant satisfaction and enhance reputation, as well as delivering significant reductions in carbon emissions.

Introduction

With the UK committed to a 60% reduction of carbon emissions by 2050, building owners and occupiers will come under increased pressure to reduce carbon emissions. A large part of the challenge in the UK is to upgrade the existing building stock.

Carbon emissions from energy use in non-domestic buildings account for around 18% of total emissions in the UK (see *Figure 1*). Much of the building stock is old and inefficient in its energy use, and is being replaced at a very slow rate. Although the Building Regulations relating to energy use in new and refurbished buildings have recently (2006) been updated, minimum compliance with Building Regulations alone will not achieve the scale of carbon emission reductions now required.

Figure 1 *UK Carbon Emissions (2003) for the whole economy and broken down by non-domestic building type*



Source: BRE 2006

- Transport
- Commercial and Public buildings
- Industrial buildings
- Domestic buildings
- Industrial process
- Agriculture
- Factories
- Retail
- Hospitality
- Warehouses
- Commercial Offices
- Remainder
  Govt Estate 3%, Other public offices 1%, Health 3%, Higher education 3%, Schools 4%, Sports/Heritage 4%, Transport 3%, Other 4%

Of the buildings that will be standing in 2050, 60% are already built and 40% will pre-date 1985 when Building Regulations relating to the conservation of fuel and power (Part L) were first introduced. It is therefore very important to tackle energy consumption in existing buildings.

Source: BRE 2006

There are increasing regulatory pressures to deliver low carbon buildings. Since April 2008, Energy Performance Certificates are required on the construction, sale or lease of larger non-domestic buildings. They take full effect from 1 October 2008 for most buildings. These certificates should provide additional incentives to exceed the minimum Building Regulations requirements for refurbished buildings.

Future regulations which could affect carbon emissions in non-domestic buildings include the Carbon Reduction Commitment, a carbon trading scheme for non-energy intensive businesses. Further revisions to the Building Regulations are expected in 2010 and a programme of revisions is likely to happen at three year intervals from 2010.

See Appendix A for information on Building Regulations in England and Wales and Appendix B for links to information about Regulations in Scotland and Northern Ireland.

As well as regulatory pressures, other drivers for low carbon buildings include:

- Reduced cost of operating facilities with lower energy use.
- Reduced risks due to future energy cost and supply uncertainty.
- Better comfort, satisfaction and productivity for occupants.
- Recruiting and retaining quality staff by demonstrating corporate responsibility.
- Sales and marketing benefits from demonstrating a commitment to reducing carbon emissions.

Despite the increasing legislative and market drivers for low carbon buildings, the principal drivers for the decision to refurbish a building are still primarily to update the brand format, improve the quality of the building for the occupants or attract higher rental values and new tenants, rather than reducing carbon emissions.

Carbon Trust experience suggests that low carbon refurbishment is not normally constrained by the availability of appropriate technologies. The key issue is more likely to be the translation of corporate level commitment into a clear vision for refurbishment projects, and ensuring this vision is translated into targets and approaches which are followed throughout the project to ensure that the low carbon objective is delivered.

This Management Guide therefore proposes a series of interventions and recommendations to assist clients and project managers to specify and deliver *low carbon* refurbishments. The process could be equally applicable for managing other sustainability objectives, such as embodied carbon and water use. This is not a general guide to managing refurbishment projects; its recommendations are specific to reducing a building's operational carbon emissions compared with 'normal' refurbishments.

The guide has been produced following an analysis of the 10 refurbishment projects included in the Carbon Trust's Low Carbon Building Accelerator (LCBA), and discussions with clients, managers and professional bodies. Wider experience from the UK and abroad of major refurbishment work has also been contributed. As such, this guide is founded on practical, on-the-ground experience of organisations attempting to pursue a lower carbon approach to refurbishment.

The Low Carbon Buildings Accelerator

The Carbon Trust's Low Carbon Buildings Accelerator (LCBA) programme has been working with 10 'typical' refurbishment projects to understand how carbon emissions can be reduced. The work has identified that, for most refurbishments, the key success factors are about setting the vision, implementing the vision through the design and construction process and ensuring good commissioning and handover.

Further findings from the LCBA programme will be published separately to this guide.

The buildings involved in the project included:

- Four retail (high street retailers, bank).
- Two restaurants.
- Two government offices.
- One leisure centre.
- One military accommodation building.

For more information see **www.carbontrust.co.uk/lcba**

The low carbon refurbishment process

This section describes the different types of refurbishment and introduces the recommended process steps to deliver a low carbon refurbishment.

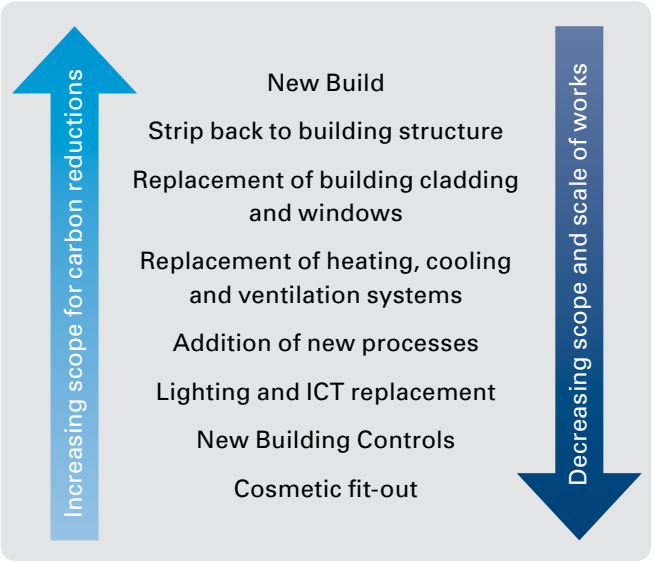
Low carbon refurbishment scope

'Building refurbishment' describes activities ranging from minor works to replacement of services and facades, which alter the interior and/or exterior of a building but fall short of demolition and rebuilding. As well as structural repairs and improvements to the external and internal appearance, refurbishments enhance the occupied space, by introducing new processes (e.g. new cooking appliances), improving comfort (e.g. by changing ventilation provision) or modernising other services (e.g. building controls).

All scales of refurbishment activity offer opportunities to deliver reductions in operational carbon emissions. In most instances, this is through increasing the energy efficiency of the refurbished building by improving the thermal performance of the building envelope (including insulation), and reducing energy use for lighting, heating, cooling, ventilation and equipment. It could also include fuel switching (e.g. from electric or oil based heating to gas heating) and on-site energy generation. There may also be opportunities for passive measures such as daylighting, shading and natural ventilation, depending on how radical a refurbishment is planned.

The larger the scope and scale of the refurbishment works, the greater the ability to influence the carbon emissions of the building (see *Figure 2*) and the lower the incremental cost of doing so. It may similarly be cost-effective to increase the scope and scale of refurbishment works to increase opportunities to reduce carbon emissions.

Figure 2 *Relationship between refurbishment scope and ability to influence carbon emissions*



Refurbishment projects differ from new builds in a number of ways, other than simply the scale. For example, existing buildings tend not to capture the imagination in the same way as new buildings. This is because organisations often do not set ambitious targets for refurbishments as they don't perceive that inspired or innovative solutions are required.

Decisions made during refurbishment processes are already constrained by the existing building structure, form and orientation, whereas there is usually a 'blank canvas' for new buildings. As a result of these perceived and actual constraints, organisations may limit the scope of their decisions more than is necessary, not realising the actual potential for reducing the carbon emissions from the refurbished building.

Refurbishment can lead to increases in energy use

Carbon Trust experience suggests that many refurbishments actually lead to increases in absolute carbon emissions. This can be due to changes in the use of the building (for instance higher customer numbers), addition of new 'non-regulated' loads or increased lighting levels.

Regulated loads are those energy uses regulated by the Building Regulations, which cover heating, cooling, ventilation, lighting and hot water. Non-regulated loads include IT, catering, EPOS (electronic point of sale) and ATMs.

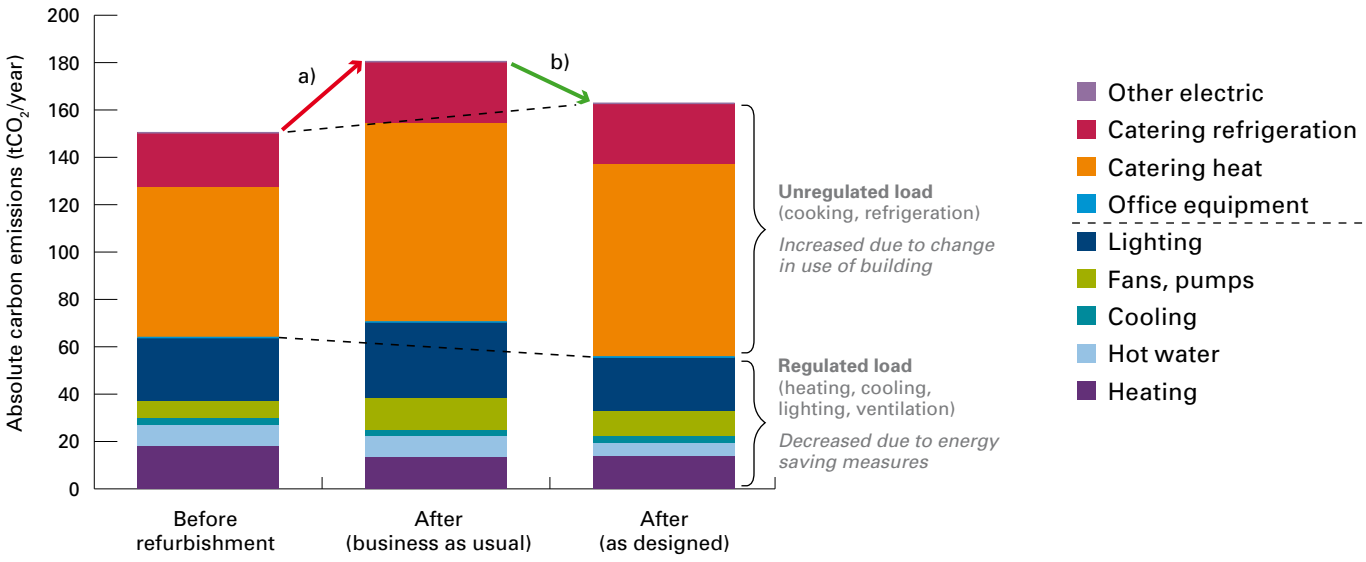
Figure 3 gives an example from a restaurant refurbishment, primarily aimed at updating the brand and improving comfort. It shows modelled carbon emissions for three different scenarios:

- **Before refurbishment**: the total annual emissions from the original building are around 150 tonnes of CO_2, of which just over 42% is from regulated energy use (heating, cooling, lighting, ventilation) and just under 58% from non-regulated use (cooking, refrigeration).
- **After refurbishment ("business as usual")**: the absolute carbon emissions following typical refurbishment procedures are around 20% higher than those for the original building, as illustrated by *arrow a*. This is mainly due to a significant increase in the number of meals to be served at the restaurant and the associated energy use, particularly for catering and refrigeration.
- **After refurbishment ("as designed")**: the inclusion of low carbon measures for the actual refurbishment design leads to reductions in predicted energy used for hot water, ventilation and lighting. As a result, the carbon emissions are around 10% lower than for the "business as usual" refurbishment, as illustrated by *arrow b*. However, despite this improvement, the overall emissions remain higher than the original building due to the increased non-regulated loads.

Structure of this guide

This guide suggests the key intervention points for a low carbon approach to refurbishment. The table overleaf provides the suggested management process flow and also provides the structure of the remainder of the guide. The figure also maps the intervention points in this process against the Royal Institute of British Architect's Outline Plan of Work 2007,[2] as this is very commonly used in managing construction projects.

Figure 3 *An example of increased energy use after refurbishment*



[2] The Outline Plan of Work is used by permission of the RIBA and is © RIBA 2007.

Phase	Low Carbon Refurbishment Process	Page	RIBA Work Stages[3]
Prepare	Commit to a low carbon refurbishment	7	**Preparation**
	Establish a low carbon vision for the refurbishment	7	**A** Appraisal
	Develop a low carbon outline brief	7	
	Establish the current carbon footprint of the building	8	**B** Design brief
	Set carbon targets for the refurbishment	8	
	Undertake a pre-refurbishment assessment	9	
	Consult stakeholders	10	
	Consider a budget for low carbon elements	10	
	Appoint a carbon champion	11	
	Choose an appropriate design team	11	**Design**
	Empower the design team	12	**C** Concept
Design	Keep the low carbon theme up front	13	**D** Design development
	Develop an integrated low carbon design	13	
	Encourage exploration of a wide range of low carbon options	14	
	Allow flexibility in design	15	
	Use energy modelling data	16	**E** Technical design
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	Manage the budget and scope	17	
	Approve the integrated design	18	
	Include targets in contracting arrangements	18	**Pre-construction**
Construct	Ensure effective project management	19	**F** Production information **G** Tender documentation
	Choose an appropriate contractor and subcontractors	19	**H** Tender action
	Get buy-in from site workers	19	**Construction**
	Monitor site progress against objectives	20	**J** Mobilisation
	Ensure high quality commissioning	20	**K** Construction to practical completion
	Set up energy monitoring	20	
Use	Make sure the occupants understand the building	21	**Post practical completion**
	Make sure the building operator understands the building	21	**L** Post practical completion
	Conduct a post-occupancy evaluation	22	
	Check energy use and comfort conditions and make changes	22	
	Make the most of the low carbon building	22	

[3] © RIBA 2007

Phase 1: Prepare

This section covers the process stages from the initial decision to refurbish to the procurement and empowerment of the design team. This is a critical stage in setting the expectations and requirements for the refurbishment.

Commit to a low carbon refurbishment

The key initial step is for the senior team to commit to a lower carbon refurbishment (or programme of refurbishments), ideally as part of the initial decision to refurbish the building. Many organisations now have environmental policies and are aware of the need to reduce carbon emissions from their operations, but miss the opportunity to embed these principles in refurbishment projects, particularly when the refurbishment is not extensive.

The drivers for low carbon refurbishment include:

- Ensuring compliance with progressively tightening Building Regulations.
- The requirement to provide Energy Performance Certificates at the time of sale or letting and to display actual energy performance (currently for public buildings only).
- Reduced cost of operating facilities with lower energy use.
- Reducing risks due to future energy cost and supply uncertainty.
- Better comfort, satisfaction and productivity for occupants.
- Recruiting and retaining quality staff by demonstrating corporate responsibility.
- Sales and marketing benefits of a demonstration of commitment to reducing carbon emissions.

Getting senior management buy-in to the delivery of a low-carbon building is a vital first step in the refurbishment process. It sets a clear mandate for the project team to focus on reducing energy consumption as well as meeting other project aims.

Establish a low carbon vision for the refurbishment

The project vision statement should clearly set out the objective for a low carbon building. The vision statement (which may be part of a statement of need or requirements) should clearly state the objectives of the project. It is important that this includes the requirement for delivery of a low carbon refurbishment as this vision statement will guide the development of the outline and detailed briefs. The project sponsor, and other senior stakeholders, should be fully supportive of the low carbon aspirations.

Develop a low carbon outline brief

The outline brief should develop the vision into more specific low carbon objectives and set targets to be achieved. This is the first stage in developing the vision statement into a full design brief. Developing the brief for the refurbishment will require the client to undertake option appraisals and feasibility studies and to develop the outline project budget and the business case. In addition, for a low carbon refurbishment, the following inputs are also important:

- Establishing the current carbon footprint of the building.
- Setting a carbon emissions target for the refurbished building.
- Undertaking a pre-refurbishment survey.
- Consulting key stakeholders such as the facility manager and energy manager.

These activities are described in more detail below. For some of these, it may be advisable to employ an independent adviser with the necessary expertise.

RIBA Work Stage A – Appraisal completed – importance of low carbon design recognised.

Establish the current carbon footprint of the building

It is essential to have a clear understanding of the energy use and carbon footprint of the building before refurbishment. This allows realistic targets to be set and post-refurbishment savings to be demonstrated.

Ideally, energy data should be based on half hourly meter readings at site level, although in many cases for smaller buildings it may be necessary to use energy bill data. If there are submeters or it is possible to install temporary meters, additional data about the energy performance of particular systems such as lighting, cooling, catering etc can be extremely valuable inputs for the design process. All data collected must be made available to the design team. Additional information on occupancy and use of the building will also put the energy consumption in context, bearing in mind any changes in usage expected following the refurbishment.

Set carbon targets for the refurbishment

Clear low carbon targets must be set for the refurbishment in the outline brief. These could be in line with best practice for the relevant sector or building type, although data is not available for all sectors (see Appendix B for references to the benchmarks available). Other approaches include benchmarking relative to other buildings within the company's building portfolio or setting a percentage energy saving or carbon reduction target relative to the current building.

Early modelling of the building's energy use is an important approach which can be used, particularly where the building fabric (ceiling, walls, windows, floors and doors) is to be upgraded. A model can be created based on the existing building, and potential energy saving measures can be incorporated, demonstrating what might be possible and allowing targets to be defined.

Targets could also be set for some specific aspects of the building, or for specific equipment (such as catering) and these should be included in the outline brief.

Targets are best defined in annual tonnes of carbon emissions, rather than in kWh of electricity, gas or oil. Different energy sources have different carbon emissions associated with their use, and setting an overall carbon target encourages consideration of the energy source to be used as well as the efficiency of the equipment.

Case study: North Wales Police

North Wales Police Headquarters has undergone its first major refurbishment in nearly 40 years. The internal working environment had limited control in both summer and winter with extreme fluctuations in temperature being reported. The key driver for this refurbishment was to improve the thermal performance of the external envelope to enable a low carbon solution for heating and cooling, whilst maintaining a naturally ventilated building. North Wales Police (NWP) has strong environmental and energy management policies and was keen to ensure that the refurbishment was low carbon. On advice from the LCBA programme, NWP agreed to set a target of a minimum of 20% reduction in carbon emissions.

This target was based on the modelling of various options undertaken by both the NWP design team and the Carbon Trust, and it was integrated into the design brief as a minimum standard which the design team were encouraged to try to exceed. The design team took up the challenge and designed the building to achieve a 30% emission reduction. This has been achieved by improvements to the fabric and addition of solar shading, together with a heating system that is zoned on the Building Management System with localised control.

Undertake a pre-refurbishment assessment

A thorough pre-project assessment of the building should be conducted to ensure that the brief captures the low carbon opportunities available. This assessment should include both a technical survey and an evaluation of occupants' perceptions of the building.

The technical survey should document the existing building condition, orientation, infrastructure, and management practices. The survey has a number of advantages, including:

- Understanding the building-specific risks and issues.
- Identification of additional building-specific opportunities for carbon reduction, for example by identifying plant or fabric elements which need maintenance or replacement.
- Identification of easy wins such as remedial commissioning of existing services or improved energy management practices.

Where standard specifications exist, for example for a rolling programme of refurbishments, a pre-project assessment should allow the standard approach to be optimised for the specific conditions and nature of each building. It may also demonstrate that improvements can and should be made to standard specifications for use in subsequent refurbishments.

The occupancy evaluation allows occupants' perceptions of the building prior to the refurbishment to be understood, and may point to further changes to be made to the building to improve productivity and occupant satisfaction. A post refurbishment evaluation should also be carried out on completion of the refurbishment. Appendix B refers to information on pre- and post- occupancy evaluation.

Case study: Hogsmill pub

Older buildings often suffer from a lack of building information such as drawings, plans, operation and maintenance manuals. In those cases where limited data is available it may be necessary to conduct a more detailed on-site survey.

In most of the Low Carbon Buildings Accelerator projects, additional building-specific opportunities were identified by on-site surveys. For example, a pre-refurbishment survey of Whitbread's Hogsmill pub in South London identified a number of site-specific carbon reduction options. These involved areas of the building which were not in the original project scope. This included improvements to the insulation levels in parts of the building and splitting the cellar in two so that the inline beer coolers and ice machine were not venting heat into the cooled part of the cellar. Additional insulation was also added to the cooled part of the cellar.

To view the Hogsmill video case study, visit **www.carbontrust.co.uk/lcba**

The pre-project assessment is an important way to identify additional carbon savings and to highlight any low carbon technologies with a long procurement lead time. This will avoid opportunities being lost due to tight project timeframes.

Consult stakeholders

It is important to understand what the key stakeholders think of the existing building and this can be a powerful input into the refurbishment design. It may have been feedback from occupants and building users which prompted the refurbishment in the first place. It is also important to involve energy managers and facility managers, both for their knowledge of the existing building and its services and because of their focus on the operation and management of the building after refurbishment.

Integrated planning is the best way to consider the needs of these various interests. This should include all of the key internal stakeholders likely to be involved in both the refurbishment project and the operation and use of the finished building. Setting the brief in this way will also create ownership, enable the most efficient allocation of capital and operational expenditure budgets and increase the range of opportunities for improvements within the scope of the refurbishment.

Consider a budget for low carbon elements

It may be appropriate to set aside a dedicated budget for low carbon measures, in order to ensure that these are not 'value engineered' out of the scope at later stages in the project. However this may not be necessary where the requirements for low carbon measures are a core part of the overall project brief and targets.

In cases where it is more practical to ringfence specific funds to be used for low carbon measures, this could be based on an initial assessment of measures which are likely to be feasible. Alternatively, a certain percentage of the overall budget could be put aside to cover the incremental capital costs of lower carbon alternatives. It is worth noting that Building Regulations now require 10% of the project budget to be spent on 'consequential improvements' to the energy performance of a building which is being extended, if the building is greater than 1,000m^2.

Case study: 'The LC' (former Swansea Leisure Centre)

As part of the City and County of Swansea's sustainability policy, there was an aspiration for the refurbished leisure centre building to be energy efficient. A number of key measures were included in the base design and budget as part of the ambition to reduce the environmental impact of the building. These included high insulation values, gas-fired combined heat and power, use of energy efficient lighting, extensive lighting controls, heat recovery on air handling units, high efficiency motors and variable speed fans and pumps.

The Carbon Trust's consultants identified some additional approaches to reducing the carbon emissions, including a biomass boiler, backwash heat recovery, water cooled ammonia chillers and plant room heat recovery. Based on the carbon emissions reduction, an additional sum of £500,000 (2% of the original budget) was included within the project budget to cover these measures.

Case study: Marks & Spencer

Marks & Spencer now approaches budgeting for energy efficiency in its store remodel programme by undertaking a pre-refurbishment energy audit to identify energy efficiency opportunities.

If any major items, such as heating, ventilation or air-conditioning equipment, need to be overhauled this can be funded from the Essential Works budget. Other measures can be funded from a separate budget allocated for energy efficiency measures across the whole store remodel programme.

Appoint a carbon champion

A carbon champion should be designated at an early stage in the project, to keep a focus on the energy use implications of design decisions. This person's role should be to ensure that the client's vision for a low carbon refurbishment is kept in the project team's focus at all times and to act as an advocate for energy efficiency. The carbon champion should be competent in building design and engineering issues so that they are not marginalised within the team. They should ideally be appointed from within the client organisation, but if the relevant skill set does not exist internally then this role can be outsourced.

RIBA Work Stage B – Design Brief completed – low carbon outline brief and targets set.

Choose an appropriate design team

The design team should have experience in low carbon design. Some designers do not have in-depth knowledge of low carbon design and may resist new, unfamiliar approaches. Including an assessment of the capability and experience of designers in delivering low carbon refurbishments, as a key element in the choice of design team, will make achieving a low carbon design much more straightforward.

The preference should also be to select an adventurous and motivated design team and project manager, who are open to solutions beyond the norm whilst also able to identify and manage any potential risks. If the outline brief has identified the need for a specialist service or expertise, this should be included as part of the design team selection process.

Project managers, whether in-house or external, should also be appointed and made aware of the low carbon objectives as early as possible, to ensure continuity and consistency and to help achieve the corporate low carbon targets.

It is important to ensure that the contract acts as a driver for low carbon design. Traditionally, design team fees are set at a percentage of the cost of installation; as many low carbon buildings have minimal services, and high carbon buildings have extensive services, designers are not financially incentivised to design a low carbon scheme. A better approach is to negotiate fees based on the amount of design, modelling and testing work required.

Building Design Advice

The Carbon Trust Design Advice service helps to identify carbon savings in new and renovation projects. Support ranges from self-help guidance, to free or subsidised design and construction consultancy advice to help you maximise opportunities for specifying energy efficient plant and fabric. To apply call the Customer Centre on 0800 085 2005, or visit **www.carbontrust.co.uk/designadvice**

Empower the design team

Make sure the design team are encouraged and supported to implement low carbon solutions. Specified individuals on the design team should be empowered to make decisions regarding meeting the low carbon targets in the brief without needing to constantly consult the client. It is also important that the carbon champion attends design team meetings and is empowered to maintain the focus on energy and carbon issues.

The carbon champion should also be able to evaluate the impact of decisions made on the carbon targets. Additionally, the design team should be required by the client and project manager to provide reasons for their decisions and suggestions related to energy issues, rather than relying on conventional wisdom or staying within their 'comfort zone'.

If some design team members do not have sufficient energy knowledge it may be appropriate to run an initial educational session covering the energy issues relevant to the building being refurbished.

If key decision makers are not sufficiently empowered, overly bureaucratic decision-making processes can result, with multiple stakeholders micro-managing elements of the project. Where appropriate, stakeholder views should be incorporated into the original vision and brief for the project; consultation during the design process should be restricted to changes to this vision or brief. Convoluted decision-making processes lead to time and cost overruns and less energy efficient solutions.

RIBA Work Stage C – Concept Design completed – design team with low carbon experience selected.

Summary of Phase 1: Prepare

- Commit to a low carbon refurbishment
- Establish a low carbon vision for the refurbishment
- Develop a low carbon outline brief
- Establish the current carbon footprint of the building
- Set carbon targets for the refurbishment
- Undertake a pre-refurbishment assessment
- Consult stakeholders
- Consider a budget for low carbon elements
- Appoint a carbon champion
- Choose an appropriate design team
- Empower the design team.

Phase 2: Design

This section covers the points to focus on during the design work for the building refurbishment. The design will translate the vision for the building into an integrated set of low carbon measures.

Keep the low carbon theme up front

All members of the design team must be aware of the requirement for low carbon design. These requirements and the principles by which they are to be achieved should be carried forward from the outline brief into the detailed brief. Having the carbon champion in the design team and attending design meetings is a good way to maintain awareness of the low carbon requirements.

As the design is developed, and equipment, materials and systems specified, the energy demand and carbon emissions will change. These changes should be related back to the project's carbon targets to demonstrate progress and avoid shocks later in the design process.

Develop an integrated low carbon design

Low carbon design must be integrated into the general building design and not be an add-on extra. The design of most aspects of a building can make a difference to the energy performance, for example:

- The envelope should be insulated.
- Low energy lighting fitted, zoned and controlled to current regulations.
- The heating and cooling plant chosen for maximum efficiency.
- Ventilation systems designed to reduce energy use.
- The interior design and fit-out planned to achieve best space utilisation and optimise daylighting.
- Office, catering and other equipment chosen with efficiency as a primary criterion.

If each designer sees low carbon design as their concern as opposed to being a different discipline, a better integrated design will evolve. A good way to achieve this integration is the use of full design team meetings or workshops, with all team members considering design ideas and approaches together. This approach to design integration should be led and maintained by the project manager, with client support.

Encourage exploration of a wide range of low carbon options

The concept design should include a wide range of possible energy efficiency measures and on-site generation opportunities appropriate for the building. This is to ensure that all relevant low carbon options are explored, rather than the scope of the project being limited by what members of the team have done before. Normally different team members will be able to contribute to this list from their experience on other jobs, even if the ideas are not within their discipline. Design team members should explore the viability and benefits of each measure, in terms of energy demand, costs, maintenance requirements, life cycle impacts and benefits and implications for other design aspects.

Measures that can be considered include:

- Passive measures such as daylighting (which reduces the need for artificial light), shading (to reduce cooling loads) and natural ventilation.
- Upgrades to the building fabric, for example increasing insulation or replacing windows, to improve the thermal performance of the building.
- Ensuring that equipment for heating, cooling and ventilation, for instance boilers, air conditioning units and fans, is as efficient as possible.
- Low energy lamps, sized to provide the correct lighting levels.
- Improvements to control of equipment, for instance heating timers and occupancy sensors for lights.
- Improvements to overall building control, perhaps involving installing a new building energy management system or upgrading the existing system.
- Specifying efficient equipment for 'non-regulated' aspects of energy use, for example catering and IT equipment.
- On-site generation, for example combined heat and power or biomass boilers.

The most viable measures should be discussed and evaluated at design team meetings. The relative performance and value for money of each option should be assessed and a refined, integrated set of 'best value' measures selected. This will enable all team members to understand and assess the effects of the different options, particularly in their area of responsibility.

Designers frequently propose designs, systems and equipment they have used previously, keeping them within their 'comfort zone'. Although this is a sensible way to use previous experience, all designers should be open to new ideas and technologies, whether they come from their own research or are suggested by others. More design time is likely to be needed to explore these new ideas, research performance data, search for other case studies, visit other buildings using the proposed technologies, check with colleagues and specify the exact performance requirements necessary.

As part of exploring the energy efficiency options for the project, the design team should consider the refurbishment as an opportunity to replace inefficient equipment which is nearing the end of its life with newer and more efficient equipment. The design team should compare the energy performance of the existing equipment with modern alternatives, and identify potential energy savings over the lifetime of the equipment and other benefits such as reduced maintenance costs.

Case study: Marks & Spencer

A long-list of generic energy efficiency opportunities has been produced for Marks & Spencer's store refurbishment programme. This list is intended to be reviewed by the design team for each refurbishment project during the design phase so that appropriate measures can be incorporated into the design. This list is not exhaustive but includes measures ranging from reducing refrigeration load to introducing natural ventilation.

The design team will be required to assess each of these measures with reference to the particular store that they are involved with and put them forward for inclusion in the design specification. The intention is for this long-list to be added to as experience is gained of particular measures.

Allow flexibility in design

All designers need to allow flexibility in their area of responsibility to accommodate new low carbon options. New energy efficiency measures and new energy generating equipment may require the adaptation of other aspects of the building design.

Additionally, designers should consider how the building might be adapted for future climate change, and could also consider ensuring the building has sufficient space and suitable connections for future installation of renewable technologies.

Some clients have standard lists of equipment to be used in all their building stock for reasons of known reliability and ease of maintenance. Although this is a reasonable approach, standard equipment lists need to be constantly reviewed and updated to incorporate the latest proven energy efficient innovations. The revised list can then be used on subsequent developments and will bring long term benefits.

There may well be conflicts between planning requirements and the energy aspects of the building, such as shading on historic facades, using wind turbines or solar panels, natural ventilation chimneys and access for biofuels. An early dialogue with the planning authority will be required to address these issues.

Case study: John Lewis Partnership

John Lewis maintains a standard list of catering equipment for their in-store restaurants. As part of the Low Carbon Buildings Accelerator project, this list was reviewed. The equipment specified for the refurbishment of one of the restaurants in their Oxford Street store compared quite well with other equipment available on the market; however, there was still room for improvement in the selection of some equipment such as ovens, hobs and dishwashers. The list has now been updated and will be utilised for the future refurbishment of John Lewis in-store restaurants.

RIBA Work Stage D – Design Development completed – all low carbon options appraised, low carbon design included in planning permission application.

Use energy modelling data

For large projects, energy modelling can be a valuable component of the refurbishment design process. Thermal modelling allows the consideration of the complex interactions between different measures, technologies and techniques. It is particularly useful, and increasingly used, for larger buildings and more radical refurbishments.

Where the required input data are available (from measurements and fuel and electricity invoices), the existing building should be modelled and inputs adjusted to reflect the previous energy performance of the building. Internal conditions, including the use of the building, should also be recorded and incorporated into the model as far as possible. In practice, it can be very difficult to use modelling to accurately reproduce or predict actual energy performance; modelling is often best used to comparatively test the impacts on low carbon performance of different technology options, using consistent assumptions based on known information.

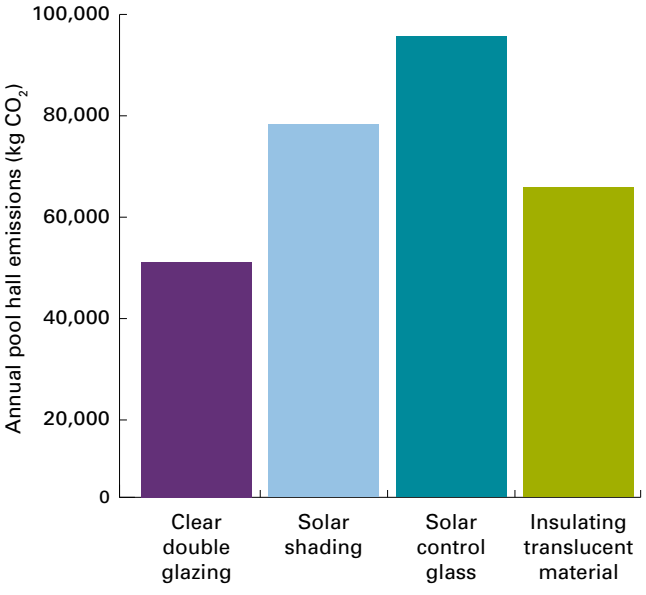
As different refurbishment design options are developed, the refurbished building's anticipated energy performance should be kept up to date. Many energy models cannot accommodate complex design changes and specific equipment, so additional information will be required in areas such as renewable energy sources, lighting controls and new equipment, for a full assessment of the emerging design's energy performance. In addition to enabling a more efficient and integrated design to be developed, this approach will enable assessments of progress towards energy targets to be provided for design team meetings and for other stakeholders. Links to further information on modelling can be found in Appendix B.

Case study: 'The LC' (former Swansea Leisure Centre)

A number of different façade options were modelled to understand how the objectives of avoiding excessive solar gain and reducing heat loss could best be resolved using passive cooling solutions. This was particularly important for the pool hall area. Four models for the pool hall were run, looking at the impact of using:

- Clear double glazing only.
- Solar shading (brise soleil) with clear double glazing.
- Solar control glass.
- Insulating but translucent building materials.

The modelling was able to demonstrate that the best option for reducing carbon emissions was the clear glazing solution, due to the ability to make use of free heating from increased solar gain during the majority of the year.



Use whole life costing to support low carbon solutions

Appraisal of low carbon systems and components should be carried out based on whole-life cost analysis. This approach is increasingly used in building design and involves assessing options based on their lifetime costs and benefits rather than simply looking at initial capital costs. Lower carbon technologies may have higher capital costs than the alternatives. Taking a whole life cycle approach to the evaluation allows operational savings such as lower energy costs and reduced maintenance over their life to be taken into account.

Whole life costing can also take into account potential future increases in energy prices, maintenance costs and the future 'cost of carbon' in trading schemes.

In addition to financial drivers, low carbon buildings can have additional benefits such as:

- Higher productivity from more comfortable buildings.
- Improved recruitment and retention of staff in some industries, where proof of corporate social responsibility is increasingly important.
- Brand enhancement.

When combined, these drivers may provide a sufficient argument to support the additional up-front expenditure involved. This is common practice on non-energy issues in both new build and refurbishment projects, in particular in publicly accessible areas (e.g. choosing a more expensive carpet type and colour because it reinforces brand messages).

Links to further information on whole life costing can be found in Appendix B.

Case study: John Lewis Partnership

The John Lewis Partnership decided to use magnetic bearing chillers following a detailed analysis of peak and off-peak performance throughout the year. It was found that these demonstrated a simple payback period of 3.7 years despite an increase in capital cost of 50% relative to standard chillers. The estimated energy savings were of the order of 750MWh per year and cost savings of £54,000 per year.

Manage the budget and scope

It is important to ensure that energy efficiency measures are not value engineered out of the project during the design stage to reduce costs. Strong carbon targets or a ring-fenced budget for low carbon measures should help to 'protect' energy efficiency measures.

Low carbon measures should also be compared to each other to ensure that those measures with the lowest lifecycle costs and greatest reduction in carbon emissions are taken forward.

Companies should also be aware of tax incentives for certain energy efficient equipment on the Energy Technology List (see box). For example, Marks & Spencer's new design guide for remodels requires designers to specify, as far as is practicable, products on the Energy Technology List.

Tax incentives

Enhanced Capital Allowances (ECAs) enable businesses to buy energy efficient equipment using a 100% rate of tax allowance in the year of purchase. Businesses can claim this allowance on the investment value of energy efficient equipment if it is on the Energy Technology List. The procedure for claiming an ECA is the same as for any other capital allowance. For further information, please visit **www.eca.gov.uk** or call the Carbon Trust advice line on 0800 085 2005.

Approve the integrated design

The full design, and individual low carbon components, should be signed off by the client. At the end of the design process, or at intermediate stages when a particular system or component design is complete, approval should be provided by the client.

This should include checking that the low carbon brief and targets have been achieved alongside the other requirements of the refurbishment. The client may need to request specific information from the designers or use third party support to carry out these checks.

RIBA Work Stage E – Technical Design completed – detailed low carbon design and costs agreed.

Include targets in contracting arrangements

Carbon emissions targets and low carbon design principles must be reflected in procurement arrangements for the construction phase. Contracting documentation must make clear the carbon targets to be achieved and the low carbon design components to be included. Where the initial design process ends in a performance specification for use in a design and build contract, clear carbon emission targets must be included both for the overall building and for individual components. The initial design should identify the best low carbon options for the particular building and expected occupancy, to ensure that the targets can be achieved by the contractor.

The documentation should also make clear that, if aspects of the design have to change during the construction phase, the energy impact of these must be assessed to ensure targets for carbon performance are still achieved.

RIBA Work Stages F Production Information and G Tender Documentation completed – low carbon requirements fully integrated into tender documents.

Summary of Phase 2: Design

- Keep the low carbon theme up front.
- Develop an integrated low carbon design.
- Encourage explorations of a wide range of low carbon options.
- Allow flexibility in design.
- Use energy modelling data.
- Use whole life costing to support low carbon solutions.
- Manage the budget and scope.
- Approve the integrated design.
- Include targets in contracting arrangements.

Phase 3: Construct

This section covers the period from the selection of contractors to the commissioning of the refurbished building. Whatever contractual arrangements are used, several steps can be taken to maximise carbon emission reductions.

Ensure effective project management

Choose and brief the project manager for their key role in maintaining the focus on low carbon. The construction project manager traditionally has an important role in project cost, timing, control, quality and oversight. For a low carbon refurbishment, a new role of maintaining the low carbon aspects of the project must be formally included. This role should be strategic, to drive the integration of the design and align the refurbishment with corporate carbon related policies. It should also be practical to ensure that specified equipment and materials are installed and that construction practices are of a high standard.

It is important to ensure that low carbon systems are correctly supplied and installed as specified, and that any substitutions or changes are carefully checked for suitability and to avoid unintended consequences.

Choose an appropriate contractor and subcontractors

Procure contractors with experience and interest in low carbon refurbishment, as this will make the journey towards a low carbon building much easier. The skills, experience and aptitude of contractors in low energy construction will have a major influence on project success and on the low carbon performance of the refurbished building. This does not necessarily exclude contractors without previous experience in delivering low carbon refurbishments, but should exclude contractors with no interest in providing a high quality, low carbon project. Tender documentation should send this message strongly, and experience in achieving low carbon refurbishments should be an important criterion in choosing the contractor.

RIBA Work Stage H – Tender Action completed – energy competent contractor approved.

Get buy-in from site workers

Site workers should understand the importance of the energy efficiency of the refurbished building. When reinforced by effective project control, establishing this site culture will help ensure that the energy efficiency implications of day-to-day on-site decisions are taken into consideration. If necessary, allowances for educating the workforce should be considered.

Ideally, all contractors involved in the refurbishment should be made aware that achieving a low-carbon refurbishment is one of the key priorities and success factors for the project.

For example, one client discovered a contractor installing draught stoppers whilst simultaneously cutting ventilation holes in the same doors – this lack of thought was reinforced by no appreciation of the client's desire for an energy efficient refurbishment.

Monitor site progress against objectives

An individual on the project team should be assigned responsibility for day-to-day monitoring of site progress on low carbon aspects and the quality of work being undertaken. This role was traditionally filled by a 'clerk of works' but is now more typically undertaken by the project manager. This person should constantly reinforce the importance of delivering the low carbon design and be empowered and available to make project-related decisions in a timely manner. If changes to the design are required in the construction phase, the energy impact of these should be assessed to ensure targets for carbon performance are still achieved.

There should also be a credible threat of the enforcement of the contractor's contractual obligations to ensure that they are focused on delivering what has been promised, in terms of cost, time and a low carbon building.

RIBA Work Stage J – Mobilisation completed – low carbon requirements communicated on site.

Ensure high quality commissioning

Component and whole building commissioning for energy efficiency must be a planned activity which is not allowed to slip. The operational energy efficiency of mechanical and electrical systems is frequently dictated by the quality of commissioning. Building commissioning is often rushed or inadequate as it is not included as part of the refurbishment schedule. A specific commissioning budget should be set, with appropriate time allowed in the schedule for these works. Building components should be commissioned individually and within the context of the entire building to maximise energy efficiency and minimise carbon emissions.

In most refurbishments, there is likely to be a mixture of old and new equipment within the building. Building controls should fully integrate both the new and pre-existing equipment and ensure that it works efficiently as a system. Logbooks should similarly provide details of old and new equipment.

Set up energy monitoring

Energy monitoring should be built into the project and designed to allow the tracking of performance in key areas of interest. Sub-meters should be installed for major energy consuming equipment as these enable action to identify and prevent excessive energy use. Measurements of temperature and relative humidity can assist in monitoring occupant comfort. It is important to ensure that all the required monitoring and metering equipment is correctly installed, and provides useful information to the facility managers and the wider organisation.

A log book is required under Building Regulations and this should contain details of thermal elements, building services, control systems (and how to operate them), and all meters and other monitoring equipment. The energy use of the building prior to the refurbishment should be compared with its post-refurbishment performance.

RIBA Work Stage K – Construction to Practical Completion completed – energy commissioning results recorded; energy monitoring installed for maintenance purposes.

Summary of Phase 3: Construct

- Ensure effective project management.
- Choose an appropriate contractor and subcontractors.
- Get buy-in from site workers.
- Monitor site progress against objectives.
- Ensure high quality commissioning.
- Set up energy monitoring.

Phase 4: Use

This section looks at the period following the refurbishment of the building and the actions required to ensure the people in the building understand the low carbon features and are motivated to operate these correctly.

Make sure the occupants understand the building

Training and education of building occupants is crucial to ensure that the building is operated as designed. Refurbishments often upgrade inefficient buildings which provide a poor working environment and, due to the refurbishment works, occupants may have been significantly disrupted. Thus, they may have an initially antagonistic approach to the new building despite improvements in comfort, especially if they have not been consulted and involved in the project. Information on aspects affecting occupants, such as lighting controls, heating and cooling set points and ventilation systems should be provided, emphasising that the design aims to minimise carbon emissions whilst providing comfortable conditions and control to occupants.

Make sure the building operator understands the building

Building operators should be briefed so they understand how to operate the refurbished building to combine energy efficiency with occupant comfort. The operation of the building is likely to be different from pre-refurbishment due to new plant, systems and controls. Easy to use manuals for the operation and maintenance of building systems should be provided in a convenient place. When occupants' needs change (e.g. opening on a weekend), the building operator should know how to change building controls to facilitate this in an energy efficient manner.

Asset registers must also be updated and rigorous maintenance procedures and schedules created to embed the improvement of energy performance.

If building operation is to be contracted out, the energy efficient operation of the building should be integrated into the procurement process for this service with clear targets set for the expected energy performance. A proactive approach to maintenance and procurement will help reinforce and build upon carbon savings achieved during the refurbishment and allow the efficient allocation of all budgets involved in operating the building. Specific carbon emissions targets should be set for the building operator, using the same targets as developed for the refurbishment process, if modelling has been used and is appropriately accurate.

Landlord energy statement/tenant energy review

The landlord's energy statement (LES) is a tool that enables landlords and managing agents to get to grips with the energy that is used, and the carbon dioxide that is emitted, in providing communal services in their buildings.

It helps landlords understand their buildings' energy efficiency, compares the performance against similar buildings with similar uses, identifies any areas for improvement and illustrates where year on year improvements have been made. LES is intended to fit with the demands of the Energy Performance of Buildings Regulations, while providing greater insights into buildings' energy efficiency.

A tenant's energy review (TER) tool has also been developed. This allows tenants to measure, monitor and benchmark their energy use and the carbon dioxide emissions that it creates. Taken with their share of the LES for their building, tenants are able to calculate their total carbon footprint.

LES and TER have been produced by the British Property Federation (BPF) with funding from the Carbon Trust and technical development by the Usable Buildings Trust, and can be found at **www.les-ter.org**

Conduct a post-occupancy evaluation

A post-occupancy evaluation should be completed to ensure that equipment is operating efficiently, that management systems and maintenance regimes are in place and that occupant perceptions of the refurbished building are evaluated. The post-occupancy evaluation should systematically collect opinions on the refurbished building in use, from the perspective of the people who use it. It should assess how well the building matches users' needs and identify ways to improve building design, performance and fitness for purpose, with a focus on reducing carbon emissions. The results of this evaluation should be communicated to users, building operators, the client and the design team to ensure that lessons for future refurbishments are learnt.

Check energy use and comfort conditions and make changes

Building monitoring should be used to discover faults, provide feedback and maintain low carbon performance. Monitored data should be used to identify and resolve commissioning issues and optimise Building Management System (BMS) settings. Energy performance and commissioning issues should be fed back to the design team and delivery contractors. Monitoring results should also be integrated into future refurbishment planning processes and design and should be communicated to those involved in the refurbishment process. Feedback from building occupants on their perception of comfort in the building should also be used to understand building performance. Where improvements in services and/or comfort have been provided as a result of the refurbishment, monitoring can show the impact of these improvements on the energy demand.

Make the most of the low carbon building

The low carbon features of the refurbished building should be clearly communicated to stakeholders, especially occupants. Pursuing a low carbon approach to refurbishment demonstrates commitment and leadership regarding climate change and resource efficiency. The communication of the benefits of low carbon features to management, staff, customers and other building users can greatly assist in generating broader cultural changes which will further improve the operational energy efficiency of the building. Highlighting low carbon features to stakeholders should be seen as standard practice in leveraging the maximum benefit out of the newly refurbished building.

The low carbon learnings and solutions should be incorporated into future projects or into standard refurbishment specifications.

Summary of Phase 4: Use

- Make sure the occupants understand the building.
- Make sure the building operator understands the building.
- Conduct a post-occupancy evaluation.
- Check energy use and comfort conditions and make changes.
- Make the most of the low carbon building.

RIBA Work Stage L – Post Practical Completion completed – building occupants and managers understand use of the low carbon design; review of low carbon performance carried out.

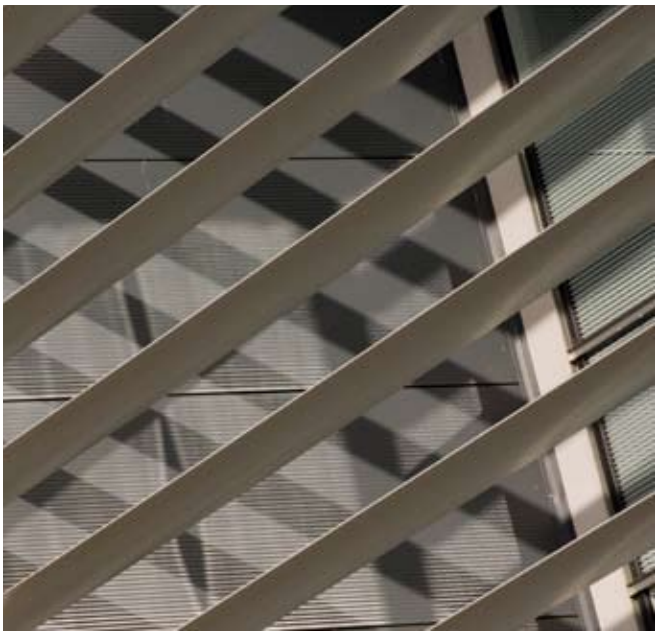
Appendix A

Refurbishment policy context

Building refurbishment is increasingly being brought within the scope of planning and building regulations. This has been a clear trend for at least the last decade, with Building Regulations, planning policies and requirements regarding the provision of information to stakeholders all progressively strengthening. Various voluntary standards have also been developed for reducing energy use in existing buildings; such standards are often a precursor to further mandatory controls. This trend will continue into the foreseeable future, as the large contribution from energy use in the existing building stock is increasingly acknowledged, and imperatives to reduce carbon emissions amplify.

Planning policies

Local planning policies supported by government legislation and Regional Planning increasingly require developments to use local heating networks (where available) and/or to use renewable energy sources (on, near or off site) to supply a proportion of their energy requirements. Exact local planning requirements regarding building refurbishments can differ significantly between local authority areas. As such, local planning requirements should always be consulted prior to any refurbishment.



Building Regulations for England and Wales

Building refurbishments that accompany a 'change in use' are subject to energy use, and other provisions, of planning and Building Regulations control. Replacements to building envelope components, including windows, ventilation equipment and mechanical and electrical services, must comply with the Building Regulations 2006 (as Amended). Additionally, building energy performance must be improved when major refurbishments are conducted for buildings over 1,000m^2 (see 'Consequential Improvements' in Approved Document L2B).

Energy requirements for building extensions and the commissioning of services are also included in Building Regulations, with Approved Document L2B forming the official guidance on compliance for refurbishment projects. Large scale refurbishments, or those which lead to a change in use of the building, may result in the project being considered equivalent to a new build, in which case Approved Document L2A would form the official guidance on compliance with Building Regulations.

The energy efficiency provisions of Building Regulations will continue to be used by government to drive improvements in the existing building stock; it is the intention that forthcoming updates of Part L and Approved Documents L2A and L2B (planned for 2010 and 2013) will further strengthen the energy performance requirements of refurbished buildings. The current version of the Regulations should always be consulted before any refurbishment is planned.

Different Building Regulations apply in Scotland and Northern Ireland. See Appendix B for links to these regulations.

Energy Performance in Buildings Directive

The European Energy Performance in Buildings Directive (EPBD) requirements have been transposed into British legislation and are coming into force in England and Wales between 2006 and 2011. Legislation will be coming into force in Scotland and Northern Ireland over a similar period. The EPBD is designed to provide information on the energy performance of a building to prospective buyers and tenants, or, in the case of 'public' buildings, the information is to be displayed inside the building to inform all visitors. The objective is to raise awareness of the energy use of buildings, allowing prospective buyers and tenants to make informed decisions, and encouraging building owners and occupiers to improve the energy performance of new and existing buildings.

Energy Performance Certificates (EPCs) are based on the Asset Rating (a calculated annual energy consumption based on a standard use of the building). EPCs provide the building's relative energy efficiency in a similar form to domestic product energy ratings, and must be provided to prospective buyers or tenants when a building is constructed, sold or rented. In England and Wales EPCs are required for large buildings (over 10,000m^2) from April 2008, for medium sized buildings (between 2,500m^2 and 10,000m^2) from July 2008 and for all other buildings from October 2008.

Display Energy Certificates (DECs) are based on the Operational Rating (the measured annual energy consumption of the building). DECs are required for buildings over 1,000m^2 that are occupied by public authorities or other institutions that provide public services to a large number of people from October 2008. DECs must be prominently displayed in the building to inform visitors. The Government has committed to consult on the possible widening of these requirements to privately owned or occupied public buildings including retail outlets, cinemas and hotels. In Scotland EPCs will be used for public display.

EPCs and DECs are produced by accredited energy assessors and are accompanied by a report detailing voluntary options for improving the energy efficiency of the building.

The whole of the UK has opted for the requirement to provide advice on the energy efficiency of boilers, and it is likely that an inspection scheme for boilers will be introduced in the future.

An inspection regime for air-conditioning systems is being implemented in England and Wales, and persons who control and operate systems rated above 250kW will need to arrange regular (not exceeding five years) inspections by accredited inspectors from January 2009. All other air-conditioning systems above 12kW will require regular inspections from January 2011 (CIBSE TM44 gives a methodology for undertaking these). Voluntary recommendations will also be provided to improve the energy performance of these systems.

Carbon Reduction Commitment

The Carbon Reduction Commitment (CRC) is a new scheme, announced in the Energy White Paper 2007, which will apply mandatory emissions trading to cut carbon emissions from large commercial and public sector organisations (including supermarkets, hotel chains, government departments, large local authority buildings), with carbon reductions of 1.1MtC per year expected by 2020. The Department for Environment, Food and Rural Affairs (Defra) are currently determining how the CRC will operate, with implementation expected in January 2010.

Further information is available at **www.defra.gov.uk/Environment/climatechange/uk/business/crc/index.htm**

Voluntary schemes and drivers

Voluntary schemes may be strong drivers for refurbishing buildings to low carbon standards and are often the forerunners to mandatory control or are used by some organisations to impose standards on buildings they occupy. BREEAM has for many years been accepted by industry as a general standard for assessing the environmental sustainability of non-domestic buildings, has been an important driver for the improvement of the building stock and has been widely used for promotional purposes.

Building Design Advice

The Carbon Trust Design Advice service helps to identify carbon savings in new and renovation projects. Support ranges from self-help guidance, to free or subsidised design and construction consultancy advice to help you maximise opportunities for specifying energy efficient plant and fabric. To apply call the Customer Centre on 0800 085 2005, or visit **www.carbontrust.co.uk/designadvice**

Many organisations have environmental policies and regularly report on their Corporate Social Responsibility (CSR). Carbon emissions form a key element of this, with energy efficiency credentials often highlighted as an indicator of a responsible approach in the community. Year on year improvements in reducing carbon emissions are usually a component of this reporting, with upgrading existing building stock a common action item.

The Chartered Institution of Building Service Engineers (CIBSE) has developed a network of Low Carbon Consultants specialising in low carbon design, construction and refurbishment of building. These individuals are trained and tested before registration and benefit from ongoing monitoring and development.

The Carbon Trust Standard

The Carbon Trust Standard is awarded to organisations that have genuinely reduced their carbon footprint and committed to making further reductions year on year. Achieving the Carbon Trust Standard confirms your organisation's green credentials, and recognises and validates the work that has been done to reduce your carbon footprint. Applying for certification is straightforward, and the cost of certification is tiered to reflect your organisation's size and circumstances.

To find out more and apply for the Carbon Trust Standard, call 0800 019 1443 or visit **www.carbontruststandard.com**

Appendix B

References and further information

General Information

- CIBSE guides: www.cibse.org
  - CIBSE, 'Guide L: Sustainability', 2007
  - CIBSE, 'Refurbishment for Improvement Energy Efficiency: An Overview', 2007
  - CIBSE, 'Introduction to Sustainability', 2007
  - CIBSE, 'Guide F: Energy Efficiency', 2004 (to be updated in 2008)
  - CABE 'Creating excellent buildings; a guide for clients', 2003 www.cabe.org.uk

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- The Government's planning portal www.planningportal.gov.uk
- Office of Government Commerce publications www.ogc.gov.uk
- OGC, 'Sustainability: Achieving Excellence in Construction Procurement Guide', 2007
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- Benchmarking data:
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- Constructing Excellence in the South East www.secbe.org.uk
- CIRIA, 'The Small Environmental Guide for Construction Workers'
- CIBSE www.cibse.org
  - CIBSE, 'Commissioning Code M: Commissioning Management', 2003
  - CIBSE TM39 Building energy metering 2006

Phase 4: Use

- British Council of Offices www.bco.org.uk
  - BCO, 'BCO Guide to Post-Occupancy Evaluation', 2007
  - BCO, 'Guide to Occupier Handover', 2007
  - BCO, 'BCO Guide to Environmental Management', 2006
- British Property Federation, 'Landlord Energy Statement/Tenants Energy Review', (LES/TER) www.les-ter.org
- CIBSE Guides
  - CIBSE, 'Guide M: Maintenance', 2008
  - CIBSE TM31 Building log book toolkit, 2006
  - CIBSE TM44 Air conditioning Inspection
- IPD (Investment Property Databank) www.ipd.org.uk
  - 'IPD Environment Code: measuring the environmental performance of buildings', 2008
- Carbon Trust CTV027 Metering technology overview

Refurbishment Policy Context

For up-to-date EPBD information, including guidance, documents and further links, see www.communities.gov.uk/planningandbuilding/theenvironment/energyperformance

For Scottish Building Standards see: www.sbsa.gov.uk

For Northern Ireland Building Regulations, see: www.dfpni.gov.uk/index/law-and-regulation/building-regulations.htm

Notes

www.carbontrust.co.uk

The Carbon Trust was set up by Government in 2001 as an independent company.

Our mission is to accelerate the move to a low carbon economy by working with organisations to reduce carbon emissions and develop commercial low carbon technologies.

We do this through five complementary business areas:

Insights – explains the opportunities surrounding climate change
Solutions – delivers carbon reduction solutions
Innovations – develops low carbon technologies
Enterprises – creates low carbon businesses
Investments – finances clean energy businesses.

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