Refresh and reduce

Maximising carbon savings in internal refurbishment
Our case study projects saved 10-30% compared to a ‘business-as-usual’ refurbishment, and some are able to replicate this across their portfolio.
‘Refresh and reduce’ is part of the ‘Sharing our experience’ series. These booklets provide advice and tips to help you to plan, build and manage cost-effective low carbon buildings and refurbishments that really work to save you money and carbon.

The insights are based on real data from nine case studies from our Low Carbon Buildings Accelerator work on refurbishments. The projects cover many sectors including retail, hospitality, offices and mixed use buildings.
Internal refurbishment

Internal refurbishment projects involve refurbishing for brand or cosmetic reasons. This sort of refurbishment is usually limited to the building’s internal services and external branding.

All of our case study projects were owner/occupied (or long-term leased) and were being refurbished by their occupant. We’ve split the types of refurbishment into internal and deep, and focused here on internal refurbishment for the following projects:

- **Department store 1** – refreshing the store with new lighting, redecoration, fixtures and fittings as well as renewed food hall in basement, no fabric improvements – 30% reduction in kg CO₂/year.

- **Department store 2** – refreshing the store with new lighting, improved layout, increased food offerings, minimal fabric improvements – 10% reduction in kg CO₂/year.

- **Pub/restaurant** – changing the internal layout (larger restaurant, smaller bar), updating the brand through decoration, new lighting, new furniture, improved ventilation, improved fabric insulation and draught proofing – 14% reduction in kg CO₂/year.

- **Bank branch** – altering the banking hall to comply with ‘corporate look’ and improve the customer facilities and welcome, minimal fabric improvements – 15% reduction in kg CO₂/year.

- **Convenience store** – to slightly enlarge a convenience store as well as refresh the look and feel and enable the installation of additional refrigeration and baking equipment, no fabric improvements – 24% reduction in kg CO₂/year.

This publication looks at how the refurbishment process can reduce the energy consumption and carbon emissions of individual buildings and explores the potential impact of rebranding or refreshing a portfolio.
Why low carbon refurbishment?

Internal refurbishment can increase your energy consumption and carbon emissions. This section shows how a low carbon refurbishment can reduce your carbon footprint, and looks at the lessons learned by our clients.

More than three-quarters of non-domestic buildings were built before 1985 and therefore pre-date any Building Regulations. By 2050, half of these buildings will still be standing. Tackling the energy performance of this building stock will therefore be fundamental in reducing carbon emissions by 80% by 2050 (against 1990 levels). Most carbon savings will be achieved by refurbishing our existing buildings. Internal refurbishment allows you to make changes to reduce the carbon impact of the building while improving its quality and usability.

Our case studies suggest that when refurbishments are made in a ‘business as usual’ fashion, the energy consumption of the refurbished building will actually be greater than the original. We’ll be looking at how you can avoid this increase.

Figure 1 Example of energy use increasing after refurbishment
“M&S has been an enthusiastic participant in the LCBA programme since its conception and supports the need for tight management and measurement of energy throughout the design, building and operation of both new builds and refurbishments”

Mervyn Bowden, Head of Energy Management at Marks & Spencer

If you don’t make low carbon a specific goal of your refurbishment, you risk increasing your energy bills through:

- increased lighting load
- localised heating and cooling systems fighting
- increased small power load.

Refurbishment is often performed to improve users’ comfort as well as the look of the building. This may involve increasing unregulated electrical equipment loads as well as lighting, visual displays, food refrigeration, cooking or specific services such as a cash machine. All of these can undermine savings made elsewhere.

Many of our retail client case studies found that by following the requirements of their brand image, their refurbishment would increase their energy consumption. This not only leads to higher costs, but also has a negative impact in terms of legislation, such as the CRC Energy Efficiency scheme, which places organisations in league tables according to their efficiency.

The savings in kg CO₂/year achieved in the projects in relation to a business as usual refurbishment, ranged from a 10% to 30% improvement. If you’re able to replicate these savings across a portfolio, then they can become very significant.
The key intervention points

By working with a range of clients, we’ve identified a number of key points in the refurbishment process when intervention can have a significant impact on carbon emissions.

Figure 2 The internal refurbishment design process and the influence of different elements on the final project

<table>
<thead>
<tr>
<th>Prepare</th>
<th>Design</th>
<th>Construct</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning for refurbishment</td>
<td>Specification</td>
<td>Installing and commissioning</td>
<td>Operating the building</td>
</tr>
<tr>
<td>Understand the current building, set objectives and targets, challenge equipment specifications and brand requirements, and chose an appropriate design team</td>
<td>Consider impact of proposed changes on internal conditions, review low carbon technology options, and ensure targets are in contracting arrangements</td>
<td>Choose appropriate contractors, monitor progress against objectives and ensure high quality commissioning</td>
<td>Ensure occupants and operators understand the building, conduct post-occupancy evaluation, check energy use and comfort conditions</td>
</tr>
</tbody>
</table>
**Intervene at the planning stage**

Our case studies found that the greatest carbon reductions could be made by intervening at the planning stage, by:

- allowing flexibility in existing standard specifications to reflect site specific issues
- choosing which equipment should be replaced based on its carbon impact, and checking whether more efficient versions exist
- selecting contractors who understand that the refurbishment needs to result in reduced carbon – with input from experts if necessary
- setting sufficient budget to avoid ‘value engineering’ of low carbon features
- setting schedules so that there is time to select and install different equipment, rather than always replacing like for like.

In reality the planning stage for internal refurbishment usually involved:

- an on-site meeting where the client told the contractors what they wanted and the contractors provided a solution based on their previous experience, or
- equipment and design being selected by the corporate branding guide.

The diagram below shows the typical pressures on a refurbishment project that drives up carbon emissions and the actions that can be taken to improve outcomes.

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**Figure 3** *Pressures on a refurbishment project and actions to improve outcomes*

- High carbon outcome
  - Corporate/brand drives standard specifications and equipment selections
  - Financial constraints do not include low carbon options
  - Programme schedule is too fast to allow alternative options

- Low carbon outcome
  - Challenge standard specifications before starting project
  - Set a budget for low carbon features and protect from value engineering
  - Allow time at planning stage to review low carbon option
Understand your building

Performing an energy audit before you begin means you’ll understand where energy is being consumed, and will be more likely to use the refurbishment to reduce energy use. As a result of taking this approach, M&S changed its refurbishment policy so that all sites must have an energy audit before being considered for refurbishment.

John Lewis undertook a detailed survey of its store to understand where energy was being consumed. This resulted in a new lighting design for sales floors which removed track lighting and replaced it with fixed lighting. This meant that sales staff had to display products according to the light available rather than be able to install additional lighting as required.

Challenge equipment specification

Equipment is often chosen and installed according to a standard specification, rather than the requirements of the site. You can reduce your energy consumption across both your site and your portfolio if you make sure that the standard specifications focus on minimising long-term running costs.

An example of this would be that localised cooling (split units) should:

- have a coefficient of performance (CoP) of greater than 4.5
- have a master and slave control rather than local control
- modulate set points according to outside air temperatures
- interlock operation to local heating systems and door/window operation.
- Rather than the usual specification of: ‘the space should be heated or cooled to 21°C throughout the year.’

Our case studies showed that installing low carbon or low energy equipment as part of a refurbishment often means changing the brand specification. For some clients this change was a very easy process, but for the majority it was a lengthy procedure as they had to prove that the proposed alternative would not affect the look or performance of the site, and would save energy, carbon and cost.

Unexpected work

At John Lewis the discovery that more ceiling tiles had to be replaced than had originally been expected meant that work to remove the existing tiles had to be completed during the night. This slowed down the refurbishment and meant that the women’s fashion department had to operate during the day with an open ceiling and all merchandise had to be packed and unpacked before and after each shopping day. However, this also provided the opportunity to undertake a larger than anticipated lighting replacement and, using John Lewis’ approved lighting design, this improved the operational energy consumption.

The Hogsmill chain standards stipulated that 50W tungsten halogen lights should be fitted above all dining room tables. For the case study site these were redesigned to incorporate 20W fittings. This reduced the energy consumption from lighting and cooling, while making no discernable difference to the ‘look’ of the restaurant.
Changing the generic specification document means significant carbon savings could be made across the portfolio with subsequent refurbishments, significant energy savings could be made across the portfolio.

**Time and budget**

Equipment is often replaced or installed on a like-for-like basis, rather than on a low energy basis. The same equipment is often used for all properties in a portfolio as it saves time to perform identical repeat installations with no surprises.

However, making time available at the planning stage to source low energy equipment, or approved alternatives means that you can avoid delays during the refurbishment timeframe by properly planning the site installation.

Our experience showed that you have to set the budget for essential low carbon features at the planning stage and ensure that these items are protected from ‘value engineering’ or cost cutting.

At one of our case studies, a BMS “front end” which had been included in the plans for the site staff to view the operational status of the plant and edit the settings from their central offices was removed as part of a value engineering exercise. This meant that faults or failures could not be picked up by the site staff until chance inspection or complaints from occupants. This also removed the ability to shut down the heating to an area based on occupancy.

**Design and specification**

It is worth considering the impact of the changes you plan to make will have on the internal environment. For example, reductions in heat loss from more efficient plant may mean that the building no longer needs localised chilling.

The Hogsmill pub found that the combination of the lower required ventilation rates (since the smoking ban) and draught proofing reduced the fresh air infiltration so the building was more prone to overheat. The pub installed fans which responded to CO₂ levels, increasing the amount of fresh air if the pub was busy. These minimised heating energy consumption while maintaining comfort levels.

The Co-op wanted to increase the amount of space available for refrigerated foods, introduce a baking facility and improve the appearance of the store.

Previously, heating and cooling capacity was inadequate, so new split units providing cooling were introduced and the size of the electric over-door heater was increased. However, the permanently open front doors (as specified by company guidelines) and the increased heat load from refrigeration and baking equipment meant that internal conditions were no better after refurbishment than before. Had this been highlighted during design, the store layout could have been changed so that the units rejected their heat and cooled where required.
Construction and installation

Many of our case study clients needed to complete very rapid refurbishments, with all front of house changes being completed while they were closed. In the case of Nationwide, the branch closed on Friday and all ‘public facing’ works had to be completed over a bank holiday weekend. At the Co-op, the store closed for a week, during which time all works had to be finished.

These timeframes mean that work has to be tightly planned, with little allowance for ‘project creep’ or changes. This means that any improvements to specified equipment can only be included at the design stage. If project creep means that you are able to improve the original design, as in the case study below, this should be taken as an opportunity to improve the quality of the refurbishments if required.

The impact of commissioning

At our case study sites, it was obvious that poor commissioning could turn a low energy design refurbishment into a high energy-consuming finished project. This can mean that you need to make more use of a contractor to correct the issues after handover, or waste money through excessive energy costs.

Commissioning usually happens at the end of the refurbishment, when the site is due to reopen to the public. Delays elsewhere in the programme can mean that commissioning is abandoned, rolled into the service contract or left up to the site’s maintenance staff. Inadequate commissioning is unlikely to ever be rectified, with plant and equipment manually running out of control, wasting energy and money and leading to increased carbon emissions.

At one of our case studies, time pressures and a disjointed team meant that the commissioning didn’t identify that a series of zone valves were installed incorrectly. Some time after occupancy the client eventually realised that something was wrong and the error was identified and corrected, at the expense of the client rather than the installer.
Using the building

Our case study clients have shown that when an internal refurbishment is designated as low carbon, savings are typically made in the heating and hot water loads, but comfort cooling, lighting and unregulated small power loads increase. These increased loads can undermine the savings made elsewhere. They can only be reduced by changing the behaviour of the end users to allow them to manage the building’s consumption more efficiently.

At Nationwide, local control of the heating and cooling for the back of house areas was beneficial because one staff member, who adopted the role of energy manager for the building, managed them. He constantly checked that units were turned off when not required, that setpoints were not changed and that any contractors who worked on the units returned them to their original settings before leaving site.

Lessons learned

- The greatest carbon reductions can be made at the planning stage by challenging standard specifications and equipment choices, setting appropriate budgets for low carbon features and selecting contractors who understand low carbon refurbishment.
- Understand the existing building by doing an energy audit to identify where energy can be saved.
- Consider the impact of the refurbishment on the internal environment and carbon emissions, particularly any new energy uses in the building (e.g. cash machines, refrigeration, baking equipment, etc) that could cancel out any efficiency improvements in other areas.
- A widening in the scope of the project can be an opportunity to find further carbon savings where additional plant or equipment has to be replaced.
- Thorough commissioning is essential to ensure that the low energy design does not become a high energy consuming finished project.
- Ensure the building operators understand how to use the building and monitor the energy use, identify high consumption and act to reduce it.
# Typical carbon saving opportunities

**Figure 4** Typical carbon saving opportunities from our clients’ case studies

<table>
<thead>
<tr>
<th>Category</th>
<th>Action</th>
<th>Carbon savings as proportion of internal refurbishment</th>
<th>Capital cost as proportion of internal refurbishment budget</th>
<th>Likelihood for replication across portfolio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lighting</strong></td>
<td>Introduce more efficient lamps and luminaires</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>Introduce lighting controls</td>
<td>H</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Reduce lighting levels through removing excessive fittings</td>
<td>M</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td><strong>Heating</strong></td>
<td>Introduce zoning to heating and cooling systems</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>Provide localised setpoints</td>
<td>M</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>Reduce heat demand i.e. doors on chiller display cabinets, automated external doors, draft lobbies</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>Insulate all pipework</td>
<td>L</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td><strong>Cooling</strong></td>
<td>Reduce cooling demand via improved insulation and equipment heat rejection routes</td>
<td>M</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>Component</td>
<td>Description</td>
<td>Carbon savings as proportion of internal refurbishment</td>
<td>Capital cost as proportion of internal refurbishment budget</td>
<td>Likelihood for replication across portfolio</td>
</tr>
<tr>
<td>------------------</td>
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<td>----------------------------------------------------------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>HVAC controls</td>
<td>Improved controls to provide heating, cooling and ventilation only when occupied</td>
<td>M</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>Increase/introduce dead bands to prevent fighting between heating and cooling</td>
<td>H</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>Fabric</td>
<td>Improve building air tightness through draught proofing</td>
<td>M</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>Glazing</td>
<td>Improve glazing (potentially via internal secondary) to prevent heat loss or incoming solar radiation</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Blank off and insulate unused windows</td>
<td>H</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Hot water</td>
<td>Size requirement in line with demand i.e. remove oversized or historical storage</td>
<td>H</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>Install localised units to remove centralised storage</td>
<td>H</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Small power</td>
<td>Reduce small power (unregulated loads) operation times</td>
<td>M</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>Use essential and non-essential circuits and switch non-essential off outside of working hours</td>
<td>M</td>
<td>H</td>
<td>M</td>
</tr>
</tbody>
</table>
Further information

The Carbon Trust
Management guide CTV038, Low Carbon
Refurbishment of Buildings
A guide to achieving carbon savings from
refurbishment of non-domestic buildings

CIBSE
Briefing 7, Energy efficiency in
refurbishment, CIBSE 2003
‘Refurbishment for Improving Energy
Efficiency: An Overview’, 2007
The Carbon Trust is a not-for-profit company with the mission to accelerate the move to a low carbon economy. We provide specialist support to business and the public sector to help cut carbon emissions, save energy and commercialise low carbon technologies. By stimulating low carbon action we contribute to key UK goals of lower carbon emissions, the development of low carbon businesses, increased energy security and associated jobs.

We help to cut carbon emissions now by:
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• setting standards for carbon reduction.

We reduce potential future carbon emissions by:
• opening markets for low carbon technologies
• leading industry collaborations to commercialise technologies
• investing in early-stage low carbon companies.

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