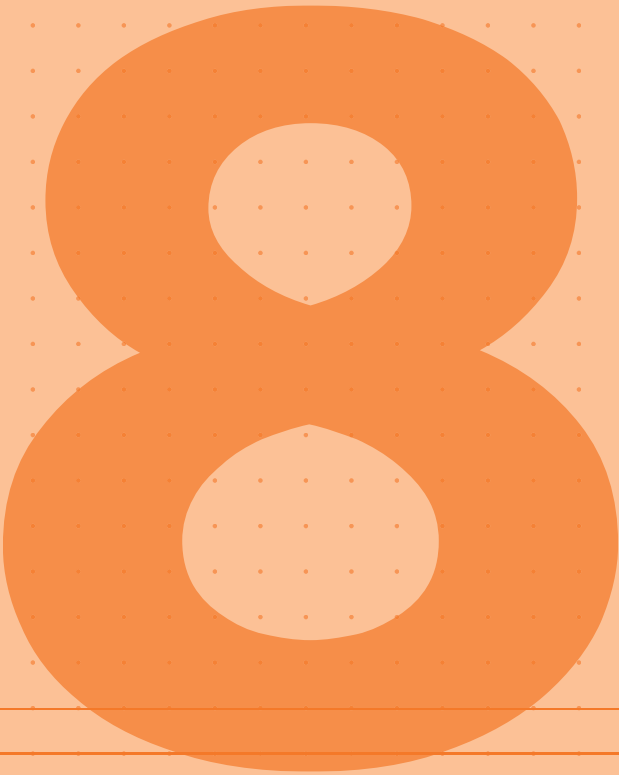


building  
opportunities  
for business

# green retrofit: materials, waste, water and maintenance



LOW CARBON DOMESTIC RETROFIT

EDITION 1, September 2011

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Institute for Sustainability

Technology Strategy Board  
Driving Innovation



# 8

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Water-efficient WCs, showers, baths, taps

Alternative insulation

Forest Stewardship Council (FSC) timber

Appropriate repointing

Eco kitchens

Green paints and floor coverings

## 8.1 Introduction

**This guide examines the non-energy environmental impacts of retrofit work including:**

- materials
- water and drainage
- maintenance
- waste and recycling

Opportunities for reducing the energy use of retrofitted dwellings are addressed by other guides in this series, in particular Guide 6 and Guide 7.

The retrofitting of the United Kingdom's housing already has a substantial environmental impact. This is set to increase further as carbon dioxide emissions policy is transformed into action and the Green Deal is introduced in 2012. It is important to combine the benefit of the potential business opportunities described in this guide with the minimisation of wider environmental impacts.

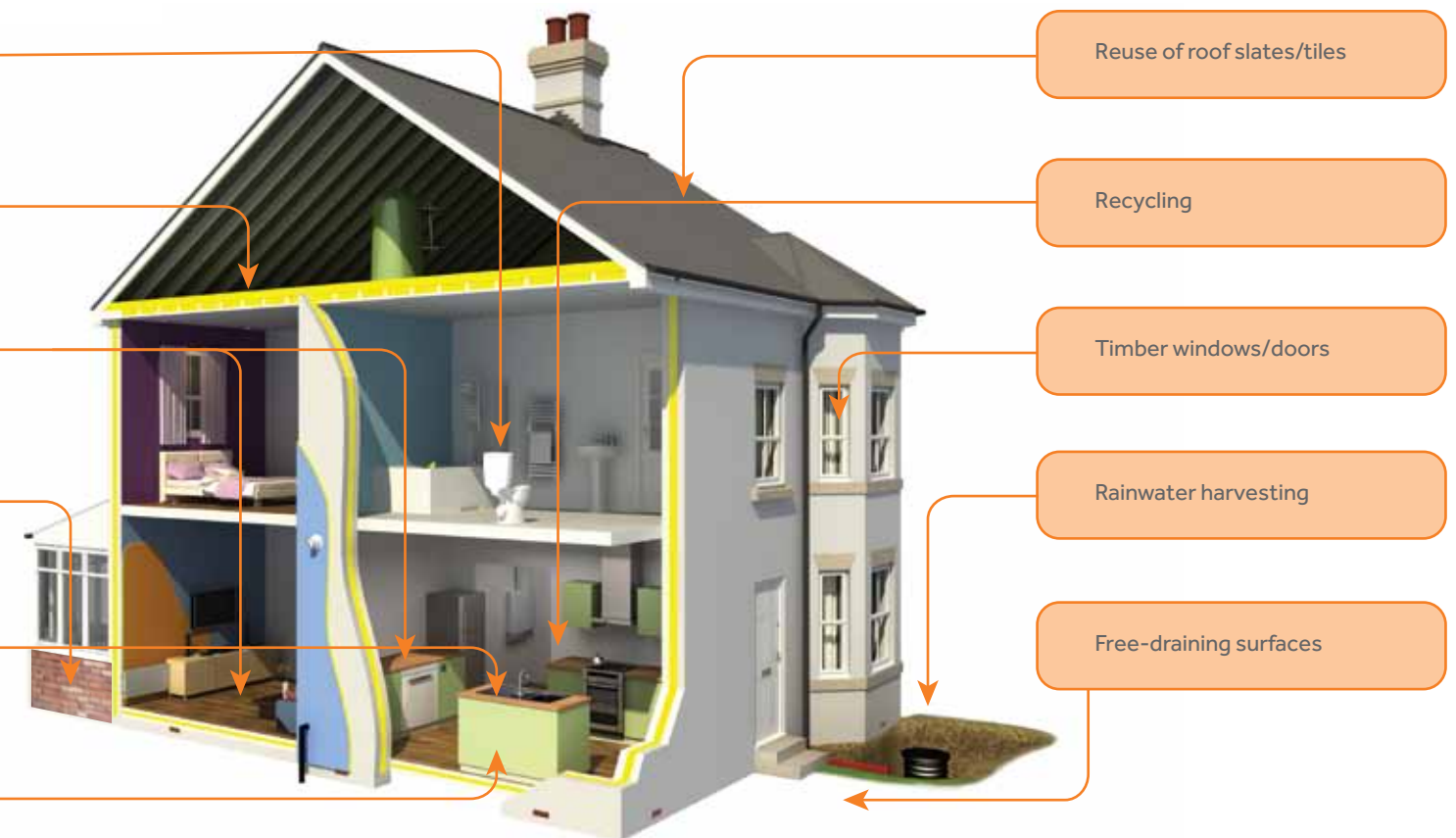


Figure 8.1 Whole-house retrofit.

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### Business Opportunities

Preparing detailed repair specifications.

Product substitution.

## 8.2 Designing for green retrofit

**The overall design of retrofit projects will largely determine the wider environmental impact of the work. The design informs the treatment of the existing materials, the selection of new materials and the performance of the retrofitted building. This section describes how designers can reduce impact by retaining elements of the building and by considering reuse and recycling from the outset. For more information on planning low carbon retrofit see Guide 3.**

### Reuse of existing building elements

With major retrofit that involves remodelling of the dwelling, an early decision to be made is which parts of a building to retain or adapt and which to demolish. This decision will be guided by the age and condition of the existing structure, but designers may also need to maintain the appearance of the building. In all cases, when deciding on which elements of a building to retain and upgrade, it is necessary to take into account the expected life of the building. As most buildings in the UK are constructed primarily from brick, block and stone, we can generally assume that they will be occupied for many decades but there may be exceptions.

### Designing for reuse in future

Materials used in retrofit projects will be reused or recycled at the end of the life of the building, or that element of the building. This applies to structural elements such as the walls, windows and roof in addition to fit-out materials such as flooring, furnishings and sanitary goods.

For example, approximately 21% of the housing stock in the UK is pre-1919 and constructed with lime mortar. Lime mortar readily knocks off bricks when a wall is demolished and the brick can be reused. Cement mortar adheres to brickwork more strongly than lime and can make the bricks impossible to reuse, as it is difficult to remove cement mortar at demolition. Repointing lime masonry with cement mortar can lead to water becoming trapped behind the cement and this in turn can lead to loss of face of the bricks, shortening the life of the building or necessitating costly replacement.

Composite materials are usually difficult to reuse and in many cases impossible to recycle. For example, kitchen worktops constructed from melamine, woodchip, formaldehyde and other adhesives cannot be reused or recycled effectively at present. By contrast, hardwood worktops can be sanded down and reused, in other joinery projects if not in kitchens themselves. At the end of their life they can become fuel. The same principle applies to furnishings – many carpets contain a mix of chemicals, which make reuse and recycling impractical.

### Designing for prevention of maintenance

The impact of construction materials is increased significantly if they require maintenance during the course of the life of the building or building element.

Systems and materials introduced to save energy can require maintenance to ensure that they continue to function effectively. The goal of the designer is to minimise this maintenance and to select robust products, which have been properly tested and certificated. Some maintenance may be unavoidable and the impact can be significant, for example, solar energy systems may only require occasional maintenance but access equipment will be required and a specialist contractor may need to travel to the site.



Figure 8.2 Timber cladding.

### Business Opportunities

Providing training on low-impact building materials.

Providing life cycle assessment (LCA) and whole life costing (WLC) tools.

Sustainable interiors.

## 8.3 Specification of green materials

This section explains the process of selecting low-impact materials to meet design requirements and how holistic and informed decision-making about materials specifications can improve overall environmental performance.

### Environmental impact

Construction materials and products are used in all retrofit work, however minor. The environmental impact of these materials is complex but on a global scale it is substantial. The main areas in which the impact of materials can be measured are:

- resource depletion
- energy use
- air pollution
- water pollution
- waste
- water consumption.

When selecting building materials during the retrofit process, the environmental impact of those materials can be minimised by considering these key factors.



Figure 8.3 Insulation options, sheepwool insulation (left) and recycled newspaper insulation (right).

There are plenty of natural and sustainable forms of insulation available (hemp cotton, wool, recycled newspaper) that could be used instead of products derived from petrochemicals such as polystyrene and polyisocyanurate foam. However, when adding insulation on the inside or outside of solid walls, space is normally at a premium. Conventional petrochemical products generally have lower thermal conductivity, ie they deliver more insulation for a given thickness than the equivalent green insulation products. For more information about how to improve the building fabric see Guide 6.

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The general principles of sustainable materials selection can be summarised as follows:

- Conserve existing building fabric; repair rather than replace.
- Reuse materials; specify reclaimed and recycled building materials.
- Use sustainable and locally sourced materials.
- Avoid building materials that have potential health risks.
- Select materials that maintain or enhance the appearance of the building.

### Reuse of materials and use of recycled materials

“It is better to reuse than to recycle.” What underlies this often-heard quotation is the fact that it takes little or no energy to reuse materials in their existing form on the same site. Recycling of materials, by contrast, requires collection, transportation and all the energy required for reprocessing, before materials are once again introduced into the supply chain.

For example, when slate or tile roofs on older buildings fail and need to be renewed, there is normally no reason why the existing roof covering cannot be reused, once the felt and battens have been replaced.

There are also plenty of building products available which are manufactured from recycled materials. Some concrete blocks have a high recycled aggregate content and many other items from damp-proof membranes (DPMs) to insulation to steel products can now be obtained from recycled sources. A guide to the recycled content of mainstream construction materials is available from the Waste and Resources Action Programme (WRAP).



Figure 8.4 Slate being stripped for reuse.  
(Source: Nigel Griffiths)

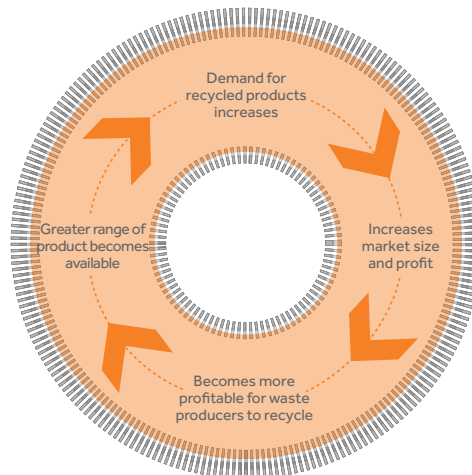


Figure 8.5 The virtuous circle of reclamation demand and supply.

## Life cycle assessment

Life cycle assessment (LCA) analyses the environmental impacts associated with all aspects of product life, from the extraction of raw materials through processing and manufacture to distribution and use through to maintenance and disposal or recycling. Assessment is not a precise science and it is always necessary to interpret the results – in other words, a value judgement is still required by the client or specifier.

## Green guide to specification

The Building Research Establishment (BRE) publishes the Green Guide to Specification. Credits under the materials section of all BREEAM (BRE Environmental Assessment Method) standards are based on the scoring of materials in the Green Guide. Potential Green Deal Providers may need to be aware of this assessment method and any BREEAM requirements that may be linked to eligibility.

Under the Green Guide, materials are rated A+ to E, with A+ representing the best environmental performance. A version of the Green Guide is being produced specifically to accompany the new BREEAM Domestic Refurbishment Standard that will be released in 2011.

## Whole life costing

Whole life costing (WLC), by contrast with life cycle assessment, only considers the economic costs and benefits of a material. Whole life costs are usually higher than initial capital costs as WLC takes into account the costs of maintenance during the lifetime of a material and disposal or recycling at the end of its life. While WLC will enable those responsible for buildings to look at the full economic cost of using a particular material, it will not take into account wider environmental impacts such as pollution or resource depletion.

Combining WLC and LCA tools may ultimately provide the best guide to sustainability. For a material to be used successfully in retrofitting projects it must be both cost-effective and have minimal environmental impact. As the production of all materials requires the consumption of resources, which in turn have a price, cost can also be a useful guide to sustainability as less cost generally means less resource consumption.

## Interiors

Interiors tend to be refurbished on a much more regular basis than building fabric so the environmental impact of replacement flooring and decoration can be significant. Sustainably sourced hardwood flooring will outlast carpets and vinyl coverings. Several ranges of paint with low or zero volatile organic compounds (VOC) content are now widely available. Kitchens can be supplied with carcassing that avoids the use of particleboards, which are generally high in formaldehyde content. Doors and worktops can also be supplied in sustainable solid timber rather than veneered chipboard.

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## green retrofit: materials, waste, water and maintenance

### Business Opportunities

Salvage services.

Local recycling centres.

Preparing site waste management plans.

Training small builders on waste and pollution.



Figure 8.6 The waste hierarchy – Rethink, Reduce, Reuse, Recycle.

### 8.4 Minimising and managing waste and pollution

**This section examines waste management and pollution control throughout a retrofit project – from design through to completion. Retrofit generates waste as fabric and technology are replaced and upgraded. Conversely, rethinking the attitude towards waste – and reducing or reusing wherever possible – is simultaneously reducing waste streams.**

#### Waste hierarchy

Retrofit work generates significant quantities of waste, some of which can be reused or recycled, with the remainder sent to landfill. To limit waste to landfill:

- Rethink the approach to retrofit and minimise demolition. Retain and reuse as much of the existing building fabric as possible.
- Reuse as much material on site as possible.

Only when the approach to waste has been rethought and reuse has been maximised should materials be taken off site for reclamation, reprocessing or to landfill. This prioritised method of addressing site waste is known as the “waste hierarchy”.

Increasingly, waste is no longer viewed as a liability but as an asset. Waste streams can be treated as a resource and the range of uses for waste streams is expanding rapidly as manufacturers take advantage of the opportunities and develop new products.

The approach to waste handling will depend on the size of the project. Large retrofit schemes that deal with multiple properties have both the economies of scale and the resources to handle waste more effectively.

#### Design

One of the most effective ways to reduce waste is to design it out (rethink). This can be achieved by:

- retention of building elements where possible
- reuse of materials eg tiles and slates
- use of off-site manufacture for components
- designing to use full-size components to reduce offcuts
- supply chain management.

Supply chain management can reduce the impact of construction materials, if there are suppliers who have strong environmental commitments in place. At present this is not widespread within the industry although most reputable suppliers now stock sustainably sourced timber, for example.

Off-site manufacture is generally more relevant to new build but, where an extension is to be built or external insulation applied, there may be elements which could be manufactured off site.

## Site waste

Demolition materials and offcuts form the bulk of waste in retrofit work. Where construction materials cannot be reused on site (topsoil, bricks, tiles can often be reused) then it may be appropriate to sell materials to salvage. This is most common during reroofing where a new finished surface is being provided and most of the old slates or tiles are still in good condition.

For lower value materials there is currently no economic way for small contractors to recycle materials effectively. The result is that waste is mixed together in skips and has to be sorted at transfer stations. Most transfer stations will accept sorted waste directly and will charge a lower rate per tonne but the contractor still has to transport the waste to the site, which may not be local. For more information about setting up a local recycling centre, refer to WRAP and the Ecotrade Centre Trial.

The UK government has set up the National Industrial Symbiosis Programme (NISP) to encourage cross-industry resource efficiency and sustainability. This includes the use of waste streams to develop new products for industries that would normally not consider waste as a raw material.

Site waste can be minimised by effective planning and ordering (reduce). This will prevent over-ordering and, where this does occur, waste can be reduced if suppliers are prepared to accept credit returns of unused materials, subject to a reasonable restocking charge.

On larger sites, with a contract value of £300,000 or greater, contractors are obliged to develop a site waste management plan (SWMP) to minimise waste to landfill. For example, this might apply where a housing association is carrying out a low carbon retrofit to a group of properties. For more information and support about reducing construction waste to landfill, refer to WRAP's Halving Waste to Landfill programme.

## Packaging

Packaging of building products also accounts for significant quantities of site waste. Use suppliers with packaging policies and seek out merchants who are prepared to accept and reuse or recycle any packaging materials. For example, pallets can be reused and some companies will collect them for free if quantities are sufficient.



Figure 8.7 Mixed waste skip.

# 8.5 Water efficiency and drainage

**This section explains the need for water efficiency and then outlines the main measures which can be installed to achieve savings in water use. Sustainable Drainage Systems (SUDS) are also covered in this section.**

## Water demand

Personal demand for water has risen substantially over the last 50 years. The UK population has also expanded during that period so the overall demand for water has risen sharply and water is becoming a scarce resource in some areas of the country.

Building Regulations now require water efficiency to be addressed in new buildings, but at present there is no requirement for small retrofit projects. Larger retrofit projects may be required to consider water efficiency if an assessment scheme is in use. For example, the voluntary BREEAM Domestic Refurbishment standard due for publication in 2011 requires minimum levels of water efficiency.

Water efficiency measures will only provide a saving to the customer where consumption is metered, so in the absence of a meter, other environmental justifications would be required. Reductions in the use of hot water will also deliver energy savings. For more information about improving building services see Guide 7.

### Business Opportunities

Water efficiency measures.

Cost-effective rainwater harvesting for retrofit.

Resurfacing.

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The average domestic demand for water can be broken down as follows:

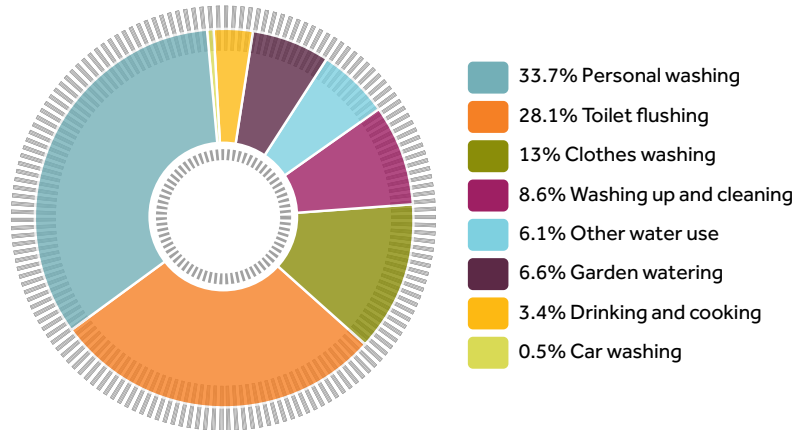


Figure 8.8 Domestic water demand.

### Toilets

Older toilet cisterns use 9 litres of water or more for each flush. While the flush volume can be reduced by the use of displacement devices, care needs to be taken with their installation to ensure that any object placed in the cistern does not interfere with the operation of the flush or siphon assemblies. Water companies often provide free displacement devices, which are designed for this purpose. Standard cisterns used in new construction now have a maximum flush of 6 litres so these are relatively easy to source. In most cases it makes economic and technical sense to replace the pan as well as the cistern and the very low flow (2 litres/4 litres) devices require a new pan in order to operate effectively.

### Baths and showers

Baths and showers are particularly important because they are the main consumers of hot water in homes and therefore affect energy use as well as water consumption. There is a point at which low water flow in showers is undesirable or impractical for the user. Low-flow shower heads can be used to deliver the same sensation of water pressure, with reduced water use by introducing air just before the water outlet, as in a whirlpool bath. Common low-flow shower heads deliver water at 9 litres per minute or less.

### Taps

Most taps currently in use have no water-saving features. There are three main features that can deliver reductions in water use:

- water flow regulators
- aerating tap heads
- automatic shut-off systems.

Flow regulators are fitted into the existing supply pipework to the tap and there is no need for tap replacement, which may reduce the cost. It is likely that the installation of flow regulators or spray-head taps would only be commissioned when a bathroom is being refurbished or within a wider package of water efficiency measures.



Figure 8.9 A low-flow shower head.

## Rainwater and grey water harvesting

Rainwater harvesting (RWH) systems collect water from the roof and provide storage for use in toilet flushing and, in some cases, for clothes washing.

RWH systems are common in many countries but in the United Kingdom they are mainly installed in new build homes as they can be integrated more easily and because water consumption is metered. However, retrofit systems are relatively expensive to install so the payback period can be lengthy.

Grey water systems collect water from baths, showers and washing for use in toilet flushing. The disinfection and storage of grey water is more complex and expensive than rainwater so systems tend to be more expensive and may not deliver the same savings.

## Drainage

Recent flooding events have also increased the focus on drainage. The rainfall run-off from urban areas is transferred quickly to the river or sewage systems and, as the size of the urban footprint has increased, so has the pressure on the drainage system. The relatively new science of Sustainable Drainage Systems (SUDS) has emerged to reduce flood risk, but also to improve the quality of surface-water run off and to increase amenity in public landscaping by providing communal attenuation ponds and soakaways. SUDS techniques include:

- porous surfacing
- attenuation ponds
- rainwater harvesting.

For more information about Sustainable Drainage Systems, refer to the Environment Agency, the Scottish Environment Protection Agency and the Construction Industry Research and Information Association (CIRIA).



Figure 8.10 A rainwater harvesting system. (Source: H2O Building Services)

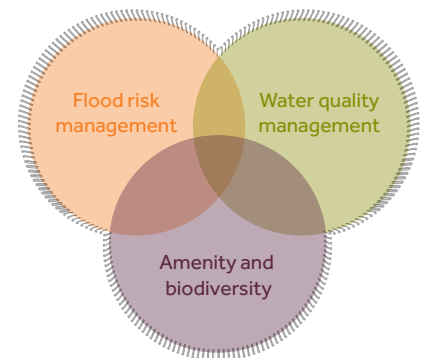


Figure 8.11 The SUDS triangle.

### Business Opportunities

Maintaining air tightness.

One-stop maintenance package for retrofit measures.

## 8.6 Maintenance

**Green retrofit will involve the removal of fabric and systems and the introduction of new materials and technologies. The aim of designers (see Section 8.2) is to minimise the burden and impact of maintenance. Inevitably some maintenance will be required and this will present opportunities for maintenance contractors. This section describes the principal maintenance requirements in homes which have had green retrofit. For more information about planning for maintenance and living in a low carbon home see Guide 3 and Guide 9.**

### Building fabric

Improving air tightness is one of the most cost-effective methods of reducing heat loss and therefore energy use from housing. Achieving good air tightness requires the application of numerous sealants, especially where different materials meet. Over time, these seals break down and require replacement.

Similarly, timber doors are prone to warping and draught-proofing needs adjustment, sometimes on a seasonal basis. Timber joinery also requires periodic maintenance. Although the overall impact of timber is lower, the proportion attributed to maintenance is generally higher than that of PVCu within the life cycle of the two materials.

Solid timber floors have a lower environmental impact than other flooring materials such as carpet and vinyl and last much longer. Should they become worn or damaged in any way, they can be sanded down and reoiled or waxed. The same is true of solid timber worktops.

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Figure 8.12 Sealing a door frame.

### Exterior surfaces

Porous paving systems require maintenance to ensure that the gaps between blocks are maintained. Gravel requires cleaning to prevent the build-up of organic matter and SUDS require occasional maintenance to ensure that surface water channels and storage areas are kept clear.

## 8.7 Summary of business opportunities

**This section sets out in more detail the business opportunities identified above.**

### Detailed repair specification

Designers can demonstrate to clients that money can be saved by careful design of the retrofit process, and they can charge fees for this work. For example, a detailed survey of defects in original windows, coupled with a good specification for secondary glazing, will save original features and improve energy performance substantially while reducing the environmental impact of the work in comparison with wholesale window replacement.

### Product substitution

There is an opportunity for designers to specify products that can easily be recycled and substitute products that cannot. This also provides an opportunity for manufacturers to develop appropriate products, especially as many green products are currently imported.

### Training on low-impact building materials

Builders are frequently prevented from using alternative materials through a lack of knowledge about their installation and performance. As builders frequently select the materials to be used in retrofit projects, the government will need to reach out to SMEs in the construction sector in order to increase the percentage of locally produced and recycled materials in use. For more information about training and accreditation opportunities see Guide B.

### Life cycle analysis and whole life costing services

Where clients are undertaking substantial retrofit projects to multiple buildings, there is a need for environmental impact assessment of the work, to minimise pollution and energy use and to maximise the social and economic benefit to the community. Opportunities exist to become qualified assessors using existing assessment methodologies and software.

### Sustainable interiors

As the general public become increasingly aware of green issues and perhaps more health-conscious, there should be more opportunities for the supply chain to develop new sustainable products. Major paint manufacturers now offer green ranges but other products are limited. The same opportunities exist for decorators, kitchen fitters and floor layers to market and install sustainable alternatives to conventional products.

### Salvage

The value of salvage has increased in recent years so the opportunities for profitable salvage are now stronger. Victorian bricks, pavements, tiles and slates are all commonly salvaged and traded, although for conservation reasons these are best reused in situ.

### Local recycling centres

Small builders often generate reusable material, which they are obliged to dispose of in mixed skips, which are expensive. A network of local recycling centres would enable segregated waste such as topsoil, timber and hardcore to be reused by other builders without the need to use mixed skips and transfer stations.

### Site waste management plans

For all construction projects with a contract value of £300,000 or greater, it is mandatory to have a site waste management plan (SWMP). There is an opportunity to provide a simplified service to smaller projects. The Green Deal will be introduced in 2012 and it is conceivable that Green Deal providers could be required to use some equivalent to SWMPs for projects over a certain size.

### Training small builders in waste

Most training opportunities only arise for members of larger organisations. The retrofit market is dominated by small contractors who have limited access to training and the capacity to undertake it. Subject to appropriate funding, an opportunity exists to reach out to small builders and provide information and training on waste and pollution. Builders' merchants may be one viable outlet.

### Water efficiency measures

At present, water-using fittings are normally replaced when bathrooms or kitchen are upgraded. However, there is an opportunity for installers to deliver a package of water efficiency for specific property types. The scale of this opportunity will increase as policymakers, regulators and water companies respond to water shortages. There is also an opportunity for assessors to carry out a water efficiency survey.

### Cost-effective rainwater harvesting for retrofit

As WC flushing accounts for approximately one third of domestic water use there is an opportunity for manufacturers to develop low-cost retrofit solutions for rainwater harvesting for specific property types. The scale of this opportunity will increase as policymakers, regulators and water companies respond to water shortages.

### Resurfacing

Driveways and patios are constructed or renewed periodically. The advent of effective permeable materials and the new regulations relating to driveways present an opportunity to promote sustainable drainage resurfacing as a functional and aesthetic improvement.

### Maintaining air tightness

From time to time seals around windows, doors, skirting boards, and other exterior seals will require replacing and reinstatement. As a whole-house measure, seals should be checked and replaced where necessary, every five to ten years, possibly accompanied by an air tightness test.

### One-stop maintenance package

The role of maintenance engineers could be expanded to include maintenance required for rainwater harvesting, SUDS schemes, microgeneration equipment, draught-proofing, green roofs and light pipes. Alternatively, a new multiskilled practitioner may emerge to maintain all these systems if electricians and plumbers do not take up this opportunity.

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### 8.8 Next steps

#### Key references

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ROYO, C (2006) *Peterborough Ecotrade Centre Trial: Final Report*, WRAP, Banbury, [www.ukceed.org/files/downloads/ecotradecentre.pdf](http://www.ukceed.org/files/downloads/ecotradecentre.pdf).

WRAP (2008) *Choosing Construction Products – Guide to the Recycled Content of Mainstream Construction Products*, WRAP, [www.wrap.org.uk/downloads/Const\\_Product\\_Guide\\_Version\\_4.1.c0c95a7f.2962.pdf](http://www.wrap.org.uk/downloads/Const_Product_Guide_Version_4.1.c0c95a7f.2962.pdf) and [rcproducts.wrap.org.uk](http://rcproducts.wrap.org.uk).

#### Key links

For more information on BREEAM Domestic Refurbishment Standard: [www.breeam.org/page.jsp?id=228](http://www.breeam.org/page.jsp?id=228)

For Building Regulations information: [www.communities.gov.uk/planningandbuilding/buildingregulations](http://www.communities.gov.uk/planningandbuilding/buildingregulations)

For more information on National Industrial Symbiosis Programme (NISP): [www.nisp.org.uk](http://www.nisp.org.uk)

For more information on rainwater harvesting systems: [www.ukrha.org](http://www.ukrha.org)

For more information about Site Waste Management Plans: [www.wrap.org.uk/construction/tools\\_and\\_guidance/site\\_waste\\_management\\_planning](http://www.wrap.org.uk/construction/tools_and_guidance/site_waste_management_planning)

For more information on Sustainable Urban Drainage Systems: [www.environment-agency.gov.uk/business/sectors/36998.aspx](http://www.environment-agency.gov.uk/business/sectors/36998.aspx) and [www.ciria.com/suds](http://www.ciria.com/suds) and [www.sepa.org.uk](http://www.sepa.org.uk)

For more information about reducing construction waste to landfill from WRAP: [www.wrap.org.uk/construction/halving\\_waste\\_to\\_landfill](http://www.wrap.org.uk/construction/halving_waste_to_landfill) [All accessed 29/06/11]

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