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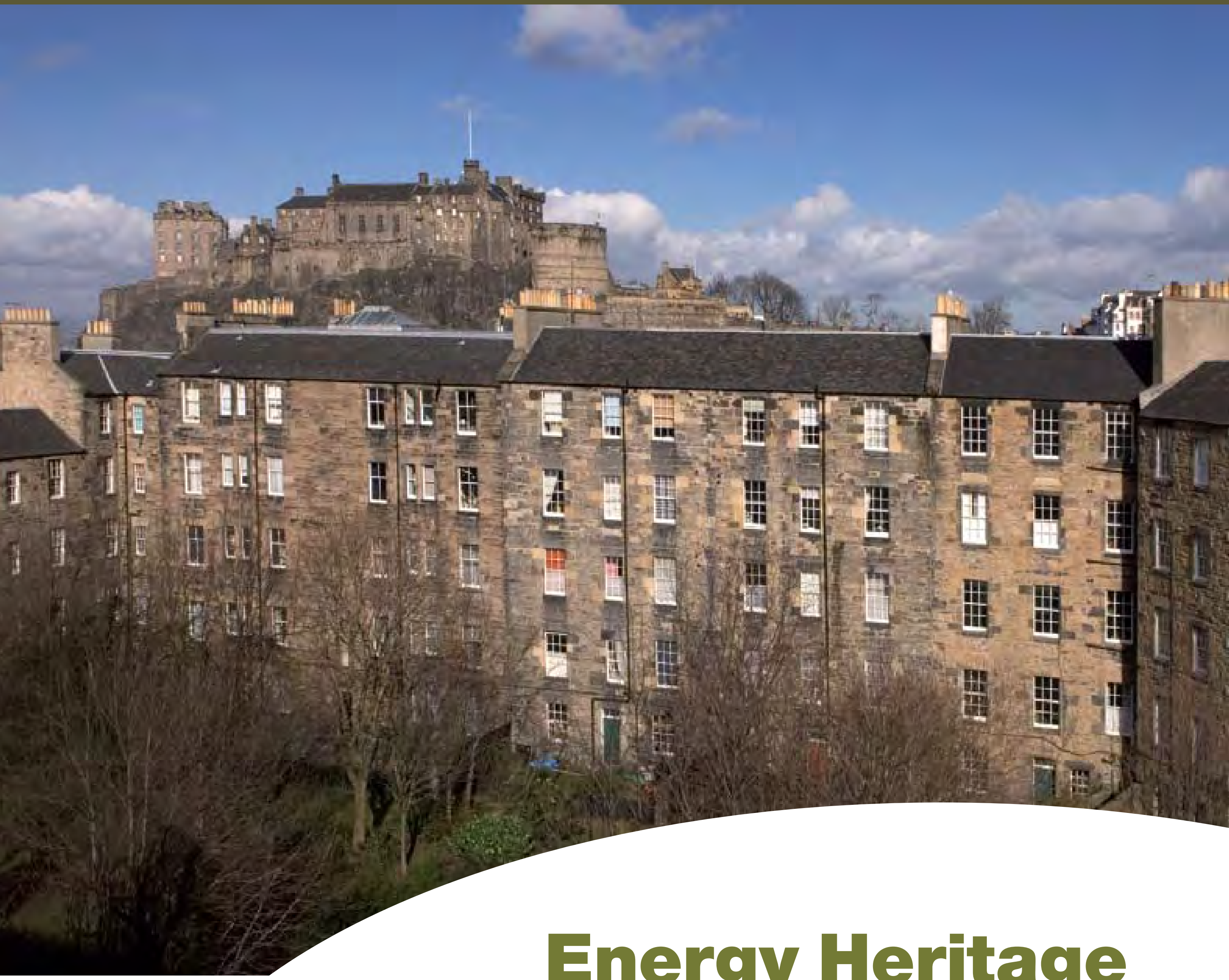

Energy Heritage

A guide to improving energy efficiency in traditional and historic homes

eaga partnership charitable trust

EDINBURGH WORLD HERITAGE

Acknowledgements

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The City of Edinburgh Council

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Historic Scotland

John Gilbert Architects

Lister Housing Co-operative

Royal Incorporation of Architects in Scotland (RIAS)

Scottish Ecological Design Association (SEDA)

ScottishPower

Sust.

and the householders involved in the Energy Heritage pilot study.

Foreword

One of Changeworks' main aims is to provide people with the information they need to make choices that lessen their impact on the environment, enabling them to lead safer, healthier and more fulfilled lives.

This document, which encourages and facilitates energy efficiency improvements in traditional and historic homes across the UK, came about as a result of Changeworks' **Energy Heritage** project. Changeworks worked in partnership with housing providers, planners and building conservation bodies to identify acceptable and effective ways of improving energy efficiency in traditionally-built listed properties in Edinburgh's Old Town.

Edinburgh is renowned for the survival and continuing use of its historic buildings. A key aim of the project was to reduce the risk of fuel poverty among householders in these protected homes, without adversely affecting the historic and architectural character of the buildings, which are within a World Heritage Site recognised by UNESCO for its outstanding cultural value.

Energy Heritage has shown that traditional homes can be made more energy efficient, often through relatively easy and minor interventions, and retain their historic character and appearance. The lessons drawn from the **Energy Heritage** project are the basis of this guidance.

Councillor Ian Perry
Convenor – Changeworks

Georgian tenement flats in Edinburgh's World Heritage Site, owned by Lister Housing Co-operative

Supporting statements

Edinburgh World Heritage:

"As World Heritage Site Project Manager, I am tremendously encouraged by this piece of work that seeks to find common ground between building conservation priorities and the need for sensitive energy-saving solutions in listed buildings. Changeworks deserve substantial credit for their own energy in bringing so many partners into the project, not least the invaluable support from Historic Scotland on some of the research elements. I am delighted with the progress made and hope that this document will further widen the debate on energy saving in the existing housing stock."

David McDonald, World Heritage Site Project Manager

The Cockburn Association:

"Conserving buildings and conserving energy are two sides of the same coin. We welcome ***Energy Heritage*** *as a practical tool for historic homeowners seeking to reduce their energy costs, lessen the impact on the environment and protect the special character of their home."*

Moira Tasker, Director

Royal Incorporation of Architects in Scotland:

"The importance of research into measures to improve the energy efficiency of existing housing stock cannot be over-emphasised. This informative guide looks at the balance between fuel affordability and building fabric efficiency, and offers advice on practical measures to improve houses in the historic built environment."

Andrew Leslie, Director of Practice

Scottish Ecological Design Association:

"Reducing the energy used by the existing housing stock is crucial to meeting national carbon reduction targets. This is particularly difficult in Scotland's many historic residential areas. Changeworks has done a great job in producing this valuable guidance, which details actual energy savings from a range of measures in use."

Richard Atkins, Chair

How to use this guide

This guide provides options for improving the energy efficiency of homes that may not be seen as viable candidates for such measures, due to their traditional construction and protected status. The guide is divided into three parts, and covers the following questions:

PART A

What issues affect energy efficiency improvements in historic buildings?

Part A outlines the nature of historic homes, the importance of domestic energy efficiency, wider sustainability issues, and the potential impact of climate change on these historic buildings. It also relates these issues to statutory and discretionary powers of local authorities and other agencies.

PART B

What opportunities exist to enhance historic homes?

Part B provides guidance on the selection and installation of energy efficiency improvement measures acceptable in historic homes. All elements of a typical traditionally-built home are covered.

PART C

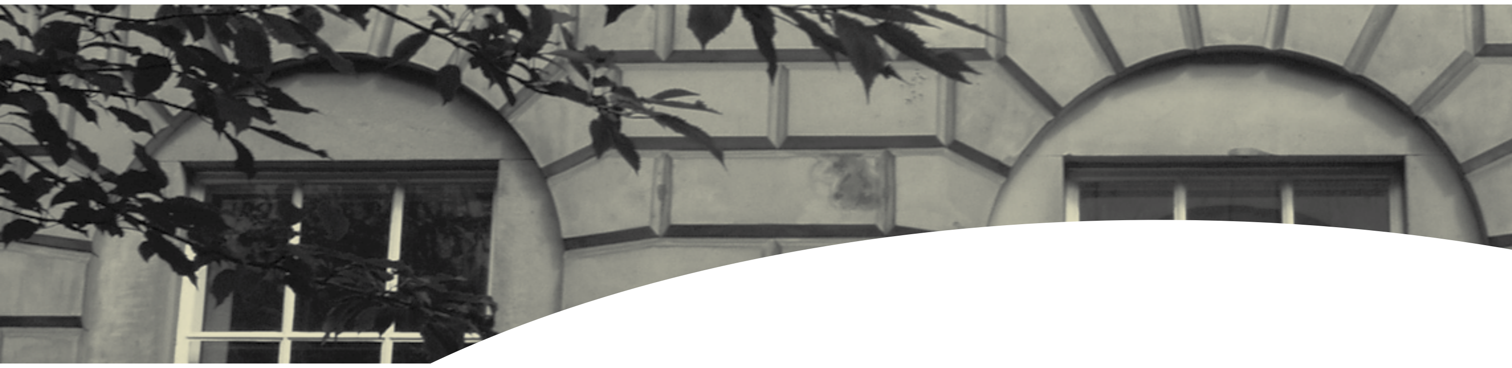
What lessons can be learned from other experiences?

Part C describes a case study of a project carried out in an 1820s tenement building (a traditional Scottish dwelling type with a common stair) in Edinburgh. The background and selection of measures are covered, specific technologies are identified and their impact measured.

Contents

PART A

Energy efficiency and historic homes



Georgian tenement flats in Edinburgh's World Heritage Site, owned by Lister Housing Co-operative

A1

Introduction

Building conservation and energy efficiency are both key aspects of sustainability. Traditionally-built properties contain a considerable amount of embodied energy and were built to last: many have been standing for hundreds of years, and well-maintained properties will continue to stand for many more. In order for them to continue to be comfortable in the future – without putting occupants at risk of fuel poverty – there is a range of viable interventions that can be adopted to improve their energy efficiency. Good levels of energy efficiency could protect the sustainability of historic homes (both their fabric and their function), and ensure that householders achieve affordable warmth.

There are no ‘one-size-fits-all’ solutions to improving the condition of historic homes and energy efficiency is no exception. However, acceptable solutions do exist, and this is recognised in planning policy: “listing should not prevent sympathetic adaptation and innovative solutions may be appropriate providing the special interest of the building is protected” (Draft Scottish Planning Policy 23: Planning and the Historic Environment, 2008).

It is possible to reduce energy inefficiency in homes, even in historic buildings, without compromising their historic and architectural character. The key lies in balancing historic buildings’ character, retention of original fabric, energy conservation and the needs of modern householders.

‘Fuel poverty’ occurs when a household has to spend more than 10% of its disposable income on energy used to heat the home adequately. There are three main causes of fuel poverty: low household income, the rising cost of fuel, and poor home energy efficiency.

A2

What is a historic building?

“Historic buildings are an integral part of our surroundings and contribute to give a sense of identity to our nation as a whole. Historic buildings are not fossils in a museum; most must earn their keep. They must change and adapt to retain their value and usefulness to people.”

(Historic Scotland website)

Photograph reproduced courtesy of Edinburgh World Heritage

A building of historic interest is generally a good example of a particular building type, design or style of construction, or has some historic or architectural significance that contributes to the character of an area and provides a sense of 'place'. It may also display examples of design, building techniques or materials that continue to inform current and future developments.

One of the most important considerations in terms of building conservation is to retain the original fabric (where it still exists) and character of historic buildings. Buildings may be protected through designation as Listed Buildings, or by being within Conservation Areas.

Listed Buildings are buildings included on the Statutory List of Buildings of Historic or Architectural Interest. There are different grades of listing (A/B/C in Scotland; I/II/II* in England). In considering applications to alter listed buildings either internally or externally, the local authority must have special regard to the desirability of preserving the building or its setting, or any feature of special architectural interest which it possesses.

Conservation areas are normally designated to protect the historic and architectural value of groups of historic buildings. These are sometimes given further protection by requiring formal planning application for more minor developments. This is to avoid a succession of minor alterations that would cumulatively erode both character and appearance.

The Georgian tenements improved by the Energy Heritage pilot study (Part C): they are 'B' listed, in a conservation area and part of a UNESCO World Heritage Site.

Improving energy efficiency standards in listed buildings can be particularly complex, because many of the solutions that apply to modern buildings cannot be applied to older properties (section A4). For this reason, formal protection exists to ensure works are appropriate.

A3

Planning and building control

Planning legislation controls the use and development of land and buildings in the long-term public interest, enabling social objectives to be fulfilled. It also ensures that development is appropriate, and is in keeping with its surroundings.

Any works that change the appearance of a building may require formal consents, which would be issued by the local authority Planning department. Technical standards of any work may be subject to Scottish Building Standards (or equivalent for other UK countries), in which case authorisation is required from the local authority Building Control department.

There are three consents to consider in relation to improving energy efficiency in historic homes: **planning permission**, **listed building consent**, and the **building warrant**.

Planning permission is required for the majority of building work affecting the external appearance of a building (although in some cases works may qualify as permitted development, in which case no planning permission is required). Fixed fees are attached to planning applications, and obtaining the necessary drawings may attract additional architects' or architectural technologists' fees.

Listed building consent is required for alteration or extension of a listed building in any manner that would affect its character as a building of special architectural or historic interest. This applies to the exterior and interior of a listed building, and any structure within their grounds. No fees are attached to listed building consent, although if technical drawings are required these will incur a fee (as above).

Building warrants are needed for most building works (except repairs), and are needed to verify that a building is safe for use and fit for purpose. Fees are attached to building warrants, and are based on the estimated cost of the work. Obtaining the necessary drawings may attract additional architects' or architectural technologists' fees.

Many of the minor works outlined in this guidance may not require formal consents. However, the requirements of the local Planning department should be researched prior to carrying out any improvements. Take the time to discuss proposed works with a Planning Officer: this will avoid difficulties later on. A simple letter outlining the extent of the proposed works might be a suitable starting point.

If a home is in a Conservation Area it may be subject to further planning constraints relating to external alterations.

If proposed works are considered inappropriate or unsuitable, the local authority is likely to reject the application. Such a proposal can be altered and re-submitted. Planning authorities have enforcement procedures to enforce reversal of works that do not have the necessary consents.

The local Planning department can confirm the status of a building or area, and whether planning permission or listed building consent is required. The local Building Control department can confirm whether proposed works require a building warrant.

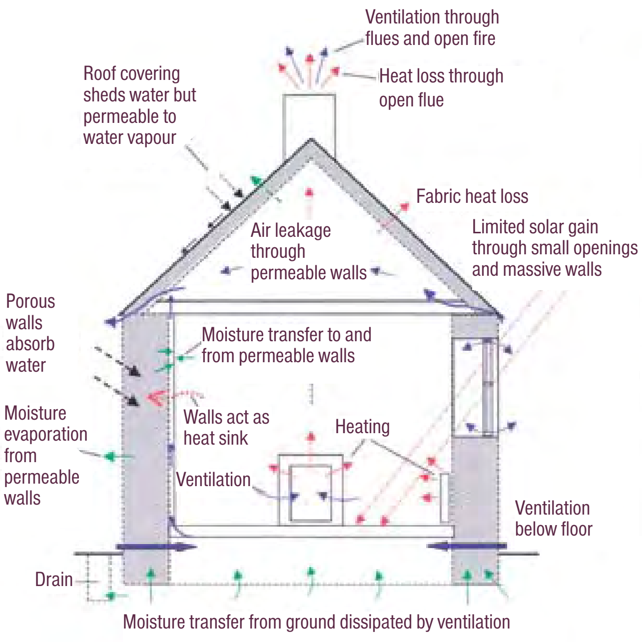
A4

Energy efficiency in older homes

"The challenge is to **refurbish the homes of the past as the homes for the future**."

(Building Research Establishment)

Older homes function in a very different way to modern homes, and can sometimes be less thermally efficient than those built to current Building Standards[1].



Moisture, air movement and thermal behaviour of a traditional building.
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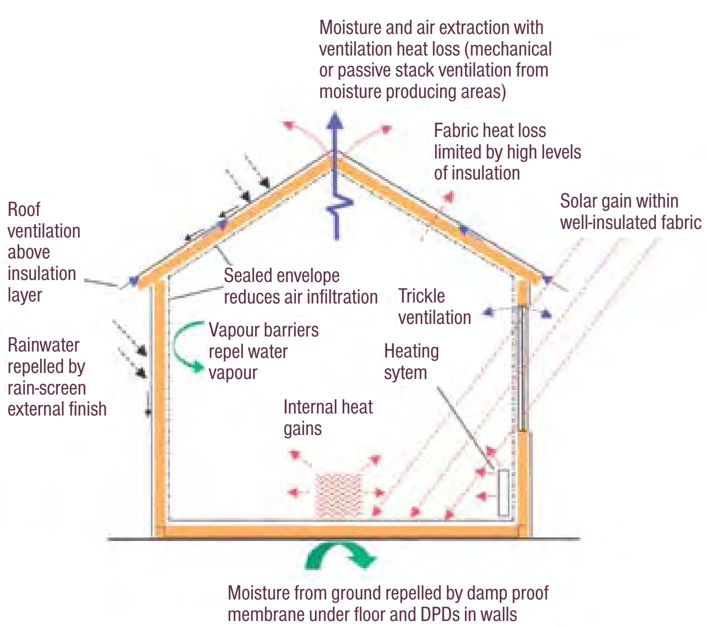

Moisture, air movement and thermal behaviour of a modern building.
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[1] A recent study carried out on court buildings in England found that older buildings had lower energy bills than more modern buildings (predominantly those from the mid-20th century). However, large commercial buildings are used and heated very differently to smaller domestic dwellings, making direct comparison very difficult. One of the study's key recommendations was to retain older, pre-1900 buildings and improve their energy efficiency. The study is titled *Age Energy Research: A study of the energy performance of buildings relative to their age* (Wallsgrove, 2007).

Modern buildings are commonly like sealed units without natural air circulation, and they often require mechanical ventilation. The construction of older buildings makes them more porous and naturally ventilated, so they 'breathe'. They generally include soft and permeable materials such as plasters and lime mortars. These materials respond to air and moisture very differently to many of the hard and impermeable materials used in modern buildings. All these factors determine their energy efficiency.

The ventilation of many older buildings can make them less prone to condensation and its associated effects. The higher thermal mass of older solid walls retains heat better than modern cavity walls, which can help regulate the temperature of a home, keeping it cool in summer and warmer in winter. The layout of traditional tenement buildings is potentially very energy efficient, due the low proportion of external walls to crosswalls / party walls (the exception being end-of-block tenement flats).

However, older buildings can often be draughty and can leak heat unnecessarily. This can be accentuated by larger window sizes and a predominance of sash and case windows, which provide a greater area of low-efficiency glazing and more potential for draughts. Older buildings sometimes have larger rooms with higher ceilings, which can need more energy to keep them warm. They were built long before modern Building Standards existed, with no insulation (although there is generally a layer of 'deafening' material between floors). Many older building components have lower levels of thermal efficiency than modern materials, leading to greater heat loss. Older heating systems also tend to be inefficient compared to modern systems, using more energy and generating less heat.

Some aspects of historic buildings can be 'hard to treat' in terms of improving energy efficiency, and for persons on low or fixed incomes this can increase the risk of fuel poverty. It is important to ensure that historic properties are comfortable, affordable and suited to contemporary lifestyles.

A5

Sustainability and historic homes

A5.1 SUSTAINABLE DEVELOPMENT

'Sustainable development' is defined as **"development which meets the needs of the present without compromising the ability of future generations to meet their own needs"** (Brundtland Commission, 1987)

Sustainable development covers three main areas: social, economic and environmental sustainability.

Below are some of the drivers for sustainable development in housing:

Social: A home that is hard to heat is more likely to cause the occupants health problems than a warm, well-insulated home. Colder buildings are prone to mould or fungal growth from condensation dampness; this can cause respiratory problems as well as the associated smells which impregnate furnishings and clothing.

Economic: The number of fuel poor households in Scotland has almost doubled since 2002, with nearly a quarter of Scottish households found to be in fuel poverty in 2005-06[2].Householders living in fuel poverty struggle to pay their heating bills, or cannot keep their homes warm. With rising fuel prices, it becomes more important to reduce the amount of energy needed to run homes.

Environmental: Existing buildings contain considerable amounts of 'embodied energy', that is, the energy that was used in their materials and construction. There are considerable environmental impacts associated with demolition and new build[3]. Poor energy efficiency leads to excessive energy consumption, contributing directly to climate change (section A5.2).

[2] *Scottish House Condition Survey: Key Findings 2005/06* (Scottish Government, 2007).
[3] In certain instances, demolition and new build can sometimes be the most viable option. *40% House* (Environmental Change Institute, 2005) provides a detailed analysis of this issue.

A5.2 TRADITIONALLY BUILT HOMES AND CLIMATE CHANGE

Historic homes may not be suited to certain energy efficiency improvements; however, they are not exempt from the potential effects of climate change.

Some issues that could affect historic homes are:[4]

The burning of fossil fuels will continue to increase in line with our increasing energy demands, adding to air pollution and acid rain, both of which are detrimental to the fabric of historic buildings;

The effects of extreme weather are likely to be detrimental to historic homes, which may not have the capacity to withstand long-term extreme weather cycles;

Rising fuel costs mean that energy-efficient properties will become even more of a priority for householders. If traditionally-built homes become unaffordable to heat, they could eventually stop being viable as homes.

More details on the broader environmental effects of climate change can be found in a recent research paper by the Intergovernmental Panel on Climate Change (available at www.ipcc.ch).

"In **global environmental terms**, the balance of advantage strongly favours the **retention of existing building stock, particularly when performance in terms of energy consumption and use can be improved.**"

(British Standards Institution, 1998)

Image courtesy of Google Earth
Image © NASA © 2008 Terrametrics

[4] A more detailed analysis of the impact of climate change on historic homes can be found in *Climate Change and the Historic Environment* (UCL Centre for Sustainable Heritage, 2005) and *Climate Change and the Historic Environment* (English Heritage, 2008).

A6

Meeting energy standards

As a result of the issues mentioned above (section A5), householders, housing providers and housing developers are increasingly aware of the growing pressure to improve standards of energy efficiency in their homes. Below are some of the regulatory tools aimed at bringing about these improvements.

A6.1 BUILDING STANDARDS

As a baseline, developers for both new and refurbishment[5] projects have to work to the Scottish Building Standards (or equivalent in other UK countries). In Scotland, the Scottish Building Standards Agency (SBSA) updates these every three years, incorporating higher energy efficiency standards (Scottish Building Standards, section 6) in response to sustainability targets.

A6.2 SUSTAINABILITY TARGETS

There are an increasing number of international, national and local targets in place to tackle the effects of climate change. Some are aspirational and others are legally binding.

Below are just some of the current targets:

European Union:	20%[6] renewable electricity generation by 2020;
Scotland:	80% reduction in CO_2 emissions by 2050;
Scotland:	eradication of fuel poverty by 2016;
Edinburgh:	most sustainable city in northern Europe by 2015;

[5] In Scotland, the most recent guidance for refurbishment of older buildings is *Guide for Practitioners 6: Conversion of Traditional Buildings* (Historic Scotland, 2007).

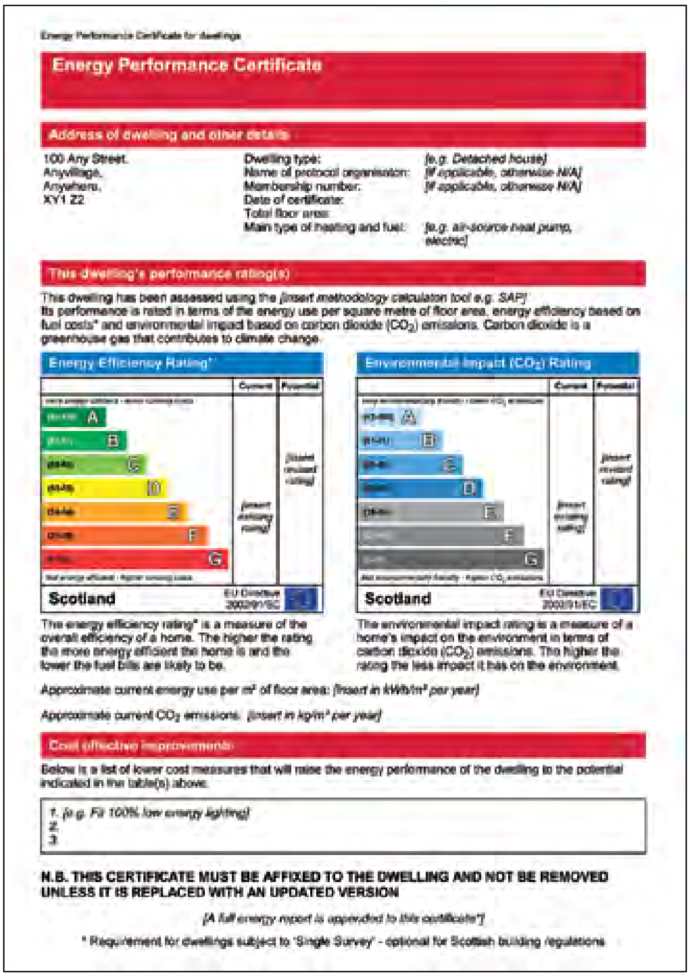
[6] This target may increase to 30% by 2020 if a global agreement, currently under negotiation, is secured.

A6.3 ENERGY PERFORMANCE CERTIFICATES

The energy efficiency of homes can be measured in various ways. These include the Standard Assessment Procedure (SAP), National Home Energy Rating (NHER) scheme, and Energy Performance Certificates (EPCs), which are produced using SAP – or in the case of existing stock, Reduced Data SAP (RDSAP) – measurements.

EPCs are being introduced under the implementation of the European Union's Energy Performance of Buildings Directive (2003). In Scotland this is being phased in; this process started in May 2007 with the revised new building standards. By the end of November 2008 all property sales will require EPCs, with a similar requirement for all tenancies from January 2009. In Scotland EPCs will be part of the Home Pack for domestic property sales; in England they are part of Home Information Packs.

The Royal Institute of Chartered Surveyors has stated that, in the longer term, EPCs are likely to impact on property values and rents. This could result in energy inefficient properties becoming less desirable and more difficult to sell or rent, resulting in more complaints and repairs, a higher tenancy turnover and longer void periods for rented properties.



Energy Performance Certificate for dwellings

Energy Performance Certificate

Address of dwelling and other details

100 Any Street, Anyvillage, Anywhere, XY1 Z2	Dwelling type:	*[e.g. Detached house]*
	Name of protocol organisation:	*[if applicable, otherwise N/A]*
	Membership number:	*[if applicable, otherwise N/A]*
	Date of certificate:	
	Total floor area:	
	Main type of heating and fuel:	*[e.g. air-source heat pump, electric]*

This dwelling's performance rating(s)

This dwelling has been assessed using the *[insert methodology calculation tool e.g. SAP]*
Its performance is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs* and environmental impact based on carbon dioxide (CO_2) emissions. Carbon dioxide is a greenhouse gas that contributes to climate change.

Energy Efficiency Rating*	Current	Potential
A		
B		*[insert revised rating]*
C		
D	*[insert existing rating]*	
E		
F		
G		
Scotland — EU Directive 2002/91/EC		

Environmental Impact (CO_2) Rating	Current	Potential
A		
B		*[insert revised rating]*
C		
D	*[insert existing rating]*	
E		
F		
G		
Scotland — EU Directive 2002/91/EC		

The energy efficiency rating* is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating the less impact it has on the environment.

Approximate current energy use per m^2 of floor area: *[insert in kWh/m² per year]*

Approximate current CO_2 emissions: *[insert in kg/m² per year]*

Cost effective improvements

Below is a list of lower cost measures that will raise the energy performance of the dwelling to the potential indicated in the table(s) above.

1. *[e.g. Fit 100% low energy lighting]*
2.
3.

N.B. THIS CERTIFICATE MUST BE AFFIXED TO THE DWELLING AND NOT BE REMOVED UNLESS IT IS REPLACED WITH AN UPDATED VERSION

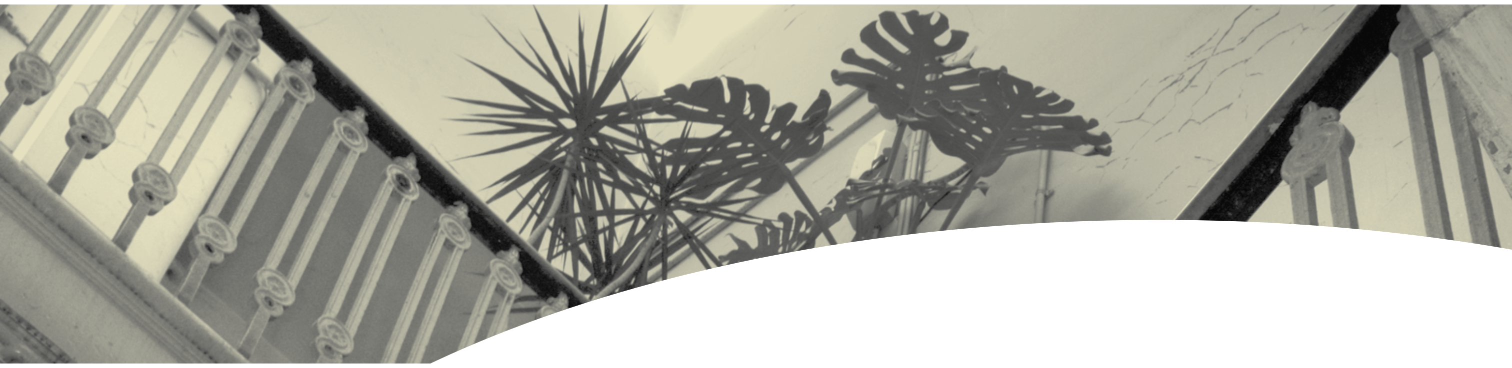
[A full energy report is appended to this certificate]*

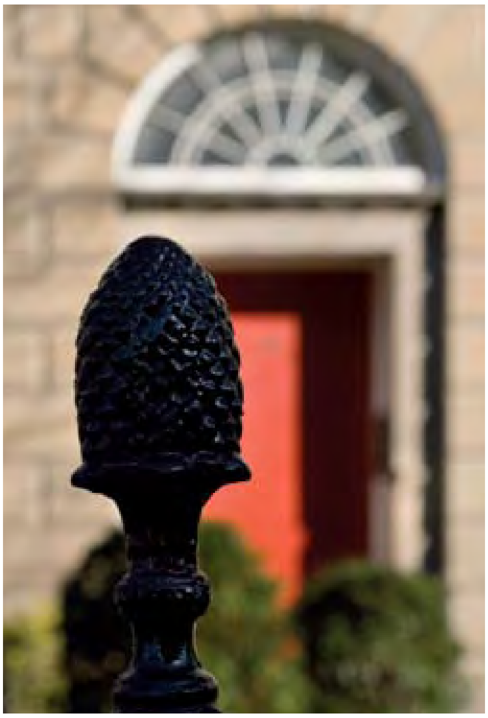
* Requirement for dwellings subject to 'Single Survey' - optional for Scottish building regulations

A sample Energy Performance Certificate

PART B

Guidance for improving energy efficiency in traditional and historic homes





B1

Key considerations

B1.1 INTRODUCTION

Heat is lost from a building in two ways: through its fabric and through ventilation. Fabric heat loss can be minimised by insulating the building. Energy demand can be further reduced by having an efficient heating system and controls, and by using energy-efficient lighting and appliances. The following pages provide guidance on selecting and implementing improvements in thermal efficiency as well as reducing energy use.

The complexities of historic homes (outlined in Part A) make preparation particularly important for any improvement works. The diagram below shows the main considerations.

The case study (Part C) may help inform other projects, by shedding light on the decision-making process undertaken.

There are also some general issues that are relevant to all improvement measures covered in this guide; these are covered in this section.

B1.2 MEASURING THERMAL EFFICIENCY

The thermal efficiency of a material or building component is defined by its 'U-value'. This is a mathematical value that illustrates the rate of heat loss through a material or combination of materials.

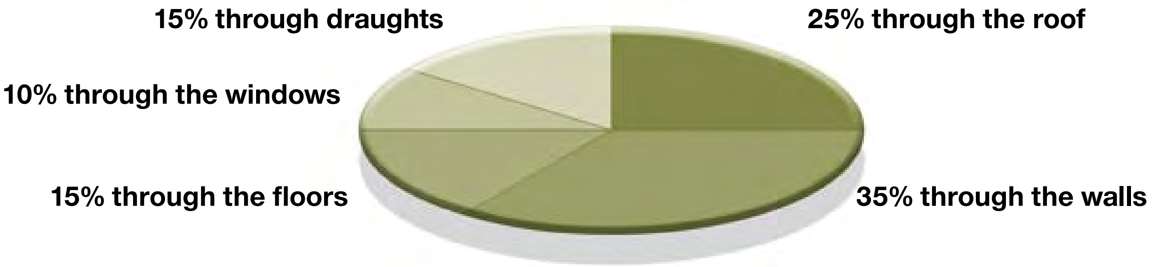
The lower the U-value, the greater the thermal efficiency. The following table provides U-values for some of the typical materials used in building construction. (These values are usually obtained in controlled laboratory conditions; the case study provides details of in situ U-values (section C5.2) for several of the building components and energy efficiency measures covered by this guidance.)

BUILDING COMPONENT	U-VALUE
Window: timber frame, single glazing	4.8 *
Window: uPVC frame, double glazing	2.0 *
Solid brick wall	2.1 *
Solid sandstone wall (pre-1900 to 1966, 600mm)	2.1 *
Brick cavity wall (1900 to 1975), uninsulated	1.6 *
Brick cavity wall (1900 to 1975), insulated	0.5 *
Pitched (sloping) roof, uninsulated	2.3 *
Pitched (sloping) roof, insulated (250mm)	0.16 *
Suspended timber ground floor, uninsulated	0.64 **
Solid ground floor, uninsulated	0.43 **

* Figures taken from *Reduced Data SAP – Collected Data Set*, FAERO on behalf of Defra, 2006

** Figures taken from *National Energy Services – NHER v.4.1 software defaults*, 2008

U-values allow for relatively easy identification of the areas most prone to heat loss, but consideration should also be given to heat loss more generally. Heat loss from a typical home can be broken down as follows[7]:



[7] Energy Saving Trust

B1.3 INSULATION MATERIALS

If energy efficiency improvements are being made to a home for environmental as well as financial reasons, insulating materials should be carefully selected. Many man-made materials require a lot of energy in their manufacture, and can cause health problems (skin or lung irritation, for example). Insulants made from natural materials are available for many parts of a home, including sheep's wool, recycled paper and hemp.

When handling man-made insulation materials (particularly soft quilt), appropriate protective clothing should be worn to protect skin, eyes and lungs from irritation. Individual manufacturer guidelines should be followed.

B1.4 COLD BRIDGING

'Cold bridging', or 'thermal bridging', occurs where a continuous element in the outside walls, roof or floors provides a direct path for heat loss. Areas of cold bridging draw heat out of a building faster than materials that are otherwise separated. Cold bridging can lead to colder internal surfaces, which attract condensation.

When installing insulation in certain areas of a home, cold bridging should be avoided. This is generally possible if full and thorough insulation is installed.

B1.5 VENTILATION

It is important that traditional buildings have adequate ventilation. Over-sealing these buildings can cause considerable problems in terms of condensation and other associated problems. In addition, in rooms where there is a gas- or solid fuel-burning appliance it is a safety requirement for adequate ventilation to be maintained.

Buildings of a traditional construction can be upgraded in terms of energy efficiency, but must also be allowed to 'breathe'. Throughout this guide, ventilation is covered in more detail in relation to specific improvement measures.

B1.6 COSTS AND PAYBACK PERIODS

There is a wide range of solutions available for improving the thermal efficiency of a home. These vary greatly in price and effectiveness. As a rough guide, however, low-cost options include loft insulation, draughtproofing around windows and doors, and reinstating existing internal window shutters; medium-cost options include new window shutters and cavity wall insulation; and higher-cost options include secondary glazing, double or triple glazing, floor insulation and solid wall insulation.

The initial cost of such measures should be considered a financial investment, as they will reduce the cost of fuel bills. While some improvement options may carry higher installation costs than cheaper options, they may also provide greater energy savings. Many improvement options will pay for themselves during their lifetime, and will sometimes pay for themselves several times over. In such situations, not acting could be the real high-cost option.

The following table shows the approximate costs and payback periods of some of the main domestic energy efficiency options. These are a guideline, and will be affected by individual properties and different specifications within each measure.

MEASURE	COST*	ANNUAL SAVINGS*	PAYBACK PERIOD*
Hot water tank insulation (800mm jacket)	£12	£20	c.6 months
Hot water pipework insulation	£10	£10	1 year
Suspended timber floor insulation	£90 (DIY)	£45	2 years
Loft insulation (270mm)	£250 (DIY) £500 (contractor)	£110	c.2 years 4-5 years
Cavity wall insulation	£500	£90	c.5 years
Draughtproofing	£90 £200 (contractor)	£20	c.5 years c.10 years
Solid wall insulation (50mm plasterboard laminates, or battens, insulation and plasterboard)	From £42/m2	£300	Dependent on property size
Double glazing (sealed units)	£3,000	£90	20+ years

* Figures taken from www.energysavingtrust.org.uk

B1.7 FUNDING

B1.7.1 Funding for Energy Efficiency Improvements

Householders in receipt of certain benefits may be eligible for a grant of up to £500 for a range of insulation works, through a Government grant, called **Warm Deal** in Scotland (this has equivalents in other UK countries).

Older and disabled householders in Scotland may qualify for a Scottish Government-funded grant called the **Central Heating Programme**.

Under their supplier licence agreement, power companies include an energy efficiency element in their tariffs. This funding, agreed by the industry regulator Ofgem, is to achieve carbon reduction targets through energy efficiency and microgeneration. This is known as the **Carbon Emissions Reduction Target (CERT)**. For householders, the funding may sometimes be accessible through other power companies than the one supplying the property.

For more information on energy efficiency and the grants and discounts available in Scotland, Energy Saving Scotland advice centres can be contacted free on 0800 512 012.

For information on energy efficiency and the grants and discounts elsewhere in the UK, Energy Saving Trust advice centres can be contacted free on 0800 512 012.

B1.7.2 Funding for Repair of Historic Buildings

Government funding is sometimes available for the repair of historic buildings. Specific energy efficiency improvements will not normally qualify for such grant assistance. You can find out more about available grants by contacting Historic Scotland (Scotland), English Heritage (England), Cadw (Wales) and the Environment and Heritage Service (Northern Ireland).

Grant assistance may be available for repairs to homes within Conservation Areas where there is a specific grant programme, but this is more likely if the property is listed. For householders on low or fixed incomes, living in an unlisted building in a Conservation Area can present financial difficulties: the building may be restricted to certain improvement options as a result of its location, but may not be entitled to any grant assistance. Checking with the relevant local authority conservation officer will confirm individual situations.

The Architectural Heritage Fund has a comprehensive and regularly-updated guide to available funds for historic buildings throughout the UK. The guide, Funds For Historic Buildings, is available at www.ffhb.org.uk.

The following Scottish documents also provide funding information and advice:

- Historic Scotland (2001) – *Grants for the Repair of Historic Buildings* (www.historic-scotland.gov.uk/repairgrants_text.pdf)
- Scottish Civic Trust (2004) – *Sources of Financial Help for Scotland's Historic Buildings* (www.buildingsatrisk.org.uk/publications/sofh.pdf)

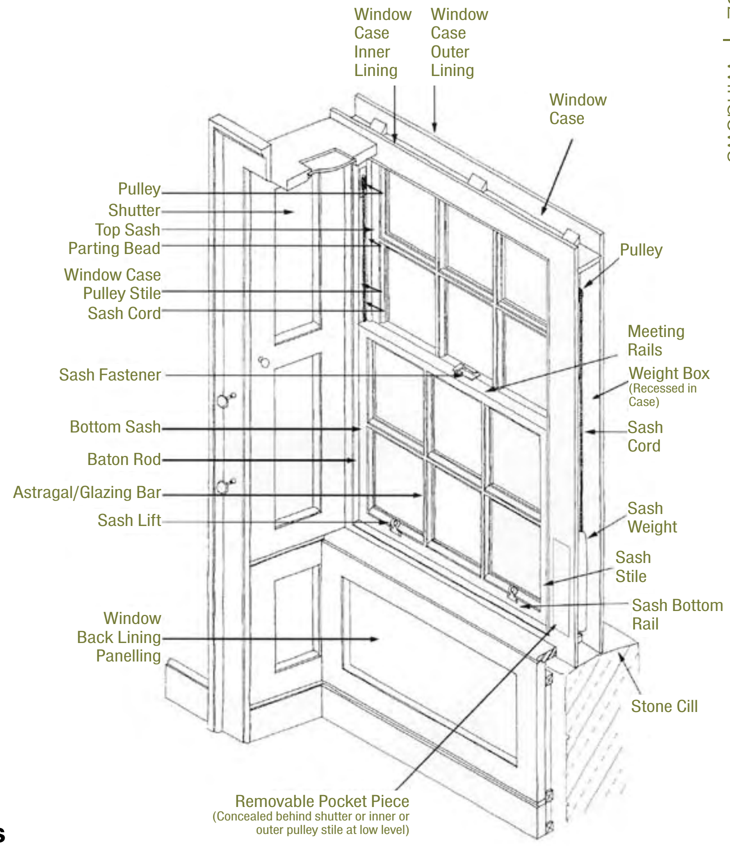
B1.8 FURTHER INFORMATION

The *Further Reading* section at the end of this document suggests useful resources for more in-depth research.

It may also be helpful to make direct contact with local or national organisations. Contact details for a wide range of relevant agencies are provided under *Sources of Further Information* at the end of this document. Useful agencies might include advice centres, local authority Planning and Building Control departments, and building conservation organisations.

B2

Windows



A typical sash and case window.
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B2.1 INTRODUCTION

While windows typically account for only 10% of the heat loss of a building, householders often place great importance on being able to make improvements to them. The appearance of windows is a significant factor in shaping the overall character of the building, and this can to some extent dictate the improvement options available for historic properties[8].

In terms of thermal efficiency, the impact of the improvement measures covered in this guide is as follows:

Timber-framed single-glazed sash and case windows can have a U-value as low as **5.5**[9]

Adding draughtproofing will reduce cold draughts and heat loss through gaps around the window (it will not prevent heat loss through the glass)

Adding secondary glazing can give a U-value of **2.3**[10] by using an efficient system incorporating low-emissivity glazing

Adding wooden internal shutters can give a U-value **2.2**[11]
This is generally a night-time-only solution

Replacing the windows with modern double or triple glazing can give a U-value of anywhere **between 3.1 and 1.3**[12], depending on the system;

This section covers the main window improvement options available.

[8] In Edinburgh, updated guidance has recently been produced which explains this issue in greater detail: *Development Control Handbook: Replacement Windows and Doors* (The City of Edinburgh Council, 2007).

[9] Historic Scotland *in situ* measurement, Lauriston Place, Edinburgh, 2008 (section C5.2).

[10] Ibid.

[11] Ibid.

[12] *The SBSA Technical Guide: U Values, Annexe A* (Scottish Building Standards Agency, 2006).

B2.2 REPLACEMENT

Considerations for historic buildings

Double- or triple-glazed windows are often not permitted due to their appearance, however in some situations they may be acceptable (the City of Edinburgh Council, for example, now allows slim-line double glazing in timber-framed 'one-over-one' sash windows in Category 'C(s)' listed buildings.) There are two main considerations regarding window appearance: the frame and the glazing.

Frame

A double- or triple-glazed window frame generally has wider astragals and transoms (the vertical and horizontal glazing bars which separate individual panes of glass in the main frame) than a single-glazed equivalent. Some manufacturers can fit double-glazed panes[13] into existing timber window frames, to conform to older framing styles. When considering window replacement, the local Planning department may have specific framing requirements.

Glazing

Modern production techniques, and the glass used for modern double or triple glazing, differ significantly from those in older single glazing. Modern glass has a flatter, more reflective quality than older glass. Some window manufacturers are now able to build new windows using older-style glass, but this may not be an option in double-glazed units. Original glass, which is no longer manufactured, can also be saved and used in new frames[14], and may be available from local architectural salvage yards.

If a home is listed, replacing windows will be subject to obtaining listed building consent. Decisions are made on a case-by-case basis, so the local authority conservation officer or Planning department should be consulted well in advance.

[13] There is a limit to the thickness of double glazing panes that can be fitted into original frames. This will affect their thermal efficiency: a wider gap (12-18mm) between the two panes of glass is more thermally efficient than a smaller gap.

[14] Further details can be found in *Conservation Matters – so cherish your crown glass!* (Edinburgh World Heritage, 2002), available from Edinburgh World Heritage.

Window replacement can be avoided in many cases by proactive window maintenance. Even relatively large areas of timber rot can often be replaced. If well maintained, a timber-framed window could be viable for hundreds of years[15]. Effective window maintenance will reduce the likelihood of draughts, however it will not resolve the poor thermal efficiency of single glazing.

However, in some instances – for example, if the entire frame is rotten – replacement may be the best solution. Being in a listed property often restricts the replacement options, as many local authorities do not permit double glazing and may require a like-for-like replacement. If replacement is necessary, integral draughtproofing should be considered as part of the new window.

If like-for-like replacement is not a requirement, double or triple glazing can be considered, using low-emissivity glass to increase the energy savings further. There are higher costs associated with multiple glazing layers and special glass, and these should be factored into the selection process. There is also a long payback period associated with installing double or triple glazing (section B1.6).

B2.3 SECONDARY GLAZING

Considerations for historic buildings

Secondary glazing is often considered to have less of an impact on the appearance of the windows than double or triple glazing, and is generally acceptable from a building conservation viewpoint if the work is not damaging and is not a permanent alteration.

Some systems come in their own sub-frame, and sit some distance from the original window. This can mean some intrusion into the room, loss of usable window ledge space, loss of use of internal shutters, the need to reposition curtains and blinds, and a 'double reflection' visible from outside. These issues may be addressed by systems that sit directly against the main window. More details about such systems are available in the case study (section C4.2).

To minimise the visual impact, the style of a secondary glazing unit should complement the existing window.

Listed building consent may be required for secondary glazing; this is dependent on the listing grade and the local authority.

[15] Detailed maintenance guidance can be found in the *Further Reading section* at the end of this document.

Additional glazing layers do not have to be incorporated into the primary window, as with double or triple glazing. Secondary glazing consists of a second window installed internally next to the original window: this reduces both radiated heat loss (i.e. through the glass itself) and air leakage (through gaps between the window and the frame). Secondary glazing can considerably improve the thermal insulation of single-glazed windows, particularly by using certain types of system and/or glazing.

Some systems are installed against the original window frame (within the staff bead) and sit directly against the original window. These have minimal impact on the original window and avoid the issues mentioned above. These systems can provide the best solution for historic buildings. They are often bespoke, so any irregularities in individual windows can be catered for. They can also be removable, so there is little impact on the original building fabric, and they can be removed at warmer times of year (safe storage space will be required). More details on these systems can be found in the case study (section C4.2).

Example of clearly visible secondary glazing.
© Crown Copyright, image reproduced courtesy of Historic Scotland

Example of the 'double reflection' caused by some secondary glazing.
Photograph © Changeworks

Slimline secondary glazing used in the Energy Heritage pilot study (Part C).
Photograph © Changeworks

Maintenance of both the original and secondary windows should be considered. Most secondary glazing should not require significant maintenance, but the chosen system should enable access to the original window for cleaning or maintenance. Safety should also be considered: should you need to leave the property in an emergency, it is important that potential exit windows can be fully opened.

Secondary glazing can be made to open by tilting, sliding (horizontally or vertically) or opening like a door. The chosen system should mirror the primary windows. Simpler closed systems are also available, and may be less expensive; however, access for ventilation and maintenance may be less easy.

Secondary glazing can also improve sound insulation. Secondary glazing designed for thermal insulation differs from acoustic glazing, though any system will reduce the amount of external noise heard from inside the home.

B2.4 DRAUGHTPROOFING

Considerations for historic buildings

From a building conservation viewpoint, draughtproofing is a popular option. Integral systems are discreet (surface-mounted systems are more visible) and all systems involve little or no removal of original materials. There is a wide range of draughtproofing technology available, the majority of which should not pose any issues for historic buildings.

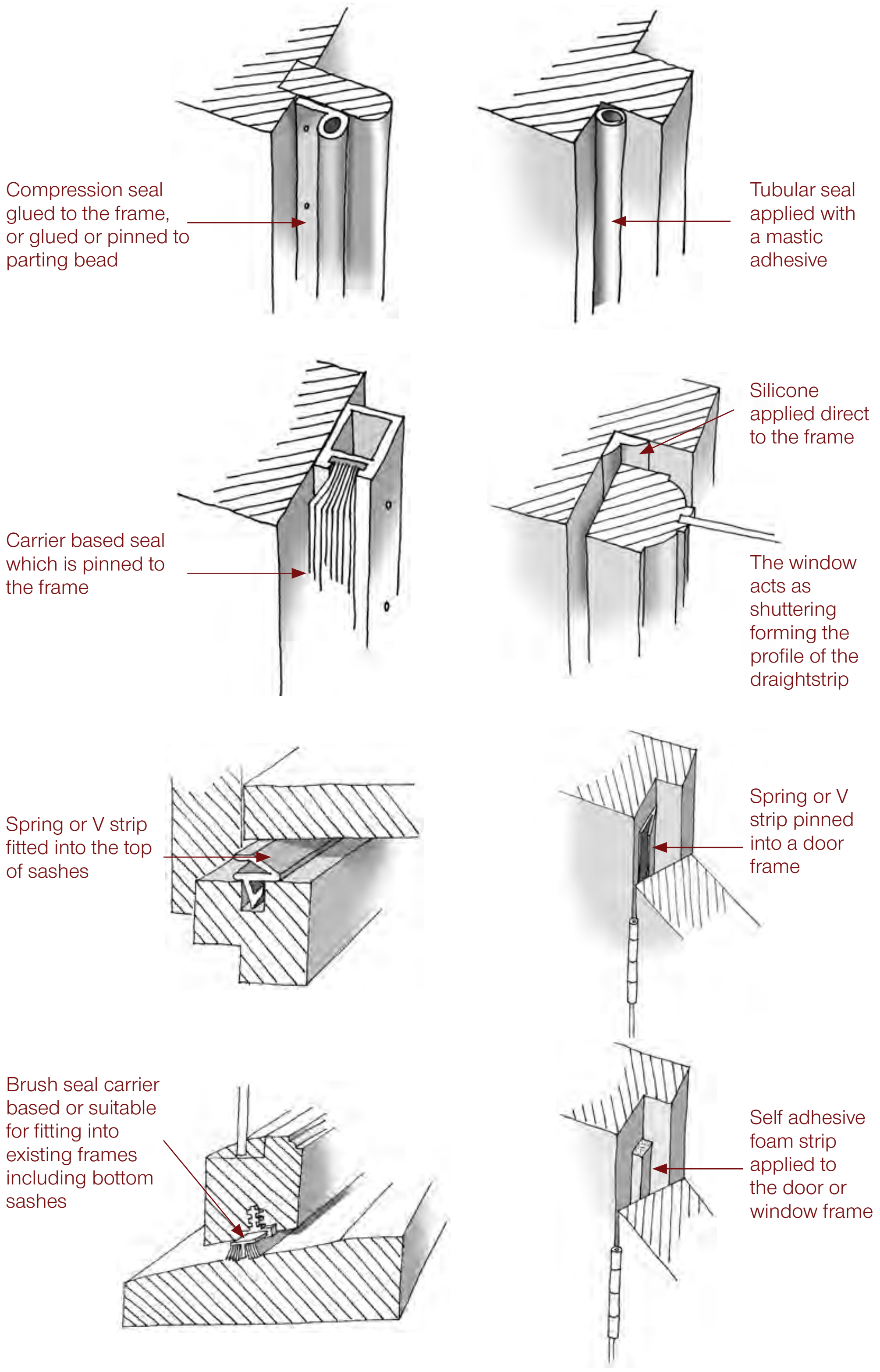
Listed building consent is not required for the installation of draughtproofing.

Heat loss through windows occurs either through the glass itself or through gaps between the window and its frame. Sealing these gaps provides a relatively simple and inexpensive way of improving the energy efficiency of windows, and is well suited to incorporation alongside the other window improvements detailed in this guide.

There is a wide range of draughtproofing, some of which can be installed on a DIY basis and others that require specialist installers. A typical draughtproofing system consists of narrow insulating strips (of various materials including plastic and neoprene in a carrier, carrier-based brush strips or mastic gun-applied sealant) installed between the window and its frame; some are more visible than others. More details on different draughtproofing types can be found in Changeworks' *Tenement Fact Sheet 2* (www.changeworks.org.uk/uploads/TFS_02.pdf).

More complex systems involve fitting draughtproofing in integral channels in the window and frame. This involves removal of the windows, however this is a relatively rapid process and the works may be carried out *in situ.* More details on such a system can be found in the case study (section C4.3). When choosing a draughtproofing system, a variety of factors should be considered including cost, effectiveness, longevity and ongoing maintenance.

Typical draughtproofing systems.
Image © Changeworks



B2.5 INTERNAL SHUTTERS

Considerations for historic buildings

There are generally no issues surrounding the installation or reinstatement of internal shutters in historic homes, as long as original timber panelling or surrounds are not adversely affected. The re-use of original features (or original-style features if new) is positively encouraged by conservation bodies.

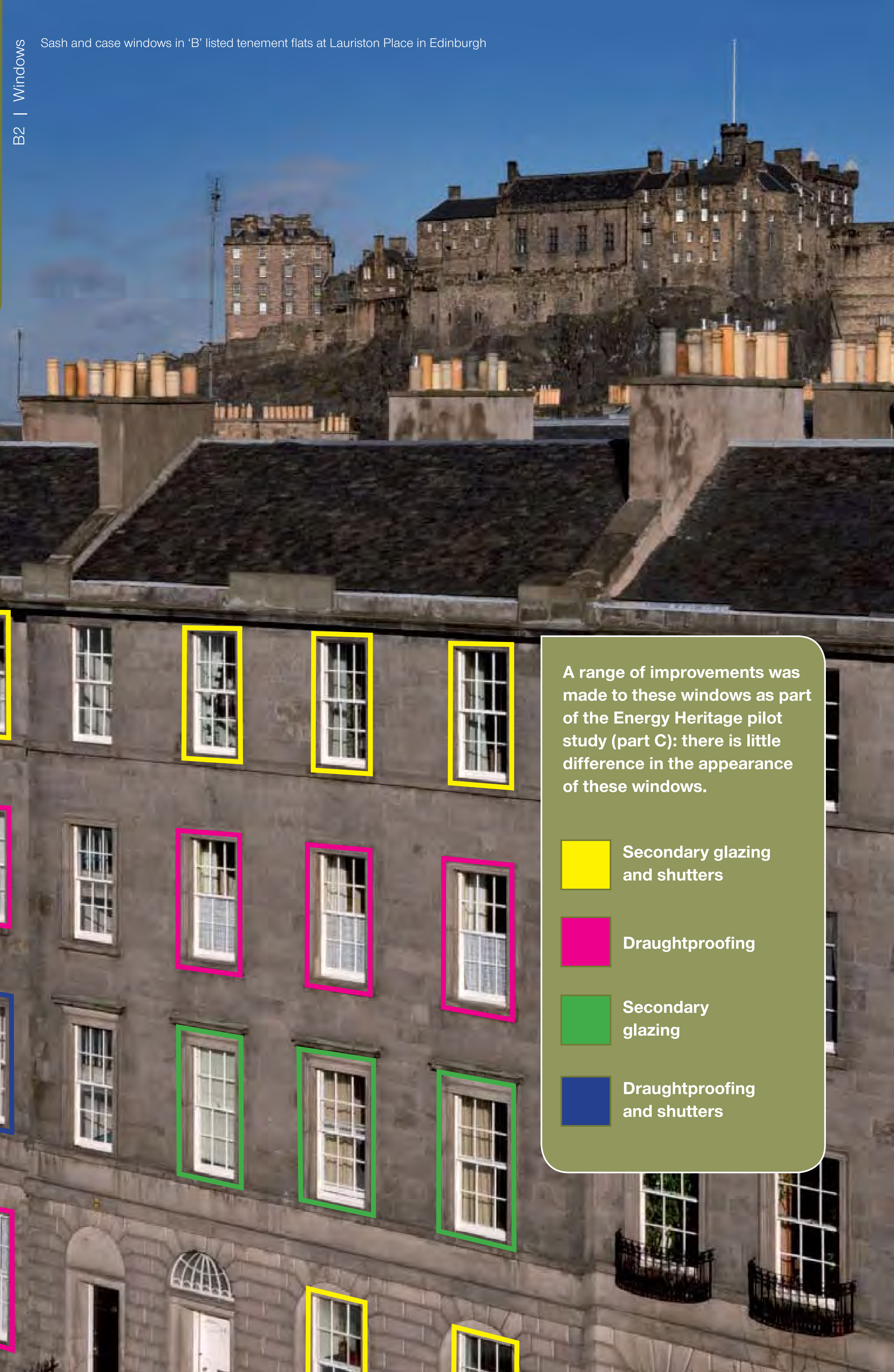
Internal shutters at Lauriston Place in Edinburgh

Many traditionally-built properties were constructed with internal wooden shutters. These were designed to protect privacy, as well as keeping light out on sunny days and retaining heat on cold nights. In some cases these have been removed over the years or sealed up. Reinstating or replacing these shutters not only improves energy efficiency during periods of use, but also helps restore the character of the property.

Installing shutters where they have been partially removed can be relatively straightforward. However, due to the variety of shapes and sizes of older windows, and the variety of shutter options, new shutters have to be made to fit individual windows (old shutters may sometimes be found in architectural salvage yards). Where shutters exist but are sealed up, the state of the shutters, and therefore the work and associated costs, are unknown until they have been re-opened.

Where the home is occupied during the daytime, shutters are not practical as a heat retention measure for daylight hours. At night, however, they can provide very effective thermal insulation.

Sash and case windows in 'B' listed tenement flats at Lauriston Place in Edinburgh



A range of improvements was made to these windows as part of the Energy Heritage pilot study (part C): there is little difference in the appearance of these windows.

B3

General draughtproofing

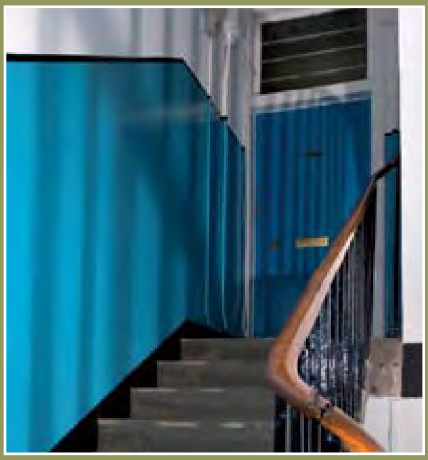
B3.1 INTRODUCTION

Draughts can account for 15% of the heat loss from a home. In general, draughts enter a home through windows, entrance doors and floors. A simple way to reduce cold draughts and heat loss is to seal these gaps.

B3.2 DRAUGHTPROOFING MEASURES

Considerations for historic buildings

Sealing draughty gaps in a traditionally-built home is unlikely to cause problems associated with over-sealing, as the traditional building materials are porous. Some floor sealing materials may affect the appearance of the flooring, and may also make it harder to lift flooring.



Front door of a tenement flat in Edinburgh

Door draughtproofing

Care is needed if sealing redundant flues, to prevent moisture becoming trapped in the space and causing rot. It may be advisable to leave some ventilation; the local authority Building Control department should be consulted in such cases.

At floor level, the simplest way of sealing these gaps is by using a gunned mastic material in gaps between the floorboards or skirting. It is possible to carry out such work on a DIY basis.

Draughts are caused by cold air moving through a home, so if there are gaps around windows and an open chimney flue in the same room, for example, the air will move from one to the other. Cold air will not enter a home as quickly if there is not a corresponding exit. It is possible to seal chimney flues, permanently or temporarily. If it can be confirmed (through the local authority Building Control department) that ventilation is not a requirement, an inflatable chimney balloon can be used to seal the flue. These will fit any chimney size, and if their presence is forgotten and a fire is lit, they will simply melt away.

For draughtproofing doors, the same principles apply as for windows. Heavy-duty materials are particularly advisable for doors, due to wear and tear from frequent opening and closing of the doors. Details of materials and installation are the same as for windows in section B2.4.

Heavy curtains at windows and doors can help with thermal insulation, although they are predominantly a night-time option.

B4

Floors

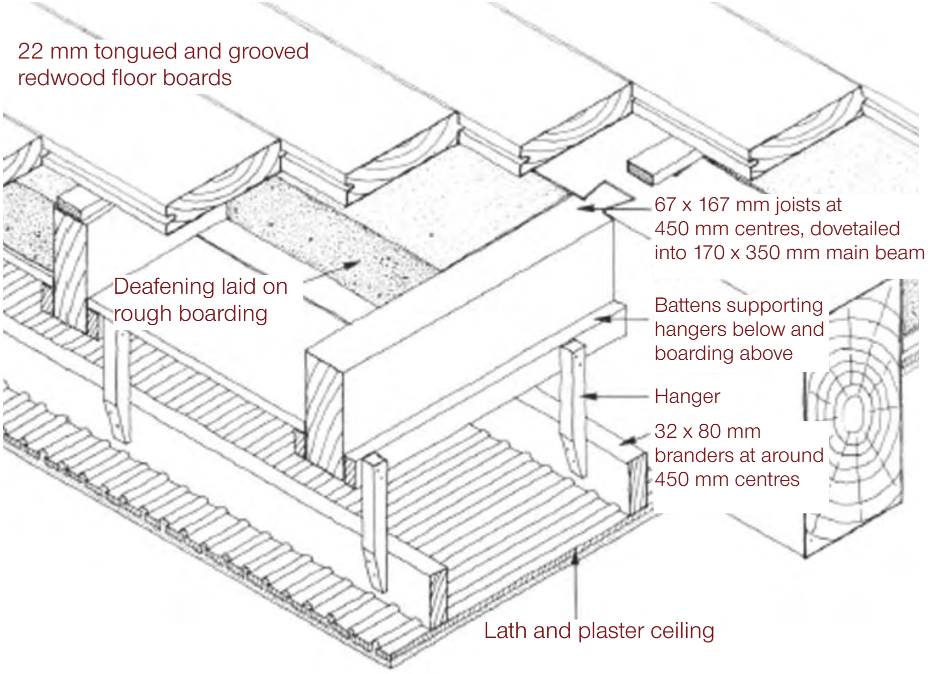
B4.1 INTRODUCTION

Ground level floors account for around 15% of heat loss from a typical house. Whether there are solid floors built directly on the ground's surface, or 'suspended timber' floors (floorboards laid across timber joists, with a 'solum' space below), it is possible to install insulation to reduce this heat loss.

Floor finishes such as laminate and carpet have to be lifted and re-laid in order for insulation to be installed. Depending on the thickness and location of the insulation, adjustments may be required to skirtings, doors and sockets.

Floor insulation can be installed in two ways, from below or from above. There is a range of materials available, which are generally either packed into spaces between floor joists and supported by mesh netting, laid on top of the existing floor and covered with a hard surface, or integrated into a replacement or 'floating' floor. The choice of insulation type and installation method will depend on the original floor type.

B4.2 SUSPENDED TIMBER FLOORS



Typical timber floor construction.
Image from *The care & conservation of Georgian houses*, 4th edition, by Davey, Heath, Hodges, Ketchin & Milne, reproduced courtesy of Edinburgh World Heritage

Considerations for historic buildings

If insulation is being installed from above, floorboards must be lifted to access the installation space. Care should be taken not to damage the floorboards, although this may be impossible to avoid. Older, wide hardwood floorboards, or boards fitted with tongue-and-groove edges, require extra care and may need a specialist joiner both for removal and reinstatement.

If original or older floorboards need to be replaced, it may be hard to source new boards as an exact match, as current metric measurements can be incompatible with the older imperial measurements. Some specialist timber merchants will make boards to size, at a cost; otherwise, second-hand matching boarding may be available through local architectural salvage yards.

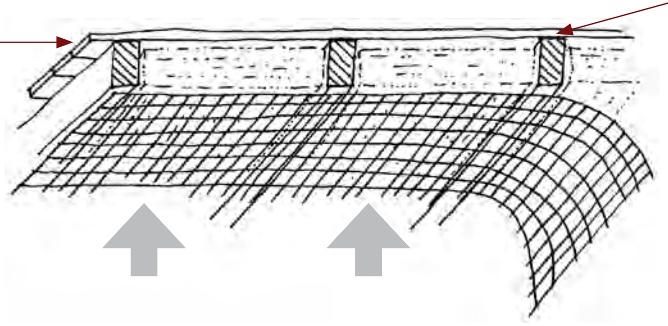
Suspended timber floors in older buildings will commonly have a layer of 'deafening' material below the floorboards, laid between the joists. This can be an effective fire retardant and so should not be removed. However, it may make space more limited, so thinner solid insulation panels or insulating foam may be more appropriate than insulating quilt.

It is unlikely that there would be a ceiling below a ground floor. Where there is one, installing insulation from below would entail temporary removal of the ceiling. In such cases the necessary permissions may not be granted; the local authority Planning department should be consulted before carrying out the works.

B4.2.1 **Installation from below**

It is easier to install soft insulation from below suspended timber floors, where the joists are exposed on their underside. The installation process is simpler if there is nothing covering the underside of joists, for example in a cellar.

From below, the installation is relatively straightforward, so long as there is sufficient space to access this area (a 900mm crawl space is the recommended minimum). Insulation is fitted between the joists and held in place with netting. Once installed there should be no need for any future maintenance.

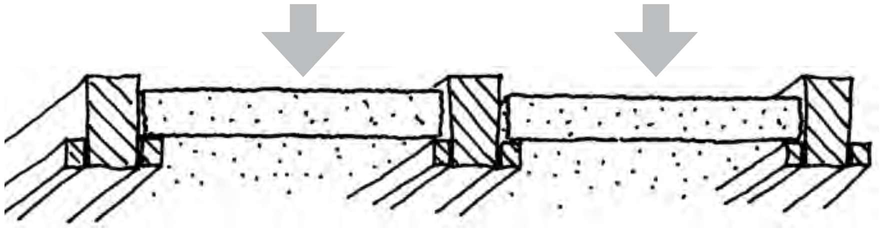


Insulating a suspended timber floor from below.
Image © Changeworks

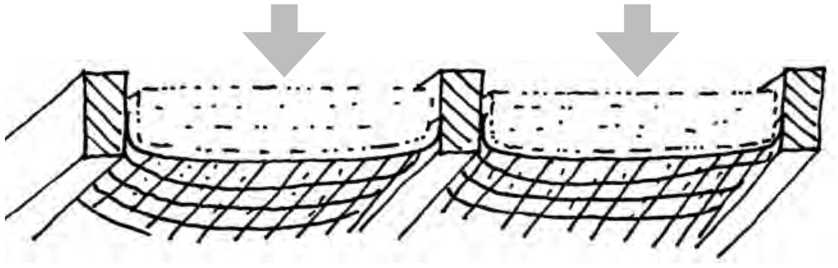
B4.2.2 Installation from above

In some cases it is not possible to install floor insulation from below. To access the joists from above, floorboards must be removed; this may cause some damage to the boards. It may sometimes be possible to insulate a floor in stages.

Once the floorboards have been removed the installation process is the same as above (section B4.2.1), however the mesh netting is fixed in place between the joists before the insulation is laid. The floorboards are re-laid afterwards.



Batons nailed to the sides of the joists to support rigid panels of insulation.



Quilt insulation rolled out between joists supported on plastic netting stapled between the joists.

Insulating a suspended timber floor from above.
Images © Changeworks

B4.3 SOLID FLOORS

Considerations for historic buildings

Original flagstone floor.
© Crown Copyright, image reproduced courtesy of Historic Scotland

The commonest method of insulating solid floors is to install a floating floor with integral insulation. This can be an issue where the original floor is of particular historic interest (flagstones or decorative tiling, for example), and covering such a floor is unlikely to be supported by conservation bodies. In such cases it is advisable to check with the local authority Planning department to confirm whether covering a historic floor is acceptable. Where the original floor has been replaced (with concrete, for example), insulation is a more acceptable energy-saving measure from a building conservation perspective.

Installing insulation to solid floors raises the entire floor level. Some conventional insulants require a considerable depth of material and impact on some fixtures and fittings: skirting and sockets have to be removed and re-fitted at an appropriate height above the new floor level, and doors have to be trimmed. In some house types with low doorways, the raised floor will reduce their height further and could contravene health and safety regulations; the local Building Control department should be consulted to confirm individual requirements.

Some modern insulation can achieve the same levels of thermal efficiency at a much-reduced depth of material, so the need to re-site fittings or fixtures and trim doors will be minimal. Further information on these materials can be found in the case study (section C4.6).

In listed buildings, original fittings such as skirting boards and other timber detailing should be retained rather than replaced, wherever possible. The local authority Planning department or conservation officer should be consulted prior to the works.

If a property has solid ground floors, the easiest way to insulate them is by laying insulation on top of the floor.

Solid floor insulation comprises a layer of insulating material, topped with a layer of particle board that protects the insulation and supports the weight of both furniture and people. A flooring finish may be laid on top of this particle board. If there is an existing floor covering (e.g. wood, laminate, carpet etc.) this can be lifted and then re-laid.

If the solid floor is very uneven it may need to be levelled; the installer may be able to provide this service. Any rising or penetrating damp should also be treated prior to installing insulation.

There may be health and safety implications if partial insulation is installed. Differing floor levels could cause a trip hazard, and a graded 'ramp' may be necessary. Floor levels should not change at doorways in particular, as this exacerbates the trip hazard. The local authority's Building Control department should be consulted before proceeding, to identify and resolve any such issues. Partial insulation could also increase the risk of cold bridging, as the uninsulated floor surfaces could attract condensation.

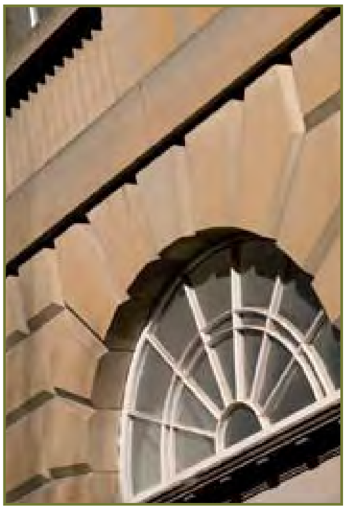
B4.3.1 **Materials**

Commonly, solid floor insulation comprises a layer of compressed polyurethane material. The thickness of the insulating material can vary, depending on the level of insulation desired and on the material used. However, to achieve a reasonable level of insulation using standard materials, the insulating material and hardboard finish may well have a combined depth of at least 75mm. This means the resulting floor level will be far higher than previously.

Using modern slim-line insulation can minimise the need for such adjustments, while retaining the same standards of thermal efficiency. Door trimming will still be necessary but skirting boards and sockets can stay in place. Doors should not need to be replaced and the effects on low doorways and grading between rooms will be minimised. Further details on such insulation can be found in the case study (section C4.6).

B5
Walls

B5.1 INTRODUCTION



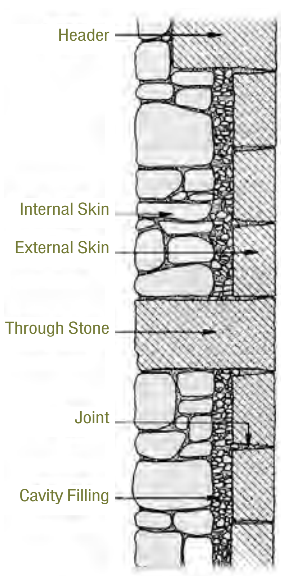
Georgian tenement façade

Up to 35% of heat loss occurs through a building's external walls. Walls vary greatly in construction and materials, and this in turn affects how or if they can be insulated.

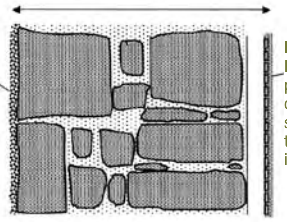
Many walls are local to their area, which increases their historic importance. This, combined with their fabric type, often makes it difficult to insulate them without compromising their appearance or performance.

The walls of older homes may include solid stone or brick, dressed stone facings with a rubble fill, and timber laths and plaster. More modern homes (from c.1920s onwards) are commonly built as cavity brick. This cavity was originally designed to keep the inner wall dry and included an integral 'damp proof course'.

Solid walls are more difficult to insulate than cavity walls. There are two main methods, external overcladding and internal dry lining. External overcladding is not usually a viable option for a historic home. It would dramatically affect appearance, and almost certainly be unacceptable to the local authority Planning department. Even replicating the material and style of the building would require realigning the roof line and rainwater goods, window reveals and sills, and doorways.

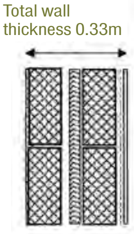


Masonry rubble wall built in lime mortar
Typical total wall thickness 0.75m - 1.00m



Typical traditional Scottish masonry wall with external render and internal dry lining. © Crown Copyright, image reproduced courtesy of Historic Scotland

Cross section of a typical tenement wall with dressed stone facing and rubble internal skin. Image from *The care & conservation of Georgian houses*, 4th edition, by Davey, Heath, Hodges, Ketchin & Milne, reproduced courtesy of Edinburgh World Heritage



Wall construction
(outside to inside)
20mm dense cement render
100mm concrete block
50mm unventilated cavity
50mm insulation
100mm concrete block
Plasterboard dry lining with impervious vapour check on timber straps or plater dabs

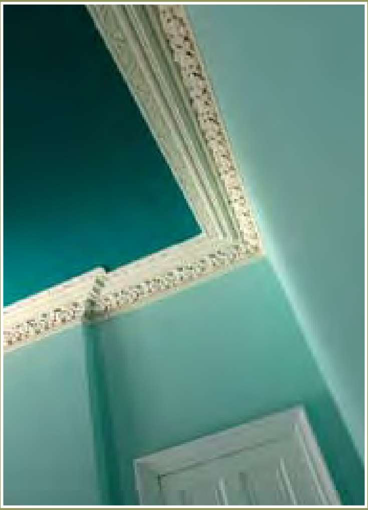
Typical modern masonry wall construction.
© Crown Copyright, image reproduced courtesy of Historic Scotland

B5.2 SOLID WALL INSULATION (INTERNAL)

Considerations for historic buildings

From a building conservation viewpoint, internal wall insulation is generally only a viable option where the original wall lining is not present or needs to be replaced.

If a non-breathing material is added to an older porous wall, its ability to breathe and regulate moisture and air levels is compromised. This could cause damp and structural damage where moisture is trapped inside the wall itself. As such, the insulating material and installation method are critical for improving the thermal efficiency of walls. Insulating materials should be breathable and compatible with the other wall materials. Installation should also be thorough, to avoid any cold bridging at junctions (e.g. between the walls and floor or ceiling).



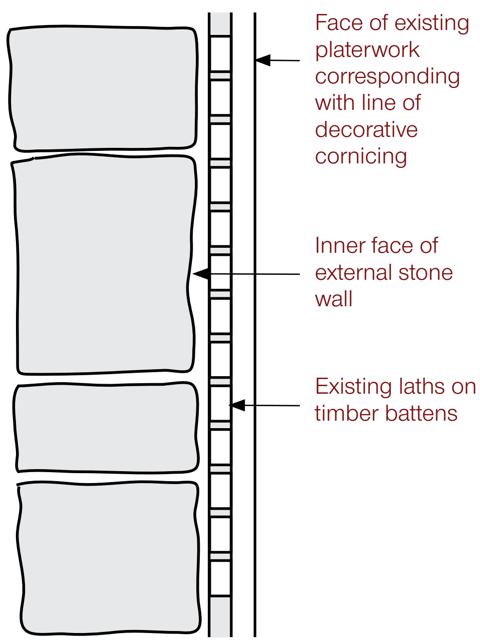
Ceiling cornice in a Georgian tenement

Internal finishes such as ceiling plasterwork are important features of historic homes, and it may not always be possible to remove and re-site these. Adding insulation to the existing wall can compromise these features unless a very thin material is used. Replacing existing wall linings with insulating materials should have less of an impact, as the original dimensions of the room may be retained, although this is often only appropriate where the original wall lining is not present or needs to be replaced.

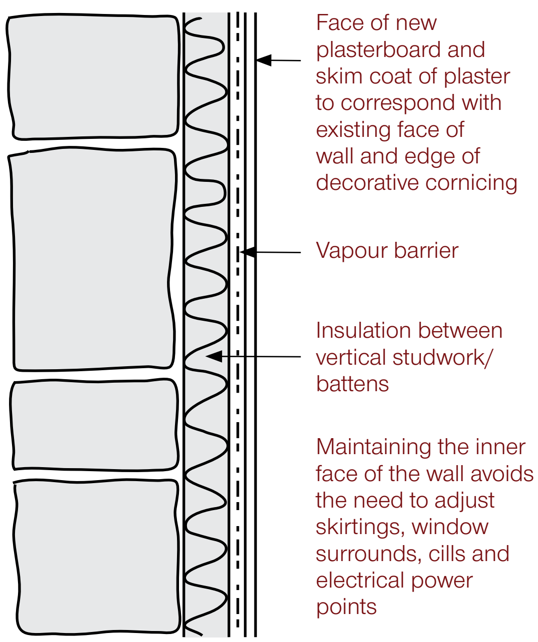
Internal wall insulation requires careful research, and the local conservation officer should be consulted for advice. In all cases the installation of wall insulation will be subject to satisfying the local Planning or Building Control department. Listed building consent or a Building warrant may be required, depending on the nature of the insulation (planning permission is not required for internal works).

Internal dry lining involves a significant amount of building work, as an extra layer is added to the wall (unless it is fitted during renovation works, in place of the existing plaster finish). Fittings such as window sills and surrounds, skirtings, decorative plasterwork, switches and sockets will all need to be repositioned. There is a range of insulating materials available, all of which vary in depth, which will affect the extent of this repositioning.

The best time to consider internal dry lining is if a home is being renovated. Dry lining can replace existing plasterwork and battens, which can be up to 60mm thick. By replacing this with thermal-backed plasterboard, the thermal insulation of a wall can be considerably improved. In addition, careful sizing of replacement battens and plasterwork can retain the inner wall surface in line with retained decorative plasterwork and timber facings, thus minimising the impact on the original features. The materials should be chosen carefully to ensure they will not affect the breathability of the walls adversely.



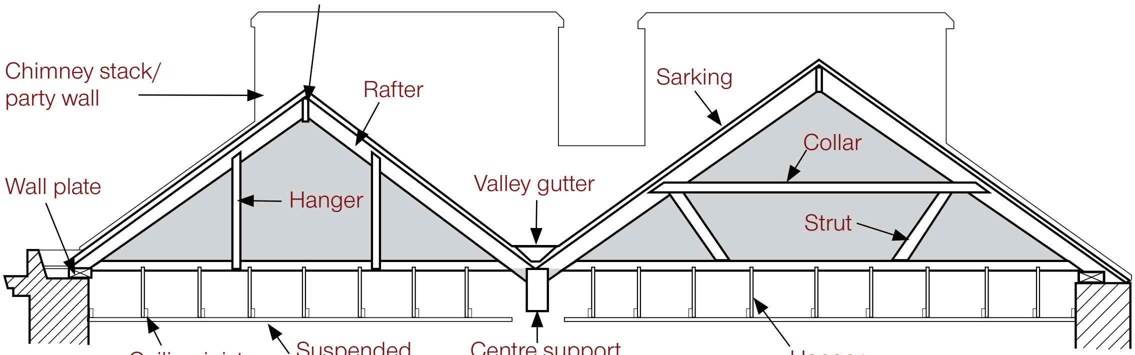
Original wall construction.
Image © Changeworks



New plasterboard and insulation.
Image © Changeworks

B6

Roofs



Typical Georgian M-shaped double-pitched roof construction.
Image from *The care & conservation of Georgian houses*, 4th edition, by Davey, Heath, Hodges, Ketchin & Milne, reproduced courtesy of Edinburgh World Heritage

B6.1 INTRODUCTION

A roof with no insulation loses around 25% of a home's heat. Insulating a roof is very simple and relatively cheap, and the considerable energy savings give a short payback period.

Until relatively recently there was no legal requirement for properties to be built with roof insulation, and many older properties have none. Partial insulation can be added to; the current best-practice standard is for a minimum depth of 250mm insulation.

Snow melt caused by heat loss through an uninsulated roof. Photograph © Changeworks

In a traditional pitched (sloping) roof, insulation is installed directly above the top floor ceiling between the ceiling joists, and is generally referred to as loft insulation. In an unfloored loft, it is easy to check whether a pitched roof is insulated simply by looking through the loft hatch (where there is one): if it is insulated there will be insulating material laid between the ceiling joists. Insulation can also be installed on the underside of the roof itself, however this should only be installed if the roof space is used as a habitable room. Flat roofs require very different treatment.

Regardless of the location, insulation should be installed throughout rather than partially, to avoid potential fabric and structural damage (timber rot due to condensation on the roof timbers) or cold bridging and condensation within the home (i.e. the habitable rooms below the loft).

B6.2 LOFT INSULATION

Considerations for historic buildings

Insulating roof spaces in historic buildings will have no adverse effects on the roof itself, as long as the installation is carried out with due care and attention. The main conservation considerations surrounding insulation of roof spaces relate to ventilation and moisture control (section B6.2.4).

The installation of roof insulation does not require any formal permissions, regardless of the listed status of a home. However, if roof vents are required to increase ventilation in the loft area, these may require planning permission or listed building consent. It is possible to obtain purpose-built roof vents which are designed to be unobtrusive.

B6.2.1 Materials

There is a wide range of loft insulation materials available and the choice will generally depend on a combination of personal choice and the nature of the roof space. Soft insulating quilt is the most common form of loft insulation. It can be made from a variety of materials, ranging from mineral fibre to natural materials such as sheep's wool.

Insulating quilt comes in rolls, which are split into different widths to avoid wastage (typical joist spacing in older properties is 400 - 450mm). Blown or loose fill insulation is also used occasionally. This comprises pellets of mineral fibre or cellulose fibre, which are effectively 'blown' into the spaces between the joists. This can be useful in awkward roof spaces where access may be problematic. Air movement in the roof space can lead to the material piling up in parts of the loft, and restricting ventilation. A 'stop end' is required as a barrier between the insulation and the eaves, to retain the passage of air into the loft. Blown insulation should always be installed by a professional.

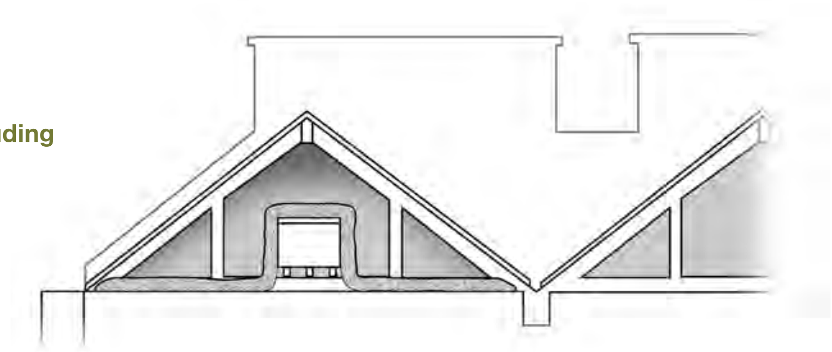
B6.2.2 **Installation of quilt insulation**

Quilt insulation being installed in a loft. Photograph © Changeworks

It is possible to install standard loft insulation quilt on a DIY basis. Any leaks in the roof itself should be repaired prior to installing insulation. If there is already some insulation present, it can be left in place unless it is damp, in which case it should be removed.

Loft quilt is rolled out between the ceiling joists. To achieve the necessary depth of insulation two layers may be needed: the second layer should also run between the joists as long as the joists are high enough, which they often will be in traditional buildings.

Installing loft insulation will make the roof space colder, so it is important to insulate the top and sides of the cold water tank (and any pipework) but leave the floor space below the tank uninsulated. This will allow heat in the home to warm the underside of the tank, and minimise the risk of frost damage. Ventilation gaps should also be left open (section B6.2.4) to dispel any moisture.



Loft insulation including cold water tank.
Image © Changeworks

The loft hatch should be draughtproofed, and insulated to the same depth as the rest of the loft. It is also recommended that the loft hatch is secured from below using a latch.

B6.2.3 **Safety considerations**

Care should be taken when moving about, as there is no flooring in most lofts and the ceiling below will not support a person's weight. A 'crawl board' should be used, consisting of a wooden board placed across the joists and moved as necessary.

Electric cables and lights should be lifted and the insulation laid underneath them; if they are covered they could overheat and pose a fire risk. Any electric apparatus should have a 75mm gap left between it and the insulating material. The same applies to any flues or metal chimneys.

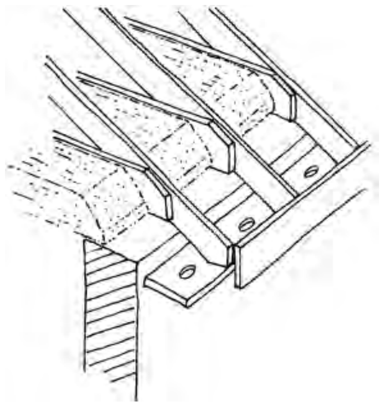
B6.2.4 **Ventilation**

Considerations for historic buildings

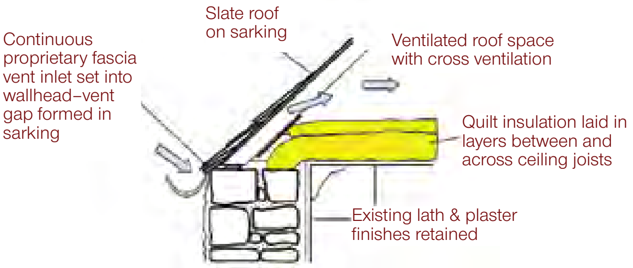
Ventilation is an important consideration for all roofs, regardless of their historic value. Consideration of the issues below should ensure a roof is not adversely affected by the addition of loft insulation, however guidance should be sought from the local authority on whether installing roof vents is acceptable.

With relation to roof vents, there can sometimes be conflict between Planning and Building Control requirements; it is therefore important to work with both departments to find acceptable solutions. The recently-updated Building Standards now allow more scope for innovative roof ventilation solutions.

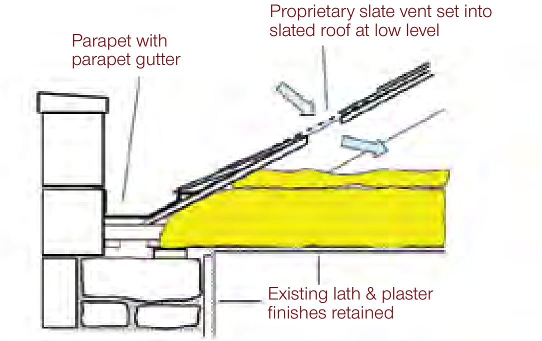
Warm air rising into the roof space carries high moisture levels. This moisture will condense on the underside of the roof and the timbers, and could cause rot. Insulating the loft will reduce this flow of warm air, but moisture will still enter and so it is important that the roof space is well ventilated, to allow any moisture to disperse.



Maintaining ventilation from eaves (where these are present).
Image © Changeworks



Traditional wallhead detail with ceiling level insulation.
© Crown Copyright, image reproduced courtesy of Historic Scotland



Parapet wallhead detail with ceiling insulation.
© Crown Copyright, image reproduced courtesy of Historic Scotland

The sizing of ventilation gaps to be left between the insulation and the eaves, and the means to maintain these gaps, will both depend on individual roof types.

B6.3 FLAT ROOF INSULATION

Considerations for historic buildings

Ventilation is an important consideration for all roofs, regardless of their historic value. Consideration of the issues below should ensure a roof's appearance is not adversely affected by the addition of flat roof insulation.

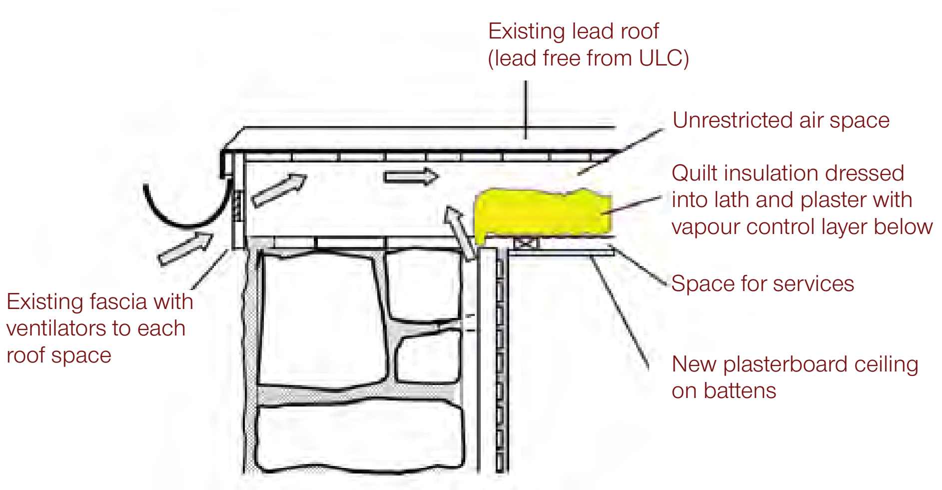
The insulation of flat roofs is a more complex process than installing loft insulation and requires considerable work to the roof[16]. This should be carried out by a professional installer.

Flat roofs vary widely in their design, though they can be broadly divided into 'ventilated cold decks', 'warm decks' and 'ventilated warm decks'.

B6.3.1 Ventilated Cold Decks

This roof construction is notoriously problematic and it is not always possible to improve their insulation. The only real solution is to install insulation with a continuous, well-sealed vapour control layer above the ceiling, ensuring there is plenty of cross-ventilation and leaving the eaves open to allow air flow.

Without insulation, these roofs often last well as a balanced environment is created inside the roof space, and any damp from the winter is dried out in the summer. Adding insulation and ventilation can affect these controlled conditions, so care should be taken to ensure both sealing and ventilation are sufficient.



Ventilated cold deck: used where lead roof is retained and removal of existing ceiling is appropriate.
© Crown Copyright, image reproduced courtesy of Historic Scotland

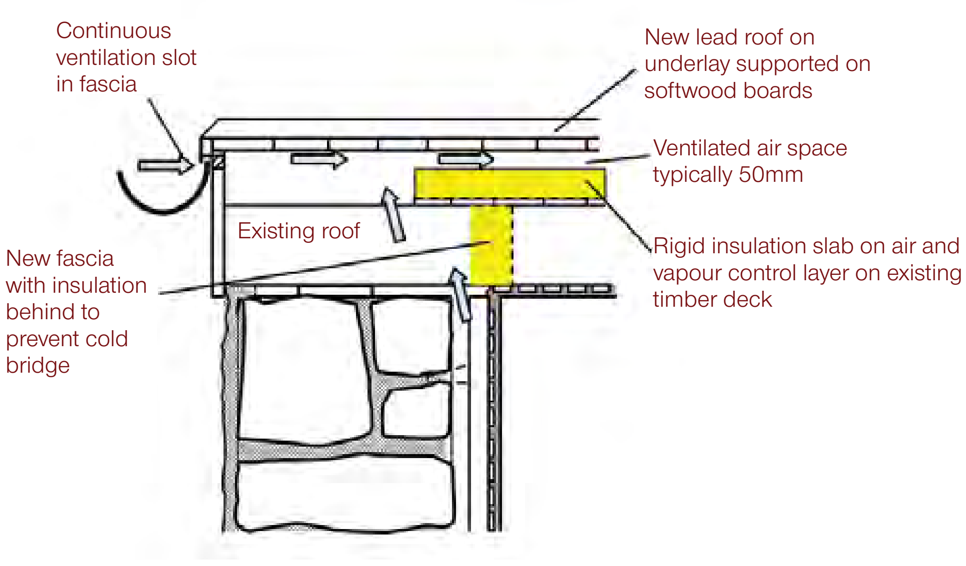
[16] The Lead Sheet Association has detailed guidance on flat roofs.

B6.3.2 **Warm Deck (Unventilated)**

Insulating a typical warm deck roof involves considerable building work. This is best suited to felt and asphalt roofs; in metal roofs there can be a tendency for moisture to build up, which can corrode the metal.

B6.3.3 **Ventilated Warm Deck**

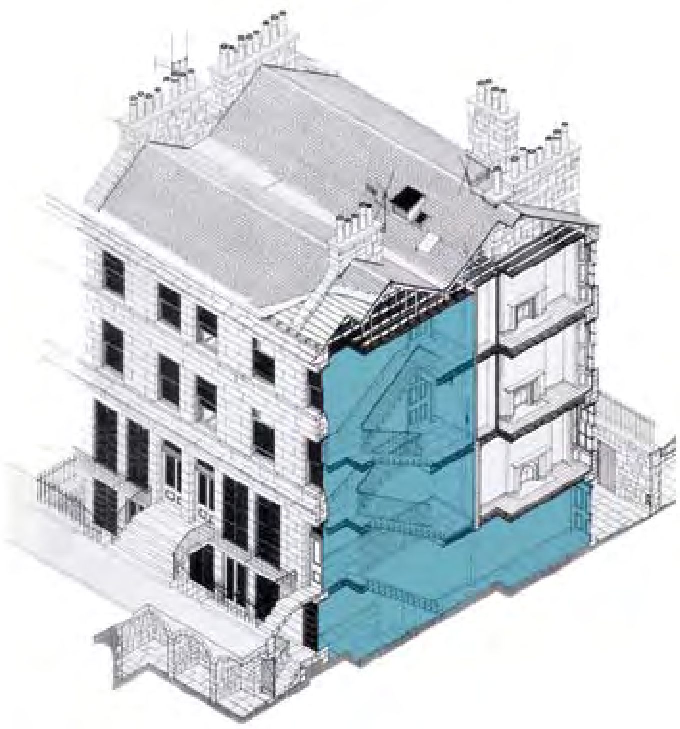
Metal flat roofs are best suited to conversion to a 'ventilated warm deck'. This involves creating a new insulated and ventilated roof structure. This can be very effective, but it involves a lot of work and care must be taken to control the ventilation and moisture levels. This intervention also requires the raising of the roof level by c.250mm, which can make it not viable in certain situations where there may be other parts of the building directly above the roof.



Ventilated warm deck with lead covering.

B7

Communal areas



The communal area of a typical Georgian tenement in Edinburgh. Image from *The care & conservation of Georgian houses*, 4th edition, by Davey, Heath, Hodges, Ketchin & Milne, reproduced courtesy of Edinburgh World Heritage

B7.1 INTRODUCTION

This section covers the variety of options available to those living in historic buildings with communal areas: this applies mainly to tenements, which are a common house type in Scotland.

Improving thermal efficiency of communal areas can be very problematic. The main reason for this is that the owners of all flats in a block generally have to give their consent to the works. Formal stair partnerships or factoring services can make the agreement process easier.

The main communal area in a tenement is the common stair (a 'stairwell' or 'close'). Usually unheated, the lower temperature in the common stair can draw heat out of the individual flats (particularly where there is only a thin dividing wall between the flats and the communal area). Various options are available to increase energy efficiency in the common stair: these are based around insulation, lighting or use of recycled heat.

Thermal improvement measures for communal areas are mainly internal, so any visual disturbance will generally be limited to the internal aspect of the building. The exception to this is skylights, which can be visible externally.

B7.2 INSULATION

B7.2.1 Draughtproofing doors and windows

Draughtproofing around the entrance door of individual flats will reduce the amount of heat that escapes into the common stair. Similarly, draughtproofing can be installed at the main entrance doors and windows of the common stair, which in turn limits the amount of heat that escapes from the common stair.

If the cost of draughtproofing to the main entrance doors to the common stair is to be split, agreement will generally be needed from all owners. The methods for draughtproofing doors are the same as those described in section B3.2.

B7.2.2 **Draught lobby**

Considerations for historic buildings

Draught lobby in an Edinburgh tenement

The introduction of a draught lobby into a listed building can be problematic where the proposed second door is deemed to impact adversely on the proportions or architectural detailing of the hallway. The local authority Planning department should be consulted to confirm whether the works are acceptable and whether planning permission is required. A building warrant will be required.

Modern blocks of flats are often designed with a 'draught lobby': this is essentially a second entrance door, inside the building and close to the main entrance door. The two doors create a draught lobby, which can be very effective at retaining heat in the common stair.

Draught lobbies can be created so long as there is sufficient space between the main entrance door and the stairs. Agreement will be needed from all flat owners.

B7.2.3 **Skylight and loft insulation**

Considerations for historic buildings

Skylight in an Edinburgh tenement

The same conservation restrictions that affect windows in homes may apply to skylights, depending on your local authority. These restrictions are in place to preserve the external visual identity of a building, and if the skylight is visible from outside, permission may not be granted.

The local authority Planning and Building Control departments should be consulted to confirm whether the works are acceptable and whether any permissions are required.

There is often a skylight at roof level in the common stair. In older buildings this will be single glazed, giving it the same poor energy efficiency as the standard single glazed windows elsewhere in the building. It may be possible to install secondary glazing in the skylight, or to replace the single glazing with double or triple glazing.

There may be considerable costs associated with improving the insulation of the skylight, as it will be difficult to access and is a non-standard window.

The process for installing loft insulation in communal area is the same as that in individual homes (section B6).

For both types of insulation, agreement may be needed from all flat owners.

B7.3 LIGHTING

Installing low energy lighting to communal areas will not reduce individual household fuel bills, however it will have a positive impact on reducing greenhouse gas emissions. Local authorities or private factoring companies are generally responsible for maintaining stair lighting, and so this should be discussed with them, although they often have standard specifications which may limit flexibility. Due to their longer lifespan, low energy lightbulbs should not need to be replaced as frequently as standard bulbs, which will save on future maintenance costs.

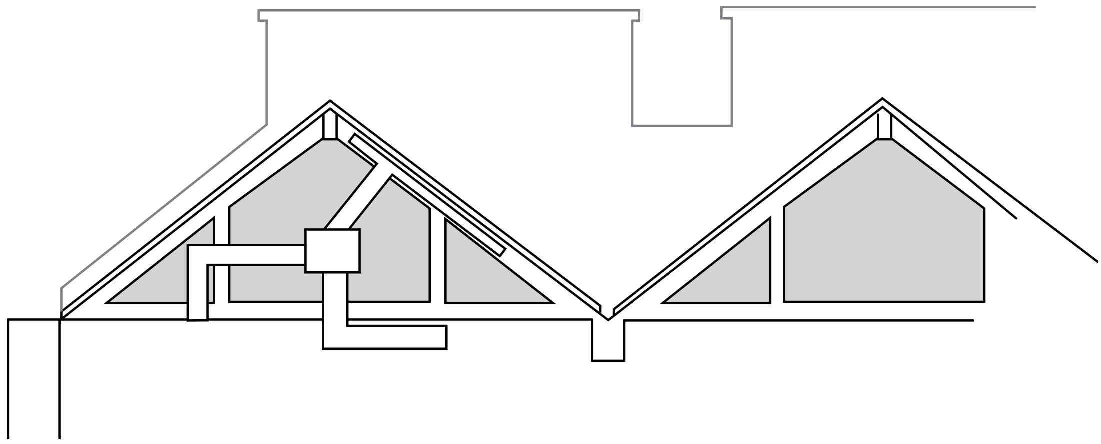
B7.4 HEAT RECYCLING

Considerations for historic buildings

As noted below, installation of heat recovery systems in tenements may often be best suited to situations where the building is being renovated.

In all cases, installation of a heat recovery system will require a building warrant. The local authority Planning department should be consulted to confirm whether the works are acceptable and whether any other permissions are required.

Heat that would otherwise be wasted can be recycled through heat recovery systems. A typical system extracts heat from a roof space (sometimes from below the roof slates), and a mechanical pump draws this heat down through pipework and releases it into the desired space. This enables the communal area to benefit from ‘free’ heat.



Heat recovery system. Image © Changeworks

The amount and size of the ducting required to bring the warm air down to ground level may make the installation of a heat recovery system impractical in some tenement buildings, unless the building is being substantially remodelled as part of a renovation project.

B8

Heating and energy use

B8.1 INTRODUCTION

Nearly three-quarters of the energy used by a domestic property is for space and water heating[17]. In order for a home to be energy efficient, insulation should be combined with an efficient heating system. Well-insulated properties reduce the demand for heat, and so a smaller system with lower installation and running costs can be used.

Older heating methods are far less efficient than modern systems. For example, over 70% of the heat generated by an open fire is wasted as it goes straight up the chimney. Central heating with a modern oil or gas-fired condensing boiler, by contrast, can run at well over 90% efficiency. However, even with the more efficient forms of heating, if the system is old or partial it may be worth replacing.

When upgrading or replacing a heating system, compatibility with renewable energy technologies could be considered if this might be a future option. Further details on renewable energy options are available from Changeworks' Tenement Fact Sheet 6 (www.changeworks.org.uk/uploads/TFS_06.pdf).

This section provides a brief overview of energy-efficient heating systems. Detailed guidance is available from Changeworks' Tenement Fact Sheet 4 (www.changeworks.org.uk/uploads/TFS_04.pdf).

B8.2 HEATING SYSTEMS

B8.2.1 Central heating

Considerations for historic buildings

Installation of modern heating systems should involve very minimal loss of original features and materials, although service holes may need to be bored through ceilings, for example. The main consideration is likely to be the change in appearance caused by the introduction of radiators, for example.

The same building conservation considerations apply for under-floor heating as for solid floor insulation (section B4).

A full central heating system is one of the most effective ways of heating both home and water.

[17] UK Climate Change Programme 2006 (Defra, 2006).

A 'dry' system comprises storage heaters throughout a home. Storage heaters retain heat in internal thermal blocks, and release this heat over time at a variable rate.

There are a number of drawbacks to such systems, however:

- Dry systems are generally more expensive to run than gas central heating;
- It can be hard to control room temperatures;
- A separate water heating system is required;
- Dry systems run on electricity, the generation of which (unless from renewable energy sources) has a greater environmental impact than the fuels used for gas systems.

Reflective panel behind radiator

A 'wet' system differs from a dry system in a number of ways:

- Hot water is circulated around a home via radiators, which radiate the heat from the water into the rooms, or through under-floor coils;
- A boiler is required to heat the water; the boiler can run on gas, oil, solid fuel or electricity;
- The boiler used to heat the radiators can heat your running hot water simultaneously, thus eliminating the need for a separate water heating system.

Reflective panels can be fitted behind radiators, and radiator shelves can be fitted above them to reflect the heat back into the room. These will maximise their effectiveness, however they could affect the appearance and character of a historic property.

B8.2.2 Other space and water heating systems

Portable heaters (electric or paraffin) and electric oil-filled radiators are alternative options to central heating systems, however they are less efficient and more costly to run. Paraffin and LPG heaters in particular emit a great deal of moisture, increasing the risk of condensation and its associated problems.

Wood-burning stoves can have the benefit of an environmentally sustainable fuel source, but are generally best suited to homes with storage areas for the fuel supply. It is important to make sure they are permitted by the local authority, particularly in urban areas.

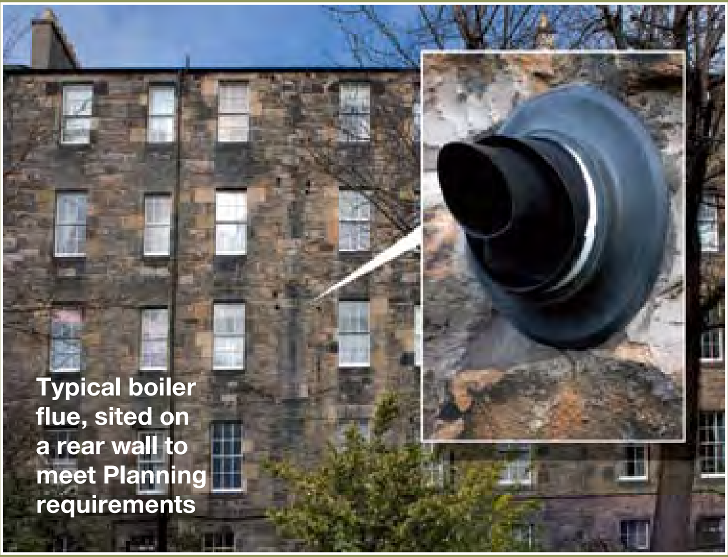
Immersion heaters are a costly and fuel-intensive way of heating water, compared with a boiler-heated system. Immersers should always be fitted with a timer, if they are not already programmed through an economy tariff such as Comfort Plus Control. Immersion systems should also have a thermostat to set the hot water temperature (which should be set at 60 degrees Celsius).

An instant electric shower heats water as it runs past the heating element. This is fuel-intensive, but as these run for relatively short periods of time they have less environmental impact than running a bath. (Similarly, if renewing showers, or taps, they can be replaced with more efficient models which use less water, reducing their environmental impact.)

B8.3 BOILERS

Considerations for historic buildings

The main consideration when installing a modern condensing boiler in a historic home is the siting of the boiler flue. To minimise visual impact, the flue should not be sited on a principal elevation as it would affect the external character of a historic building. In some cases it may be possible to use an existing flue.



Typical boiler flue, sited on a rear wall to meet Planning requirements

Care should be taken not to damage external stonework and detailing.

The local authority Planning and Building Control departments should be consulted before installing a boiler flue, to confirm any safety issues and establish whether any formal permissions are required.

Replacing a 15-year-old boiler with a new condensing model can save approximately a third on fuel costs. The efficiency of boiler models can be checked on the SEDBUK (Seasonal Efficiency of Domestic Boilers in the UK) boiler efficiency database at www.sedbuk.com. New boilers have energy efficiency ratings displayed on them, making it easy to select the best option.

Modern boilers are predominantly ‘condensing’, which allows the recycling of heat which would otherwise be lost. All new boiler purchases must now be condensing models, unless there are technical restrictions which make this impossible. A standard condensing boiler will deliver water and space heating together. This requires a hot water tank to store the heated water. This system is suitable in households with more people, where there is a greater demand for hot water.

Controls on a combi boiler

A combination ('combi') boiler provides instantaneous hot water on demand, avoiding the need for stored hot water. This may be the best option where there is not space for a hot water tank, as it avoids the cost (financial and environmental) of heating water which is not needed.

Some older boilers are known as 'back boilers': this refers to their placement, normally behind a gas fire in an existing fireplace. These should not be confused with traditional back boilers integral to the chimney of a coal-burning grate, which heat hot water. It is not possible to fit a condensing boiler as a back boiler, as condensing boilers require a drainage connection. Consequently, use of back boilers is becoming less popular.

A condensing boiler flue emits water vapour into the air outside the home. To do so, the flue must pass through either a wall or a roof. The siting of the flue is important, not only in relation to external visual impact, but to ensure the vapour plume does not compromise the view from a window or enter a roof space where it could lead to condensation and timber rot.

B8.4 VENTILATION

Considerations for historic buildings

Ventilation is an important health and safety issue in rooms with gas or solid fuel-burning appliances, where it is mandatory to ensure adequate ventilation.

The siting of any ventilation accessories (such as grilles, trunking, and pipework) should be as discreet as possible. Listed building consent may be required, depending on the nature of the proposed work.

Gas and solid fuel appliances require fresh air to operate, and to avoid the build-up of noxious fumes. In such cases the appliance manufacturer's guidelines should be followed, to ensure adequate ventilation is maintained.

B8.5 HEATING CONTROLS

Considerations for historic buildings

There are no special considerations for heating controls in historic buildings, other than trying to place timers and room thermostats discreetly (without compromising its performance, in the case of the room thermostat).

As well as employing modern technology, energy-efficient heating must be controllable. An efficient heating system should include the following: an electronic timer, a room thermostat, thermostatic radiator valves (TRVs) and a hot water tank thermostat (with combi boilers this is on the boiler itself). Most of these can be added to existing systems.

For advice on efficient use of heating systems in Scotland, Energy Saving Scotland advice centres can be contacted free on 0800 512 012.

For advice on efficient use of heating systems elsewhere in the UK, Energy Saving Trust advice centres can be contacted free on 0800 512 012.

Room thermostat

Thermostatic radiator valve

Mechanical and digital space and water heating system timers

B9

Lighting and appliances

B9.1 INTRODUCTION

The lighting and appliances in a home can account for up to 40% of its electricity consumption. By using energy-efficient lighting and appliances a considerable amount can be saved on electricity bills, the amount of electricity used can be reduced without compromising on either lighting or appliances.

This section provides a brief overview of energy-efficient lighting and appliances. Detailed guidance is available from Changeworks' Tenement Fact Sheet 5 (www.changeworks.org.uk/uploads/TFS_05.pdf).

B9.2 LIGHTING

Considerations for historic buildings

The main consideration for lighting in historic homes is one of visual aesthetics. The sparkle of traditional incandescent lightbulbs is sometimes preferred as an 'authentic' feature (although many historic homes were built before electric lighting), however the quality of low energy lighting, and its colour spectrum, are now comparable with older lighting.

Fitting recessed spotlights in ceilings may be inappropriate where there is decorative plasterwork.

No formal permissions are needed when upgrading lighting in historic buildings.

Only around 5% of the energy burned by a traditional incandescent lightbulb actually generates light; the other 95% is emitted as heat. Low energy CFLs (compact fluorescent lamps) typically use only a fifth of the electricity needed by a traditional bulb to provide the same light output. Their long lifespan makes them well suited to high ceilings (common in many traditionally-built homes), and other inaccessible places where changing bulbs is difficult.

Compact Fluorescent Lamps (CFLs)

This longevity combined with their low energy consumption means that despite the higher purchase price (compared with traditional bulbs) CFLs will save money. A 20W CFL used for 3-5 hours per day will repay its purchase cost in under a year, and will deliver savings on fuel bills of up to £60 over its lifespan.

Some issues have been raised in relation to CFLs, including the following:

- CFLs contain very small amounts of mercury. This is also present in strip lighting, and is not generally deemed a health risk. Moreover, traditional bulbs emit more mercury into the atmosphere through the burning of fossil fuels to generate the high levels of electricity they need to operate. Further details on this issue, and on disposal and recycling of CFLs, can be found on the Energy Saving Trust website (www.energysavingtrust.org.uk).

- Migraines can be induced by the flicker of older CFLs. Using newer models will prevent this.

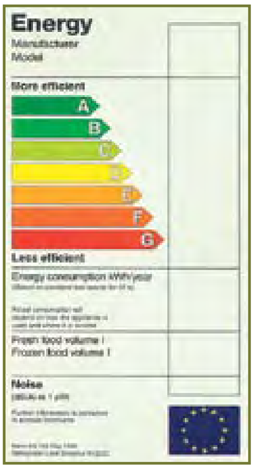
- Some skin conditions can be exacerbated by CFLs. In such cases alternative low energy lighting can be considered.

Energy saving halogen spotlights

Halogen bulbs have become more popular in recent years, commonly for spotlighting; these also use less electricity than traditional bulbs. LED bulbs are also being developed for low-energy domestic lighting.

Whichever bulbs are chosen, they now have energy efficiency labels on the packaging. These should be checked before purchase, as bulbs vary in quality.

B9.3 APPLIANCES



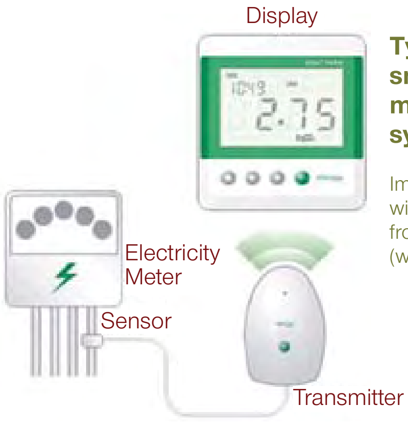
Over its lifespan, the running cost of a domestic appliance is far more than its initial purchase price. This provides a strong financial incentive for buying appliances which need less energy to run. As with the other aspects of this guide, these financial benefits are accompanied by a lower environmental impact.

As an example, replacing an older fridge freezer with a more efficient model can save up to £50 per year on running costs. Over its lifespan (normally around 10-12 years), these savings will more than pay back the purchase cost.

Typical domestic appliance energy efficiency label

B9.4 SMART MONITORS

Electricity meter



Typical smart monitor system

Image reproduced with permission from Efergy limited (www.efergy.com)

Being more aware of the energy demand of appliances makes householders more conscious of the ways money can be saved. It can be hard to equate lifestyles with fuel bills. One reason for this is the fact most fuel is invisible. Being able to see the consumption and cost of fuel in real time allows the identification of the appliances which use most energy and cost most money.

Smart Monitors (sometimes called Real Time Display Units) are now available, which show the amount and cost of electricity usage at any time, together with greenhouse gas emission levels. The readings change as appliances are turned on and off, so the energy consumption of individual appliances can be calculated.

These simple devices comprise a small box which is attached to the electricity meter by a manual clip, and a handheld display which receives remote readings. This display either runs off batteries (so it can be carried around the house) or plugs into an electricity socket. The readings are updated continuously, so the details are in real time.

Smart meters are likely to be introduced to all domestic property over the next 10 years. They will be hard-wired into the home and monitor both electricity and gas use.

‘Energy can seem like an invisible magic in our homes. Most of us are still not making the connection between climate change and the way we use **lights, heating and appliances that are responsible for 27% of our UK carbon emissions’**

PART C

Case Study:
“Energy Heritage’, Lauriston Place, Edinburgh

Case study funded by

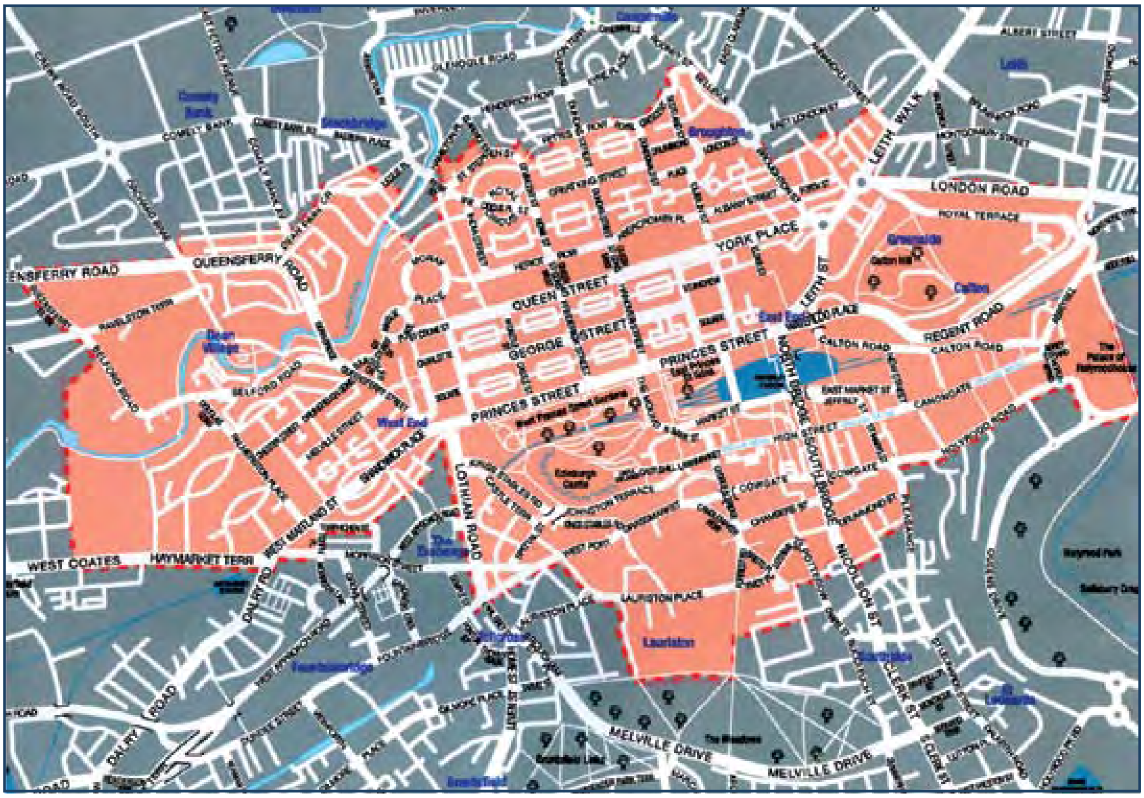
Georgian tenement flats in Edinburgh's World Heritage Site, owned by Lister Housing Co-operative

C1

Case study summary

This case study describes a project carried out in Edinburgh in 2007-2008 by Changeworks, in collaboration with a number of key partners including Eaga Partnership Charitable Trust, Edinburgh World Heritage, Historic Scotland, Communities Scotland and Lister Housing Co-operative.

A range of energy efficiency improvement works was carried out to nine flats within one stair of a B-listed Georgian tenement building in the heart of Edinburgh. The properties lie in the Old Town Conservation Area, and form part of the Old and New Towns of Edinburgh UNESCO World Heritage Site.



The Old and New Towns of Edinburgh World Heritage Site.
Image reproduced courtesy of Edinburgh World Heritage

The Georgian tenement improved by the Energy Heritage pilot study

As a result of the project[18]:

- **The annual energy costs of each flat were reduced by an average of £175 (and in some cases up to £400);**
- **The annual CO2 emissions of each flat were reduced by an average of over 1 tonne (and in some cases up to 2.4 tonnes);**
- **The annual energy consumption of each flat was reduced by an average of 5,000 kWh (and in some cases up to 12,000 kWh);**
- **The National Home Energy Rating (NHER) of each flat was increased to an average of 8.9 (in some cases increasing by up to 1.5).**

A number of factors contributed to the project's success. Among the most important were thorough research, open dialogue and effective partnership working between the key parties involved in the project: planners, conservation bodies, housing professionals, energy consultants, technical experts and the householders themselves.

[18] NHER projections (further details in section C5.1).

C2

Project background

Changeworks is an Edinburgh-based sustainable development organisation. In early 2007, funding was secured for the Energy Heritage project, which would identify issues and solutions to improving energy efficiency in domestic historic buildings. The solutions aim to reduce fuel poverty among occupants of historic homes, and increase the long-term sustainability of historic buildings as affordable housing for the future.

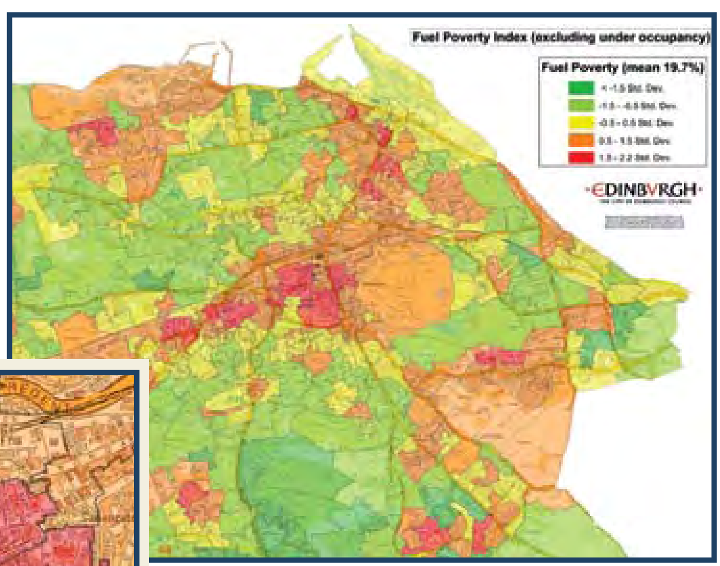
Energy Heritage involved three phases:

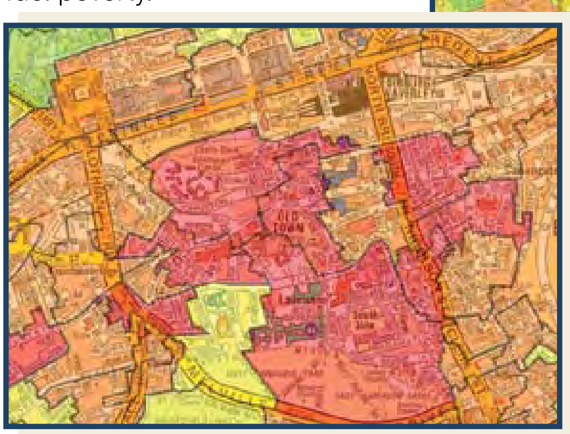
- research and extensive negotiations with key organisations;
- a pilot study, carrying out a series of improvement measures to listed homes and monitoring their impact;
- production of best practice guidance, and promotion to encourage replication.

This case study examines the key aspects of Energy Heritage, from inception through to completion, and identifies critical success factors for others wishing to improve the energy efficiency of historic housing.

C2.1 NEED FOR THE PROJECT

In 2005, Changeworks and The City of Edinburgh Council collaborated in the production of a Fuel Poverty Map of Edinburgh. This map (based on data from the 2001 census) shows which areas are at highest and lowest risk of their occupants falling into fuel poverty.





One of the areas whose occupants were shown to be at highest risk of fuel poverty is the Old Town, which is in a Conservation Area and forms part of the UNESCO World Heritage Site.

Fuel Poverty Map of Edinburgh (inset: householders in the Old Town are shown to be at particular risk). Images © The City of Edinburgh Council

“We estimate that around 75% of the buildings in this (WH) Site are listed, and there is **a real need to reduce household energy bills and to alleviate fuel poverty** in this Site”

David McDonald,
Edinburgh World Heritage

Fuel poverty has three contributory factors: poor building energy efficiency; low household income; and the cost of fuel. The majority of buildings in the Old Town were traditionally constructed some time ago. For the reasons outlined in Parts A and B of this document, some of these buildings, while visually outstanding, do not always have high standards of energy efficiency.

The Energy Heritage pilot project also draws on previous Changeworks projects aimed at reducing energy consumption in domestic buildings in Edinburgh. Reports on these projects are available at www.changeworks.org.uk/content.php?linkid=182.

Having identified the Old Town as an area where householders are at high risk of fuel poverty, Changeworks then carried out extensive research and negotiations to identify the following:

- barriers to improving energy efficiency in historic homes protected by their historic status;
- effective solutions, acceptable to planning and conservation bodies, and to householders;
- properties in which to showcase a series of improvement options.

C2.2 RESEARCH AND NEGOTIATIONS

Changeworks carried out research and discussions with the following bodies:

- the City of Edinburgh Council
- the Cockburn Association
- Edinburgh World Heritage
- Historic Scotland
- John Gilbert Architects
- Royal Incorporation of Architects in Scotland (RIAS)
- Scottish Ecological Design Association (SEDA)
- Sust. The Lighthouse On Sustainability

This ensured that critical issues were all explored, and solutions were found that were acceptable from all perspectives.

In addition, there is a considerable body of written material which informed the case study decisions, and this guidance document. These publications, and direct links to each document, are all included in the *Further Reading section*.

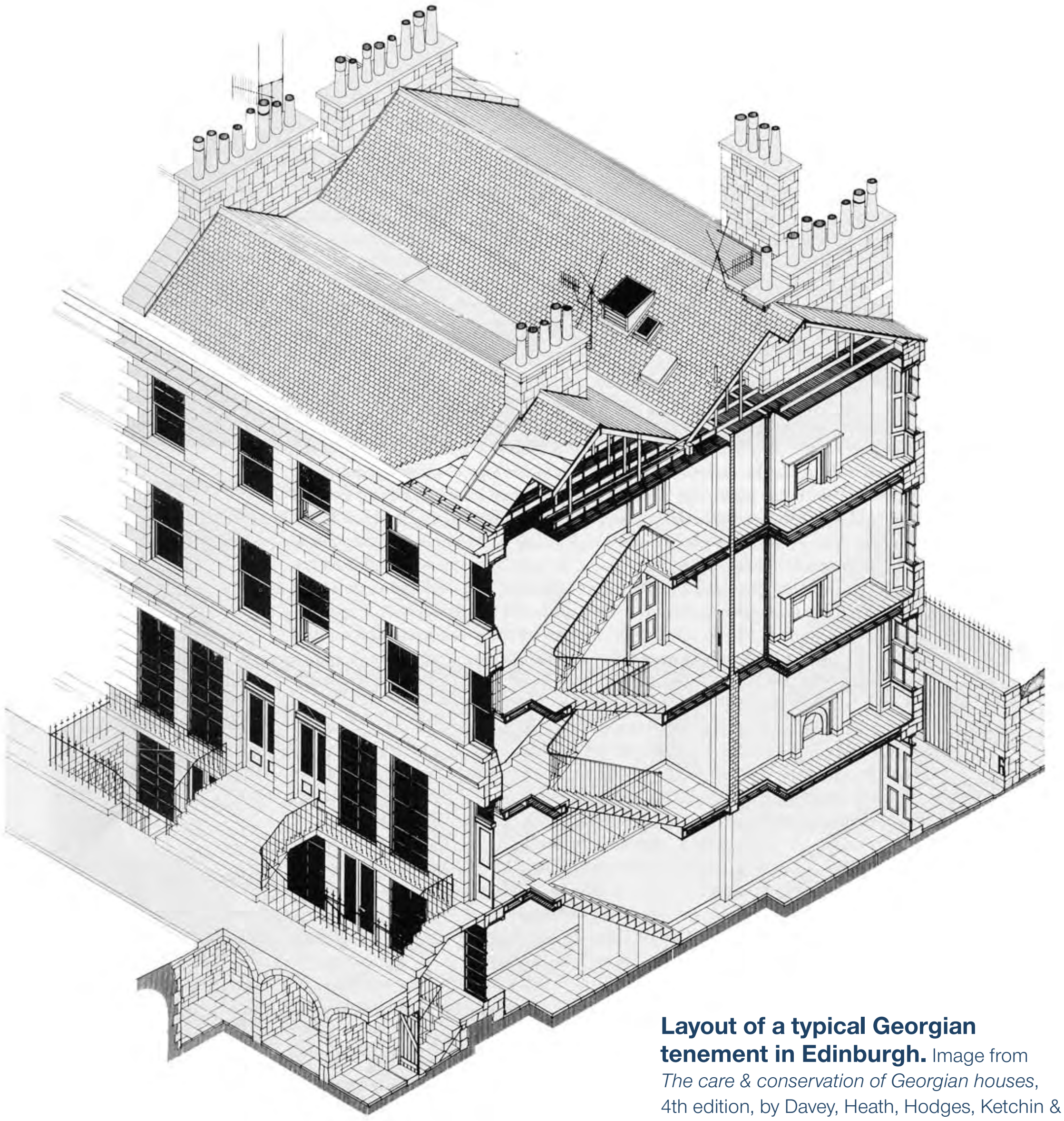
C2.3 ENERGY HERITAGE PILOT STUDY

Following the identification of key issues for occupants of traditional and historic homes, and appropriate solutions to improve the energy efficiency of their properties, a site was needed to test the various solutions.

Lister Housing Co-operative tenement

Project partners were found in Lister Housing Co-operative, which owns 184 social housing properties in Edinburgh's Old Town, and Edinburgh World Heritage, champion of Edinburgh's World Heritage Site.

The pilot study involved a series of energy efficiency improvement measures to a stair of 9 flats in an 1820s Georgian tenement building. The building is B-listed, lies in the Old Town Conservation Area and forms part of the World Heritage Site.



Layout of a typical Georgian tenement in Edinburgh. Image from *The care & conservation of Georgian houses*, 4th edition, by Davey, Heath, Hodges, Ketchin & Milne, reproduced courtesy of Edinburgh World Heritage

Detail of Lister Housing Co-operative tenement

Lister housing Co-operative tenements from above. Image courtesy of Google Earth. Image © 2008 The GeoInformation Group © 2008 Tele Atlas

C3

Pilot study considerations

C3.1 Partners

Lister Housing Co-operative was keen to promote energy saving measures to improve the condition of their housing stock and ensure householders' fuel bills remain affordable.

Edinburgh World Heritage's key role lies in 'the support, management and promotion of the Old and New Towns of Edinburgh World Heritage Site'[19]. Edinburgh World Heritage is very keen to take a lead in promoting sustainability within the Site. As such, it was most supportive of the project and provided heritage expertise throughout.

Historic Scotland also provided expertise on issues relating to building conservation, and assisted in carrying out thermal efficiency testing to the buildings involved in the pilot project.

C3.2 Partnership working

The importance of working together on projects such as Energy Heritage cannot be over-emphasised. The complexities of improving energy efficiency in historic buildings are such that input is needed from all relevant parties (energy efficiency, building conservation, Planning, and householders).

Regular liaison by Changeworks energy professionals with building conservation bodies and the local authority Planning and Building Control departments were necessary to ensure the best possible solutions were achieved.

As well as regular contact with official bodies, open evenings with all householders were organised by Changeworks and Lister Housing Co-operative. These provided a forum for the proposed options and measures to be explained to householders, and gave an opportunity for any concerns to be raised. Involving householders was particularly important to ensure that the options they chose met their lifestyle needs, and to give them ownership of the project[20].

[19] *Outcomes Agreement between Historic Scotland and City of Edinburgh Council and The Edinburgh World Heritage Trust* (October 2007)

[20] *Seeing The Light: The Impact of Microgeneration on the Way We Use Energy* (Sustainable Consumption Roundtable, 2005) provides insight on the importance and benefits of involving the recipients of energy saving measures in any project.

C3.3 FUNDING

Funding for the project as a whole (the research, the pilot study and this guidance) was provided by Eaga Partnership Charitable Trust.

Funding for the capital costs arising from the pilot project was provided by the following bodies:

- Edinburgh World Heritage
- Communities Scotland (Wider Role funding stream)
- Lister Housing Co-operative
- ScottishPower (Energy Efficiency Commitment[21] (EEC) funding stream)

C3.4 IDENTIFICATION OF IMPROVEMENT MEASURES

A list of all the potential solutions to improving domestic energy efficiency was compiled, and Changeworks assessed each solution individually to establish its suitability for application in historic buildings.

Factors which excluded some of the measures were predominantly related either to their incompatibility with historic buildings, or to their intensive nature which would render replication unrealistic for many householders (one specific aim of Energy Heritage is to encourage replication).

Once a list of acceptable measures was confirmed, each potential measure was explored in depth, in order to select the most effective solution for each (for example, which window option was deemed most suitable in terms of energy efficiency, building conservation and householder need: secondary glazing, shutters, draughtproofing, etc.?).

The key considerations in assessing different systems included the following:

- impact on the energy efficiency of the property;
- impact on the appearance of the property;
- impact on the fabric of the building;
- cost-benefit ratio;
- replicability on other historic homes;
- innovation.

[21] EEC changed to the Carbon Emissions Reduction Target (CERT) with effect from 1 April 2008.

C4

Improvement measures

Prior to the works, all nine B-listed Georgian tenement flats were in a good state of repair. Lister Housing Co-operative takes a sensitive approach to maintenance, using contractors who appreciate the historic nature of the buildings and who use suitable materials and techniques when carrying out maintenance works. Additionally, all flats had gas central heating systems with individual room heating controls.

C4.1 SELECTING IMPROVEMENT MEASURES

Walls and communal areas were outside the scope of the study, for the following reasons:

Walls:

- **Cost:** solid wall insulation is a major undertaking, too costly and disruptive to be replicable by the standard householder[22];
- **Technical:** potential breathability implications of installing modern insulation to traditionally-built walls;
- **Conservation:** only supported by building conservation bodies in cases where original wall lining is absent or needs replacement.

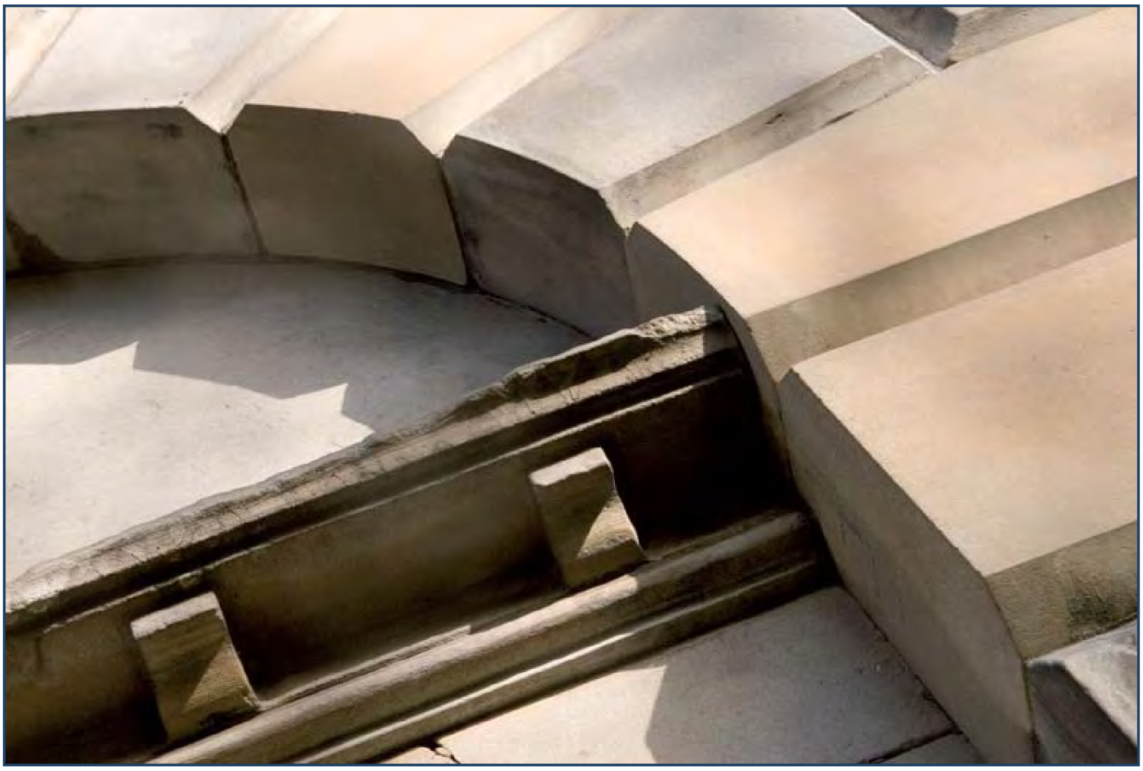
Communal areas:

- **Cost:** most options (heat recovery, draught lobby, additional glazing to skylight were deemed major works, too costly and disruptive to be replicable by the standard householder;
- **Replicability:** it was decided to focus on improvement measures within individual properties, to maximise replicability.
- **Technical:** insufficient space for draught lobby; no skylight; insufficient room for heat recovery system;

The main building aspects covered by the Energy Heritage pilot study were floors, roofs and windows. Heating systems and lighting were also considered, together with awareness raising among householders. Combinations of the following energy efficiency improvement measures were implemented:

- Secondary glazing
- Draughtproofing
- Shutter refurbishment
- New, ‘A’ rated condensing boilers
- Floor insulation
- Top-up loft insulation
- Low energy lighting
- Smart Monitors
- Home energy advice visits

[22] This also applies in terms of value for money: NHER ratings show low cost savings for solid wall insulation.



Different combinations of measures were installed in each flat. The determining factors included the location of the flat and the preferences of the householder. This allowed the impact of the measures (particularly with respect to window improvements) to be measured both in isolation and in combination, as well as allowing side-by-side comparisons.

The energy saving measures chosen were not new measures. For example, while secondary glazing is not a groundbreaking technology, the system selected had been designed specially for historic buildings, and meets the most important criteria for improving energy efficiency without compromising the character of the home, and being replicable.

Changeworks energy professionals discussed all works with the local authority Planning and Building Control departments, who confirmed that none of the works required formal permissions.

The following sections provide details of each measure applied to the flats.

C4.2 SECONDARY GLAZING

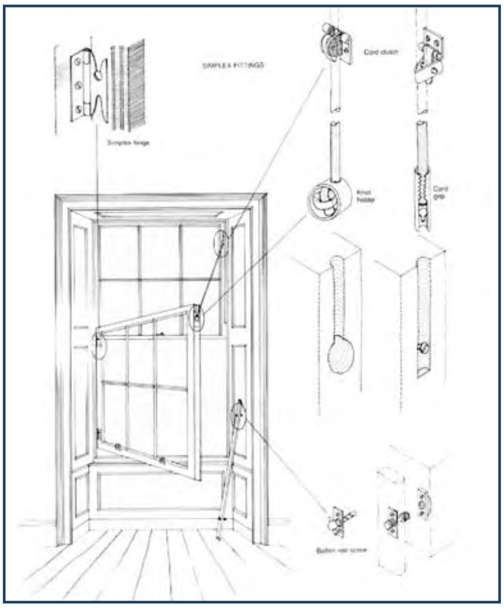
The secondary glazing system installed for the pilot study.
Photographs © Changeworks

Double glazed windows are not permitted in B-listed buildings in Edinburgh; secondary glazing was chosen as a viable alternative.

The system[23] selected for the **Energy Heritage** project was designed specifically for historic buildings, and has the following advantages for such situations (see section B2.3 for details of potential secondary glazing issues):

- It is a very slim-line product, minimising its physical impact;
- It sits within the primary window frame;
- The bespoke design allows installation in individually-shaped or misaligned windows;
- The secondary window is designed to open in the same way as the primary window;
- There is no impact on the operation of internal shutters;
- Use of internal window sills is maintained;
- The external 'double reflection' is minimised;
- The use of low emissivity glazing increased thermal efficiency;

This system is entirely reversible. It can also be removed temporarily (safe storage space would be needed), as it sits within a slim magnetic sub-frame which remains in the primary window frame when the secondary window is removed. The original window locks cannot be used, so new locks were provided. The 'easy-clean' slotted hinges had to be removed from the original window frame, however these were retained as they can be re-affixed as and when window maintenance is required. With a sash window design, only one glazing panel (top or bottom) can open; this can be chosen prior to design. The choice was dictated by individual household preferences.



The slotted 'easy clean' hinge system on a sash and case window. Image from *The care & conservation of Georgian houses*, 4th edition, by Davey, Heath, Hodges, Ketchin & Milne, reproduced courtesy of Edinburgh World Heritage

Continued

[23] The system chosen was Storm Windows (www.stormwindows.co.uk).

A partial, surface-mounted draughtproofing system was installed to the top sash of the primary windows, prior to installation of the secondary glazing.

The secondary glazing system used can achieve a maximum U-value of 2.0[24] when combined with single glazing.

Secondary glazing was installed in thirty windows, in five of the nine flats. It was also installed in Lister Housing Co-operative's head office before starting the project, so householders could see and test the product before making a decision on which improvement measures they wanted.

C4.3 DRAUGHTPROOFING

Secondary glazing was offered to householders as the preferred energy-saving option for windows, due to its projected energy-saving potential. Some householders did not want to have secondary glazing, due to the reduced access to the original windows. These householders instead opted for a high-quality draughtproofing system, to reduce the ventilation heat loss from their homes.

Draughtproofing being installed for the pilot study. Photograph © Changeworks

All windows already had surface-mounted draughtproofing, installed through government Home Energy Efficiency Scheme grant funding. This was 12 years old and in need of replacement. The system[25] selected for the Energy Heritage project was installed by removing the window sashes from their frame (the windows did not have to be removed from site), cutting channels into the sides of the sashes, and installing brush strip draughtproofing into these channels. The windows were then replaced, providing a near-invisible draughtproofing system.

This type of system can reduce the number of air changes per hour from 2.5/3.0 – the typical standard of sash windows on an exposed building – to 0.4[26].

Draughtproofing was installed in twenty-four windows in four flats.

[24] www.stormwindows.co.uk
[25] The system chosen was Ventrolla (www.ventrolla.co.uk).
[26] www.ventrolla.co.uk

C4.4 SHUTTER REFURBISHMENT

Internal shutters installed for the pilot study. Photograph © Changeworks

All the properties were built with integral internal wooden shutters, however in the majority of the flats they had been sealed closed. Where the householders felt they would use these shutters it was decided to reinstate them to their original working condition. This also allowed their thermal performance to be compared to more modern interventions.

All works were carried out by joiners. The works were all relatively straightforward, however their extent was unknown until the shutters were freed. The condition of the freed shutters was variable: in some cases new whole or partial leaves were required, and in all cases some decoration was required.

Where secondary glazing had also been installed, recessed ring pulls were substituted for the standard brass knobs, to avoid them hitting the secondary glazing when shut.

Shutters were reinstated at twenty-four windows in five flats.

C4.5 BOILER REPLACEMENT

All the properties had gas central heating systems with individual room controls. However, Lister Housing Co-operative maintenance records showed that the boilers in some flats were between thirteen and nineteen years old and were, according to SEDBUK ratings, operating at less than 75% efficiency. It was decided that these would be replaced with modern, 'A' rated condensing boilers.

The model[27] of boiler installed was determined by Lister Housing Co-operative's maintenance programme: the model is energy-efficient, had been tried-and tested and had a good maintenance track record. Again according to SEDBUK ratings, all the new boilers run at over 90% efficiency.

Condensing boiler being installed for the pilot study. Photograph © Lister Housing Co-operative

[27] Vaillant ecoTEC Plus boilers were installed in all four flats.

C4.6 FLOOR INSULATION

The basement flats had their original solid ground floors removed in the 1970s as part of a previous refurbishment. At that time they were replaced with solid concrete floors laid directly on top of aggregate. These concrete floors not only had a very poor thermal performance, they also had a very cold feel which is uncomfortable for occupants. Insulation was laid on top of these concrete floors throughout both flats. The only exception was below kitchen units, as they had only recently been fitted and the disruption was undesirable.

The insulating material[28] selected for this project was a slim-line system, and allowed the floors to achieve a thermal efficiency as close as possible to new build standards, without the disruption of removing and re-siting room features (section B4.3). 21mm of insulating material was bonded to 9mm of particle board, giving a total depth of 30mm. The manufacturer's U-value was given as 0.25.

Floor insulation being installed.
Photograph © Lister Housing Co-operative

In some rooms there was a laminate finish on top of the concrete floors, and the householder was concerned this might be damaged during the works. However, the installation company was able to lift the laminate, install the floor insulation, and successfully re-lay the laminate with no detrimental effects.

The cost of this slim-line floor insulation was partially offset by the reduction in alteration works, as would have been necessary if a deeper insulating system had been installed, and which would have incurred additional costs.

Floor insulation was installed in the two basement flats.

C4.7 TOP-UP LOFT INSULATION

The flats were built without loft insulation. At some point 50mm of insulating quilt had been installed, and an additional 150mm had been added relatively recently. However, as this falls short of current best practice standards, this was further topped up as part of the Energy Heritage pilot study, to give a total depth of 300mm.

Loft insulation was installed in the two top floor flats.

[28] The material chosen was Spacetherm C (www.spacetherm.com).

C4.8 LOW ENERGY LIGHTING

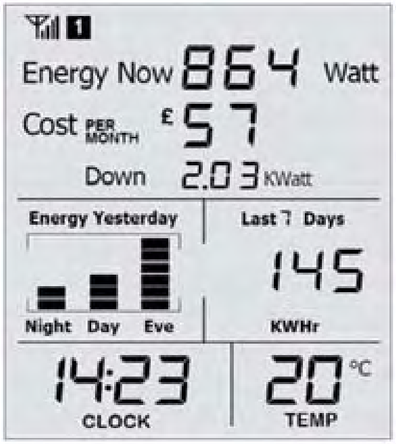
Compact Fluorescent Lamps (CFLs)

The majority of the lighting in the flats was provided by traditional incandescent lightbulbs. As part of the works the overhead lights were replaced with low energy CFLs.

In keeping with the tailored approach taken throughout this project, powerful 23W bulbs were chosen due to the large rooms and high ceilings.

All overhead lights had CFLs installed in all nine flats.

C4.9 SMART MONITORS



Typical smart monitor display

As well as physical energy-saving measures, it was felt important to address householders' energy efficiency awareness. Smart Monitors were installed in each flat, to allow householders to see the cost, consumption and emissions associated with their energy use in real time. These were installed during the home energy advice visits (section C4.10), so the advisers could explain how the monitors worked.

The smart monitors[29] chosen for the project were selected for their simple display, and the wireless display screen which allows the device to be carried around the property. However, it was not possible to install these monitors in three of the flats: due to the meters' wiring systems, there was insufficient space to install the connecting clip around the incoming supply wire. In these three flats it was decided to use a different model[30]. A different style of clip allowed these to be installed successfully, and the different model also has a memory, allowing data to be stored and compared over time.

Smart monitors were installed in all nine flats.

[29] The first smart monitor model chosen was the Electrisave monitor (www.electrisave.co.uk).
[30] The second smart monitor model chosen was the Current Cost monitor (www.currentcost.com).

C4.10 HOME ENERGY ADVICE VISITS

A Changeworks energy adviser with householder

As part of the awareness-raising aspect of the project, all householders received home visits from Changeworks energy advisers. Energy advice commonly includes advising on insulation and draughtproofing measures, discussing eligibility for grants and referring householders for measures when appropriate. Advisers also give guidance on a range of energy topics including the efficient use of heating systems and the reduction of fuel bills, highlighting the benefits achievable through simple behavioural changes.

Home energy advice visits were carried out to all nine flats.

C4.11 COSTS

The costs of the project components are detailed in the table below. All costs are inclusive of VAT (5% for draughtproofing and insulation works, 17.5% for all other works).

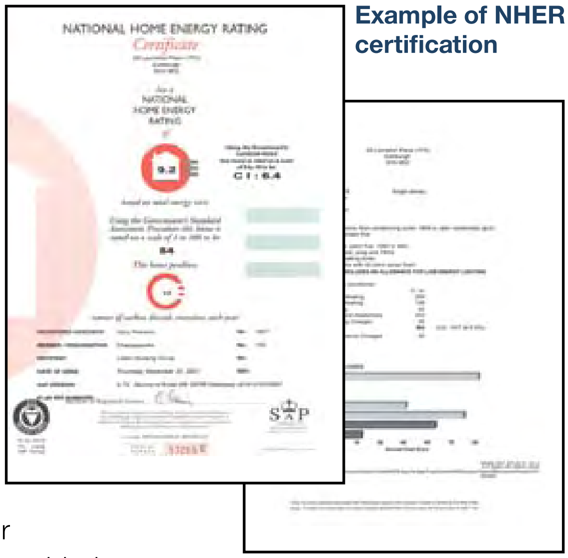
MEASURE	QUANTITY	COST PER FLAT	COST PER UNIT
Secondary Glazing	5 flats (30 windows)	£5,040	£840
Draughtproofing	4 flats (24 windows)	£2,262 *	£377 *
Shutter refurbishment	5 flats	£1,800 **	£316 **
'A' rated boiler	4	£2,434	£2,434
Floor insulation	2 flats (161m^2)	£9,434	N/a
Loft insulation	2 flats	£431	N/a
Low energy lighting	9 flats (90 bulbs)	£25 ***	£2.50 ***
Smart Monitors	9	80 / £30 ****	£80 / £30 ****
Energy advice	9	£135	N/a

* Cost included timber repair work to window frames. ** Cost included draughtproofing work to upper sashes of windows where secondary glazing was installed, and the manufacture and installation of some new shutter leaves. *** Costs estimated based on current prices. **** Retail price of smart monitors at time of installation.

As mentioned in the guidance (section B1.5), these are solely capital costs and will be offset to varying degrees by the money saved on heating bills, although maintenance costs were also a consideration. The majority of the measures will have long lifespans, maximising the return they will provide.

C5

Monitoring impact


NATIONAL HOME ENERGY RATING
Certificate

Example of NHER certification

The impact of the above works was measured in a number of ways, in order to provide a thorough cost-benefit analysis.

C5.1 NATIONAL HOME ENERGY RATINGS

Prior to the works taking place, an energy assessor carried out surveys of all nine households. These provided a National Home Energy Rating (NHER) for each property, which acted as a baseline from which to measure the impact of the works. The NHER scale ranges from 0 (very poor) to 10 (excellent), and provides projected estimates of annual energy consumption, CO2 emissions and fuel costs, and an NHER energy efficiency rating.

Using NHER modelling[31], in one year the Energy Heritage pilot study would save a total of:

- **9.4 tonnes of CO2**
- **44,779 kWh**
- **£1,576 on fuel costs**

The results below show the average impact of the works for each individual flat.

	NHER	**Energy** (kWh p/a)	**CO2** (tonnes p/a)	**Running Cost** (£ p/a)
Before	7.9	26,971	6.5	£1,107
After	8.9	21,996	5.4	£932
Impact	**+1.0**	**-4,975**	**-1.1**	**-£175**

The figures above are averages; there was a range of savings between individual households. The NHER values improved by anything from 0.6 to 1.3; the projected annual energy savings ranged from 1,194kWh to 12,291kWh; the projected annual CO2 emission reductions ranged from 0.4 tonnes to 2.4 tonnes; and the projected annual cost savings ranged from £70 to £404.

In order to provide a robust analysis, at the time of writing this guide these are being compared alongside the other monitoring methods described here, including the actual fuel consumption data (section C5.4).

[31] These are theoretical figures based on NHER software modelling. NHER values are nationally recognised standards, however they can generate non-standard ratings depending on different build types. The tenement flats in question only have two exposed walls and therefore a relatively low external wall to floor area ratio, which gives them a relatively high NHER value. The figures have been independently verified by National Energy Services.

C5.2 THERMAL TESTING

Temperature and heat flow monitoring equipment installed on single glazed window.
Photograph © Changeworks

Thermal testing equipment installed above and below concrete floor.
Photograph © Lister Housing Co-operative

Concurrently with the Energy Heritage project, Historic Scotland have been carrying out thermal tests on different building components, across a range of building types and ages. This work included testing on the building used in the Energy Heritage pilot study.

Historic Scotland's work generated U-values for each of the building components tested. Significantly, these U-values were all obtained in situ, in contrast to the majority of U-values which are obtained in controlled laboratory conditions.

The significant findings of this testing include the following:

- **The thick sandstone walls of traditionally-built tenements do not have such poor U-values as is sometimes claimed;**
- **Adding a good secondary glazing system to single-glazed sash windows can bring their thermal performance close to that of standard double-glazed windows;**
- **When closed, internal wooden shutters next to single-glazed sash windows can more than double their thermal efficiency;**
- **Adding a good insulation system to solid concrete floors can improve their thermal performance by nearly 500%.**

The table below provides details of the U-values for each component tested.

Building Component		U-value
Wall	Front wall, ground level[32] (Sandstone, 600mm)	1.4
Window	Timber-framed single-glazed sash & case window	5.5
	Timber-framed single-glazed sash & case window + secondary glazing[33]	2.3
	Timber-framed single-glazed sash & case window + draughtproofing[34] + timber internal shutters	2.2
Floor	Concrete basement floor (c.150mm on top of aggregate)	3.5
	Concrete basement floor + insulation[35]	0.6

(The thermal performance of draughtproofing cannot be measured by a U-value, and is instead measured in terms of 'air changes per hour'. The system used in the pilot study can reduce the number of air changes per hour to 0.4[36] , providing a considerable improvement to a standard single-glazed window with no draughtproofing.)

[32] Construction: rusticated V-joint ashlar facing sandstone with rubble fill; internal lath and plaster finish.
[33] Storm Windows.
[34] Ventrolla.
[35] Spacetherm C.
[36] www.ventrolla.co.uk

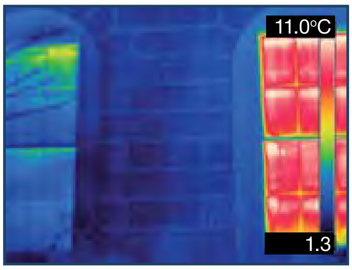
C5.3 THERMAL IMAGING

Changeworks secured the support of The City of Edinburgh Council for the Energy Heritage project. Part of this support included time and capacity for taking thermal imaging photographs of the building used in the pilot study. This allowed for a graphic visual presentation of the impact of some of the works carried out, primarily to the windows.

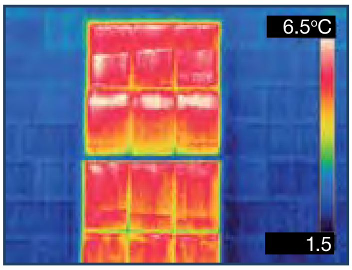
Householders were notified of the date and time when the thermal imaging would take place, as were those in the neighbouring tenement stairs. To maximise the effectiveness of the exercise, and to ensure consistency, all householders were asked to turn the heating on one hour before the photographs were taken; turn up all radiators to maximum output; close all windows; open all curtains; and close all functioning shutters.

The following photographs illustrate the impact of adding different measures to timber-famed single-glazed sash and case windows.

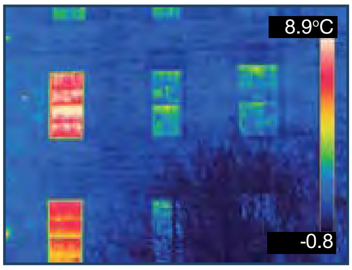
A wooden single-glazed sash and case window



These single-glazed windows are both in the same room: the one on the left has secondary glazing

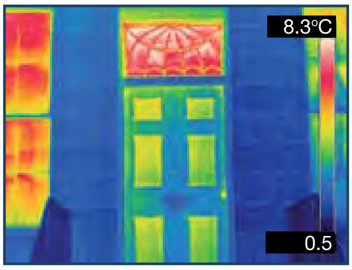


This window has had integral draughtproofing



The blue windows have internal shutters

The three top windows have both secondary glazing and internal shutters



Heat loss through a wooden front door

C5.4 Seasonal fuel bill analysis

As part of the energy advice home visits, Changeworks secured permission from all householders to access their fuel billing data. Accessing this data directly from the power suppliers eliminates the need to bother the householders, who may not have complete records in any case.

The seasonal nature of this analysis (i.e. winter comparisons) is such that the data is not available at the time of writing this guide. Results will be available from Changeworks later in 2008.

C5.5 Householder satisfaction surveys

Following the energy efficiency improvement measures, all the participating households were asked to complete a satisfaction survey. As mentioned in section C3.4, including householders in the project, including gaining their feedback, was felt to be an important factor in its success.

Overall, the householders were extremely pleased with the improvements to their homes. The following are some of the key points and statistics:

- The average satisfaction level with the improvement project as a whole was 9 out of 10;
- The majority of householders struggled to make their homes warm enough before the improvements, and felt their fuel bills were high (one householder felt the only time their flat was warm was when the heating was on);
- All householders have now noticed an improvement in their comfort levels;
- All householders now pay more attention to energy efficiency and their daily habits in relation to energy use;
- The majority of householders would recommend some of the improvement measures to friends and relatives;
- The effectiveness rating averaged 5 out of 5 for most measures (4 out of 5 for CFLs and smart monitors);
- Shutters, boilers and smart monitors were rated easiest to use:
- The secondary glazing provided an added benefit of external noise reduction: one householder “did not even hear the New Year’s Eve fireworks!”

A number of important comments and learning points also came out of the surveys, as follows:

- The importance of taking the time to involve householders and explain proposed measures is clear: all householders confirmed the helpfulness of the pre-works meetings in improving their understanding;
- The smart monitor is definitely a useful visual tool: it “gives you a bit of a shock sometimes”, and is “an eye-opener for friends and family”;
- The secondary glazing was felt very effective not only in reducing heat loss, but also in reducing window rattling in high winds, and reducing noise from outside;
- There was a good understanding of the nature of energy use, regardless of improvements: “You have to pay for the choice to switch on!”
- The importance to householders of efficient, professional and tidy contractors was highlighted by the high number of positive comments on this aspect of the project;
- One householder now feels the only way their domestic energy efficiency can now be improved upon is by installing solar panels on the roof.

C6

Summary

C6.1 SUMMARY OF ACHIEVEMENTS

This pilot study proved highly successful, satisfying the requirements of all stakeholders, as the following table demonstrates.

STAKEHOLDERS	ACHIEVEMENTS
Householders	Reduced fuel bills; improved comfort levels.
Planning	All planning requirements met; little impact on appearance or character of historic properties.
Building conservation	Almost no loss of original building fabric; progress on research into thermal efficiency in historic homes.
World Heritage Site	Successful marriage of energy efficiency and building conservation; improved sustainability of housing within Site; successful demonstration of progressive approach to Site management.
Housing provider	Secured more affordable housing; satisfied tenants; established and assessed costs and benefits of a range of energy conservation measures to inform future improvement planning.
Environmental agency / Project leader	Reduced risk of fuel poverty among householders; reduced greenhouse gas emissions; improved sustainability of historic homes; successful demonstration of energy-saving potential in historic homes; raised profile of energy and historic homes; production of good practice guidance to facilitate replication in other traditional and historic homes.

C6.2 CRITICAL SUCCESS FACTORS

Many factors contributed to the success of the Energy Heritage project, but some proved particularly critical. The table below provides a summary of these factors.

SUCCESS FACTOR	DETAILS
Partnership working	Working together enhanced the project's success by bringing greater understanding of the different issues involved in improving energy efficiency in historic homes; all parties learned a great deal from others.
Communication	Effective communication was key to success, particularly when addressing potentially contentious aspects of the project; this allowed all parties to learn and appreciate other perspectives.
Research	Understanding the subject matter was vital to ensure identification of appropriate and effective solutions.
Negotiation	Individual parties sometimes had differing priorities. Being able to negotiate effectively allowed approaches to be found which optimised outcomes for all partners.
Flexibility	The viability of prospective solutions often changed as research and negotiation between parties shed greater light on particular aspects of the proposals. A willingness to adapt (by all) meant solutions were found which were acceptable to all parties.
Perseverence	As with any project, difficulties arose: the topic of energy efficiency and historic homes is not a simple one. Finding ways around complex situations, and identifying alternative ways forward where necessary, was an important requirement for the project partners.
Funding	This pilot study would not have been possible without financial support from the various project partners.

SOURCES OF FURTHER INFORMATION

Action For Warmth *Installation Assistance*
www.changeworks.org.uk/content.php?linkid=179
0845 002 8466

Cadw *Historic environment protection agency (Wales)*
www.cadw.wales.gov.uk
01443 336000

Changeworks *Sustainable development charity*
www.changeworks.org.uk
0131 555 4010

The Cockburn Association *The Edinburgh Civic Trust*
www.cockburnassociation.org.uk
0131 557 8686

Ecology Building Society *Funding & grants*
www.ecology.co.uk/index.htm
0845 674 5566

Eco-Renovation Network *Sustainable housing network*
www.eco-renovation.org

Edinburgh World Heritage *World Heritage Site manager*
www.ewht.org.uk info@ewht.org.uk
0131 220 7720

Electricityinfo *Independent information source on UK power company fuel sources*
www.electricityinfo.org

Energy Action Scotland *National fuel poverty charity*
www.eas.org.uk
0141 226 3064

Energy Efficiency Partnership for Homes
Network of agencies working to reduce energy use
www.eeph.org.uk
0207 222 0101

Energy Saving Scotland advice centre *Energy saving and grants advice*
0800 512012 (Freephone)

Energy Saving Trust *Domestic energy advice agency*
www.energysavingtrust.org.uk
0207 222 0101 (England)
0131 555 7900 (Scotland)
029 2046 8340 (Wales)
028 9072 6006 (N. Ireland)

English Heritage *Historic environment protection agency (England)*
www.english-heritage.org.uk
0870 333 1181

Environment and Heritage Service *Environmental protection agency (Northern Ireland)*
www.ehsni.gov.uk
028 9054 3145

Green Building Press *Sustainable construction information specialist*
www.newbuilder.co.uk
01559 370798

Green Electricity Marketplace *Green electricity information*
www.greenelectricity.org enquiry@greenelectricity.org

Historic Scotland *Historic environment protection agency (Scotland)*
www.historic-scotland.gov.uk
0131 668 8600

Institute of Historic Building Conservation *Building conservation*
www.ihbc.org.uk
01747 873133

Listed Property Owners Club *Listed building advice service*
www.listedpropertyownersclub.co.uk
01795 844939

Lister Housing Co-operative *Housing co-operative (Edinburgh)*
www.lister.coop
0131 229 6176

National Energy Action *Domestic energy efficiency and fuel poverty campaigner*
www.nea.org.uk
0191 261 5677 (England)
028 9023 9909 (Northern Ireland)
07971 005578 (Wales)

Royal Incorporation of Architects in Scotland *Scottish architects institute*
www.rias.org.uk
0131 229 7545

Scottish Community & Householder Renewables Initiative *Renewables advice & grants*
www.energysavingtrust.org.uk/schri

Scottish Ecological Design Association *Ecological building design association*
www.seda2.org seda-info@uk2.net

Sust. *Sustainable building design agency*
www.sust.org
0141 221 6362

FURTHER READING

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English Heritage (2007) – ***Understanding SAP Ratings for Historic and Traditional Homes*** (www.english-heritage.org.uk/upload/doc/SAP-ratings2.doc)

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Changeworks
36 Newhaven Road, Edinburgh EH6 5PY
T. 0131 555 4010
F. 0131 555 2768
W. www.changeworks.org.uk

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