Feb 2013

Improving Historic Soho's Environmental Performance

Practical Retrofitting Guidance

Photograph by Gareth Roberts (2012)

For:

City of Westminster, English Heritage and the Soho Community Environment Fund

City of Westminster ENGLISH HERITAGE SOHO COMMUNITY ENVIRONMENT FUND

By:

Sturgis Carbon Profiling LLP, Ramboll, Sampson Associates and Donald Insall Associates

sturgis carbon profiling RAMBOLL SAMPSON ASSOCIATES DONALD INSALL ASSOCIATES

February 2013

Improving Historic Soho's Environmental Performance

Practical Retrofitting Guidance

For:

City of Westminster, English Heritage and the Soho Community Environment Fund

By:

Sturgis Carbon Profiling LLP, Ramboll, Sampson Associates and Donald Insall Associates

Forward

"Sustainability is a core value for those employed in the cause of heritage conservation. We work to ensure that the significance, of those heritage assets that have endured from the past until today, is passed on to future generations for their enjoyment.

Improving Historic Soho's Environmental Performance represents a thoroughly 21st century way of achieving just that. We hope that this report demonstrates how conservation evolves to embrace and inform new areas of understanding in the field of sustainable development. We trust that it proves that subtle intervention, allied with a comprehensive understanding of heritage significance, can effect meaningful change and enable real progress.

English Heritage is proud to have joined with Soho Community Environment Fund and the City of Westminster to contribute to a project that we believe will help sustain the historic core of one of London's most vibrant neighbourhoods. Soho has helped inspire some of the great pioneers in our history; it continues to draw creative industry to its heart and inspires visits from all over the world. It is fitting that it should be at the forefront of an innovative approach to improving environmental performance that welcomes, sustains and celebrates character."

Baroness Kay Andrews OBE

English Heritage
25th January 2013

"Westminster's rich architectural inheritance is typified in Soho. Its well known and loved townscape and buildings constitute an irreplaceable asset of unique economic and cultural value.

While we strive to conserve this for future generations, we are mindful of rising energy bills, an overstretched power grid, and the requirement to reduce carbon emissions across the built environment. This study demonstrates that sympathetic changes to upgrade the environmental and economic performance of our extensive historic buildings stock can be embraced and if done with care, can extend the life of our cherished historic building stock.

We hope that this study presents its data in a format that will encourage the individual to consider its findings in relation to their own building. We are excited about its presentation of choices that are broken down according to building typology and the interest of the stakeholder and we hope that the findings, whilst based on typical Soho buildings, will stimulate wider interest and debate and promote a more informed choice"

Councillor Robert Davis DL

Westminster City Council
21st January 2013

Terms of reference

This guidance was commissioned by Westminster City Council and its partners English Heritage and Soho Community Environment Fund, to build upon previous work and publication of *Retrofitting Soho: Improving the Sustainability of Historic Core Areas* [1].

The aims of the guidance are twofold: to encourage the retrofitting of buildings in historic core city areas to improve their environmental performance, and to highlight the importance of preserving the heritage value of those buildings.

The project brief set out the following objectives:

- Consider and comment on carbon reduction measures implemented in building works for a representative range of scenarios:
    - Listed buildings in multiple ownership (mixed use if possible);
    - Listed buildings in residential use (single ownership if possible);
    - A historic building in the ownership of the Crown Estate; and
    - Historic building(s) in the ownership of Shaftesbury Plc.
- Provide a detailed assessment of appropriate retrofitting measures for the above scenarios, and an appraisal of the resulting environmental improvements.
- Provide an assessment of the potential to extend this retrofitting approach to other similar buildings in the area.
- Consider the factors that will benefit or impede a wider extension of the approach identified in the scenarios including broader matters of access and tenure, where appropriate.

[1] (Max Lock Centre, 2008)

This guidance was produced by:

Sturgis Carbon Profiling

Sturgis Carbon Profiling have a strong track record in low carbon retrofitting, with over 20 years experience of refurbishing historic buildings. They are represented on industry steering groups, advising on issues such as the Carbon Reduction Commitment and conducting property market research for the Royal Institution of Chartered Surveyors and British Council for Offices.

In collaboration with:

Donald Insall Associates

Donald Insall Associates see the re-use of existing buildings as a key part of any programme of sustainability, and have particular expertise in the preservation, enhancement and creative re-use of listed buildings. Their refurbishment and restoration work has included renewal of all building services, and enhancing passive measures for energy conservation where these can be undertaken without prejudice to the historic fabric of the building.

Sampson Associates

Sampson Associates were set up in 1983 as a dual discipline Architecture and Quantity Surveying Practice and have particular experience costing complex historical refurbishments in London's West End.

Ramboll

Ramboll, are one of the UK's largest independent engineering and environmental consultancies. Over 600 strong, they work creatively to design and help deliver buildings and infrastructure projects that work commercially, socially and environmentally. The teams have experience of providing specialist advice on energy, sustainability, and services/utilities infrastructure, on major development and regeneration projects.

Definitions

Building fabric

'Building fabric' is a collective term referring to the roof, floor slabs, walls, windows, and doors of a building.

Building services

'Building services' refer to all of the non-fabric components of a building – energy supply, heating and air conditioning, water drainage and plumbing, natural and artificial lighting, building facades, escalators and lifts, ventilation and refrigeration, communication lines, telephones and IT networks, security and alarm systems, fire detection and protection.

Carbon

In the context of this guidance, 'carbon' refers to the bundle of greenhouse gases, including carbon dioxide, emitted as a result of human activities that contribute to the increased retention of heat by the atmosphere. Their unit of measurement is carbon dioxide equivalents (CO2e), usually kilograms (kgCO2e) or tonnes (tCO2e).

Climate change risks

In the context of this guidance, 'climate change risks' are the potential negative impacts of climate change, such as increasing demands for energy use in buildings (for example, to respond to increasing temperatures), higher operating costs, the performance limitations of existing heating and cooling systems, deterioration of building fabric, damage to building fabric and contents from flooding, and impacts on the health of occupants. As climate change continues, some buildings may be unable to deliver the levels of internal comfort required by occupants, and consequently may face 'climate change induced obsolescence'.

Renewables

Items of technology, such as solar panels, that can generate energy from sources that are not being depleted and do not give rise to additional net carbon being released into the atmosphere.

Retrofitting

In the context of this guidance, 'retrofitting' refers to the alteration of existing buildings through the replacement, alteration or augmentation of existing fabric components and fixed services. All of the retrofitting options covered in this guidance are intended to improve the environmental performance of the building in some way.

Soho

Whilst this guidance focuses on buildings in and around Soho in the West End of London, many of its findings are also applicable to buildings of similar age and construction beyond this geographical area. Care should however be taken to consult the planning requirements of the local authorities concerned with respect to heritage preservation.

Costs

All costs shown in this document are priced at 3rd quarter 2011 and subject to subsequent price fluctuation, tender action and project specific factors.

Individual project costs vary according to many factors thus project specific cost advice is required and the generic cost information in this report is for relative comparison purposes only.

Contents

Executive summary

Introduction

The introduction to this guidance provides readers with a background to the Soho area, to key concepts such as heritage value and climate change, and to the policies and initiatives that influence the retrofitting of historic buildings.

The guidance provides an integrated approach to dealing with the challenges and opportunities of improving the environmental performance of buildings in the context of historic city centre communities. It addresses the various issues associated with retrofitting historic buildings to improve environmental performance, through four stages:

Case studies

This section provides examples of the issues likely to arise in retrofitting buildings in the area, and identifies solutions that might be appropriate in each case.

The section is based on a representative sample of historic buildings in and around Soho, which were surveyed to identify the issues and retrofitting options appropriate to the structure, features and listing status of the building. Each survey involved a series of site visits and discussions with building owners to understand the issues from their perspective.

The Elemental Approach

The Elemental Approach identifies and evaluates a range of retrofitting options for each element of building fabric and services. This allows building owners to compile a suite of measures best suited to their own situation.

This ground-breaking approach, developed in the course of producing this guidance, provides detailed information and advice on a wide range of specific measures, including a breakdown of the costs and estimated energy savings, opportunities to improve the heritage value of the building and planning requirements. [1]

Guidance by building typology

This section provides a brief overview of how to apply The Elemental Approach to five building types typical of the Soho Area. It provides estimated costs and savings of a range of measures for both listed and non-listed buildings, and compares the relative cost-effectiveness of different measures in each case.

The section also discusses possible solutions to the misalignment of incentives between landlords and tenants, and the issues involved in combining different types of solutions. It also suggests a wider range of measures, for example conserving water and enhancing biodiversity, beyond those with the potential to deliver energy savings directly.

Community based interventions

Having considered the potential for energy, carbon and cost savings in individual buildings, the focus of the guidance shifts to consider systems serving several buildings or a wider area.

The previous sections demonstrate that carbon emissions can be reduced by up to a half, and that upgrading services can be more cost-effective than retrofitting the building fabric. However, even substantial uptake of the various retrofitting measures is unlikely to deliver the 80% reduction in emissions required by 2050, and area based solutions will also be needed.

This section draws on findings from other studies to illustrate the potential for community based solutions in Soho, and to signpost the way for future research

[1] *Similar resources in the past have been developed such as English Heritage's The Whole Home Energy Toolkit but not in a mixed use and urban scale context.*

Introduction

Background

The historic buildings of Soho survive today because of the value ascribed to them by successive generations. This value is partly economic, in that they each fulfil useful and profitable functions, and partly social in that collectively they are fundamental to the cultural memory and heritage that gives Soho the unique character it has today. Before looking at the impact of climate change and the issues of low carbon retrofit, it is important to understanding the rich history of the area.

A French immigrant area in the eighteenth century, by the nineteenth century Soho was a place of music halls, small theatres and pubs with 'exotic' nightlife. Unlike the neighbouring areas of Bloomsbury, Mayfair and Marylebone, it did not attract much large scale property development. Individual buildings have changed incrementally, with the overall historic texture one of richness and variety.

This pattern of development has been matched by the cultural evolution of Soho as a fashionable area for writers, artists and intellectuals, which, together with the sex industry, continued until the 1960s. It was then home to a vibrant music scene including the famous rock venue the Marquee Club, and the jazz club Ronnie Scott's. Today Soho has evolved into the home of the advertising, theatre and the film industries. It is also host to a large and eclectic retail and restaurant trade, and is becoming an increasingly desirable residential area.

The smaller scale of buildings in Soho, and their comparative affordability, in contrast with the large and opulent theatres of Shaftesbury Avenue and nearby, has enabled a diverse range of individuals and organizations to settle in the area, interact, and generate the cross-fertilisation of ideas that goes to the very heart of the way in which cities function. The ghost of Jeffrey Bernard walks the streets, together with those of Karl Marx and Mary Seacole.

Figure 1: Coffee drinkers on Frith Street

Source: Jamie Barras 2007

A detailed account of the history of the area is given in Westminster City Council's conservation area audit [2], an essential reference document for readers of this guidance. (This and other relevant policy documents are summarised in Appendix 2). The boundaries of the area are as shown in Figure 2.

Figure 2: Soho Conservation Area

Source: City of Westminster

[2] City of Westminster, 2005

The street pattern of the area has changed little since the mid-eighteenth century, and its boundaries can be traced on John Rocque's map of 1746 (Figure 3)[3].

Figure 3: Extract from John Rocque's map of 1746, with approximate boundaries of Soho

Source: Ancestry.com/Sturgis Carbon Profiling

The historic quality of a building or area can also be assessed in relation to the four 'heritage values' identified by English Heritage[4]. These values provide an objective way of understanding the heritage value of a given building or area. They cover:

- *Evidential value,* which derives from the potential of a place to yield evidence of past human activity;
- *Historical value,* which derives from the ways in which people, events and aspects of life can be connected through a place to the present.
- *Aesthetic value,* which derives from the ways in which people draw sensory and intellectual stimulation from a place.
- *Communal value,* which derives from the meaning of a place for the people who relate to it, or for whom it figures in collective experience or memory.

Soho is an architecturally diverse area, with buildings from many periods over the last 250 years, often in juxtaposition to each other. Overlaying this diversity is, in the more retail orientated areas, a street level environment of shopfronts and fascias that can be strikingly contemporary in contrast to the buildings above. This predominantly 'communal value' nevertheless also has historic and aesthetic attributes.

An example of 'evidential value' specific to Soho is the Broad Street pump which, although it has been moved, was identified by Dr John Snow as the source of the 1854 cholera outbreak in which many hundreds died. This was a major event in the history of public health in England, leading to major changes in the management of sewage and water distribution in London, and to the birth of the science of epidemiology.

Another example is St Patrick's Church, which in 1792 became the first Catholic Church created in England after the Reformation. The current building in Soho Square was built between 1891 and 1893 to replace the original chapel behind Carlisle Street. This church is a good example of the combination of historic, aesthetic and communal values based not simply on its impressive architecture but on its role in the local community throughout the years.

The rich social history manifested in the built environment we see today also leads to direct economic benefits. The unique character of the built environment and the activities it houses makes Soho a world famous tourist destination for visitors.

Maintaining this environment whilst responding to climate change is as much a challenge as an opportunity. The introduction of legislation aimed at reducing carbon emissions has led to major changes in the design of new buildings. Historic buildings also need to adapt to these challenges and opportunities if their social and economic value is to be further enhanced.

[3] This map is freely available from Ancestry.com at http://freepages.genealogy.rootsweb.ancestry.com/~genmaps/genfiles/COU_files/ENG/LON/Rocque/rocque_index.htm

[4] English Heritage, 2008

Figure 4: St Patrick's Church, Soho Square

Source: Jamie Barras 2007

Climate change is increasingly influencing policy at both national and global level. For the built environment, this is reflected in measures aimed at reducing the damage caused by greenhouse gases. The Government's Low Carbon Construction Innovation and Growth Team[5] has described 'the challenge of carbon reduction' as "… probably the biggest change management programme that the industry and the society it serves has faced since the Victorian times."

Historic and traditional buildings however have a number of significant initial advantages. Unlike new projects in development, the embodied carbon emissions associated with their construction occurred decades or indeed centuries ago. Many traditional buildings and building materials are durable and perform well in terms of the energy needed to make and use them. In addition, there is a growing body of evidence that the thermal performance of many traditional buildings is better than has been assumed, and that simple non-invasive improvement measures can be highly effective[6].

These buildings have proven to be adaptable over time and their maintenance requirements are simple and cost effective in both environmental and economic terms, whilst their demolition and replacement would require a major reinvestment of energy and resources. Retaining historic buildings can therefore be inherently sustainable. From a 'whole life' perspective, the carbon footprint of historic buildings is typically 50% lower than that of new buildings[7] .

The main carbon emission impacts that need to be tackled are the operational emissions that result from the use of a building, chiefly through heating and the use of power. These emissions can be reduced either by reducing the energy used in the building or by providing energy that results in low carbon emissions (or none at all). The process of altering buildings to achieve these improvements is referred to in this guidance as 'low carbon retrofit'.

Part of the solution to dealing with climate change is in the inherent benefits and potential additional contributions that the historic built environment can make towards society. In other words, adapting to climate change can be achieved hand in hand with enhancing heritage potential.

The benefits of preserving historic buildings are shared between building owners, the communities within which the buildings are situated and the visitors who contribute to the local economy. Responding to the opportunities of climate change by retrofitting buildings with historic and cultural value can therefore involve both the community and the individuals responsible for the buildings. Solutions may also need to be considered on

[5] Low Carbon Construction Innovation and Growth Team, 2010

[6] Wood, Bordass & Baker, 2009. Baker, 2008. Rye, 2010. Rye & Hubbard, 2011. Wallsgrove, 2008.

[7] McIntosh & Roberts, 2012

a community wide basis, as well as in relation to specific buildings.

At the same time, the social potential of Soho as a community will be enhanced by the retention, in a sustainable and economically viable form, of the built environment that provided opportunities for social mixing in earlier generations.

By preserving historic buildings for the wider community, and reducing carbon emissions, building owners will be providing a social benefit for all. These benefits to the wider community and to the economy as a whole should be accounted for in the taxation system.

Various subsidies and grants are available to improve the quality of historic buildings (see Appendix 1 for further details). Some retrofitting measures (such as reintroducing window shutters) can also enhance the historical and aesthetic value of the building. Retrofitting of historic buildings also encourages continued employment and the retention of traditional building skills, as well as investment in communities.

Policy perspective

Planning policy

Planning policy in England is currently based on twelve core principles[8], one of which is to "conserve heritage assets in a manner appropriate to their significance, so that they can be enjoyed for their contribution to the quality of life of this and future generations". Another core principle is "to support the transition to a low carbon future … including conversion of existing buildings", although no connection is made between the two issues.

Although local authorities can choose how to identify, define and protect heritage assets within their areas, Listed Buildings are protected under national legislation[9] which requires owners to seek consent from their local authority for any work that may alter the character of the building. The same legislation prohibits any work involving even partial demolition without consent of buildings in conservation areas, and gives local authorities powers to designate these areas and establish policies for their preservation and enhancement.

House owners have 'permitted development rights' to make a range of alterations to their homes without planning permission, although many types of work will require approval under the Building Regulations. For commercial premises, the range of permitted development is more limited. Owners of flats and other leasehold properties do not have permitted development rights and are likely to require planning permission to, for example, fit replacement windows that alter the appearance of the building. The notable exception to this is the installation of domestic microgeneration equipment, such as solar panels, for which flats do benefit, although it is worth checking with your Local Authority. They would also need to check that any alterations are within the terms of their leasehold agreement.

[8] Department of Communities & Local Government, 2012

[9] Planning (Listed Buildings and Conservation Areas) Act 1990

Two policies in Westminster City Council's Core Strategy[10] are particularly relevant to improving the environmental performance of historic buildings. CS24 states the Council's intention to preserve the historic fabric of the built environment, and identifies improving environmental performance as one of the main aims of alterations to historic buildings. CS27 emphasises the need for new developments to have high standards of environmental performance, but the supporting text also notes the crucial importance of retrofitting existing buildings in a densely built up area with little scope for large-scale redevelopment.

"CS24: Heritage:
Recognising Westminster's wider historic environment, its extensive heritage assets will be conserved, including its listed buildings, conservation areas, Westminster's World Heritage Site, its historic parks including five Royal Parks, squares, gardens and other open spaces, their settings, and its archaeological heritage. Historic and other important buildings should be upgraded sensitively, to improve their environmental performance and make them easily accessible."

"*CS27: Design:*
Development must incorporate exemplary standards of sustainable and inclusive urban design and architecture. In the correct context, imaginative modern architecture is encouraged provided that it respects Westminster's heritage and local distinctiveness and enriches its world-class city environment.

Development should:

- *reduce energy use and emissions that contribute to climate change during the life-cycle of the development, in line with national and regional standards as a minimum; and*
- *ensure the reduction, reuse or recycling of resources and materials, including water, waste and aggregates.*

[10] City of Westminster, 2011

This will include providing for an extended life-time of the building itself through excellence in design quality, high quality durable materials, efficient operation, and the provision of high quality floorspace that can adapt to changing circumstances over time."
The Core Strategy is supplemented by a more detailed policy document, the City Management Plan, currently (2012) in draft form. This document provides some guidelines on retrofitting and design issues[11]. Policy CMP 2.17 is particularly relevant:

"CMP 2.17: Retrofitting sustainability measures
A) The council will encourage improvements to the environmental performance of buildings subject to heritage protection.
B) Development proposals which affect such buildings will also incorporate measures to improve their energy efficiency where these do not adversely affect their significance.
C) The installation of renewable energy and equipment will be acceptable where it is sited and designed to minimise its visual impact, does not result in loss of historic fabric or otherwise affect the significance of the building."

The conservation area audit for Soho[12] has the status of a Supplementary Planning Document, as does the Council's guidance on sustainable buildings, although the latter pre-dates many significant technological and policy developments[13]. The Council's guide to retrofitting historic buildings (currently in draft)[14] provides more detailed guidance on this issue.

Further guidance on the conservation of heritage assets[15] is available from English Heritage, and defines 'conservation' as *"the process of managing change to a significant place, in its setting, in ways that that will best sustain its heritage values, whilst recognising opportunities to reveal or reinforce those values for present and future generations"*.

[11] City of Westminster, 2011b
[12] City of Westminster, 2005
[13] City of Westminster, 2003
[14] City of Westminster, 2011c
[15] English Heritage, 2008

The conservation principles defined by English Heritage provide a framework within which the need for, and scope for, adaptation of historic buildings can be assessed and the local community involved in their preservation and enhancement. Most retrofitting measures by their nature require some change to buildings and some may be visible either internally or externally. A balance will need to be struck between maintaining complete historic integrity and achieving the improved performance needed to preserve and enhance the social and economic value of these properties. However, it would clearly be counterproductive if the measures required to achieve this had the unintended effect of damaging the historic assets. It is therefore essential that retrofitting measures are seen as opportunities to enhance heritage assets, and are undertaken with consideration and sensitivity.

Improving the environmental performance of buildings should therefore be seen as an opportunity to enhance the historic environment, and to demonstrate the inherent environmental advantages of historic buildings and the social and economic benefits achievable through their retrofitting.

Beyond energy performance

The focus of this guidance, retrofitting historic buildings to reduce their energy use and the carbon dioxide emissions associated with it, is only one of many aspects of improving the efficiency and sustainability of the UK building stock in response to the challenge of climate change. The following are amongst the equally important issues that fall largely outside the scope of this guidance:

- Managing water resources;
- Encouraging biodiversity;
- Minimising the use of toxic products;
- Reducing waste generated by construction and operations;
- Minimising the transport demands generated by development;
- Minimising the embodied carbon represented by new developments and refurbishments;

- Developing large-scale renewable energy technologies.

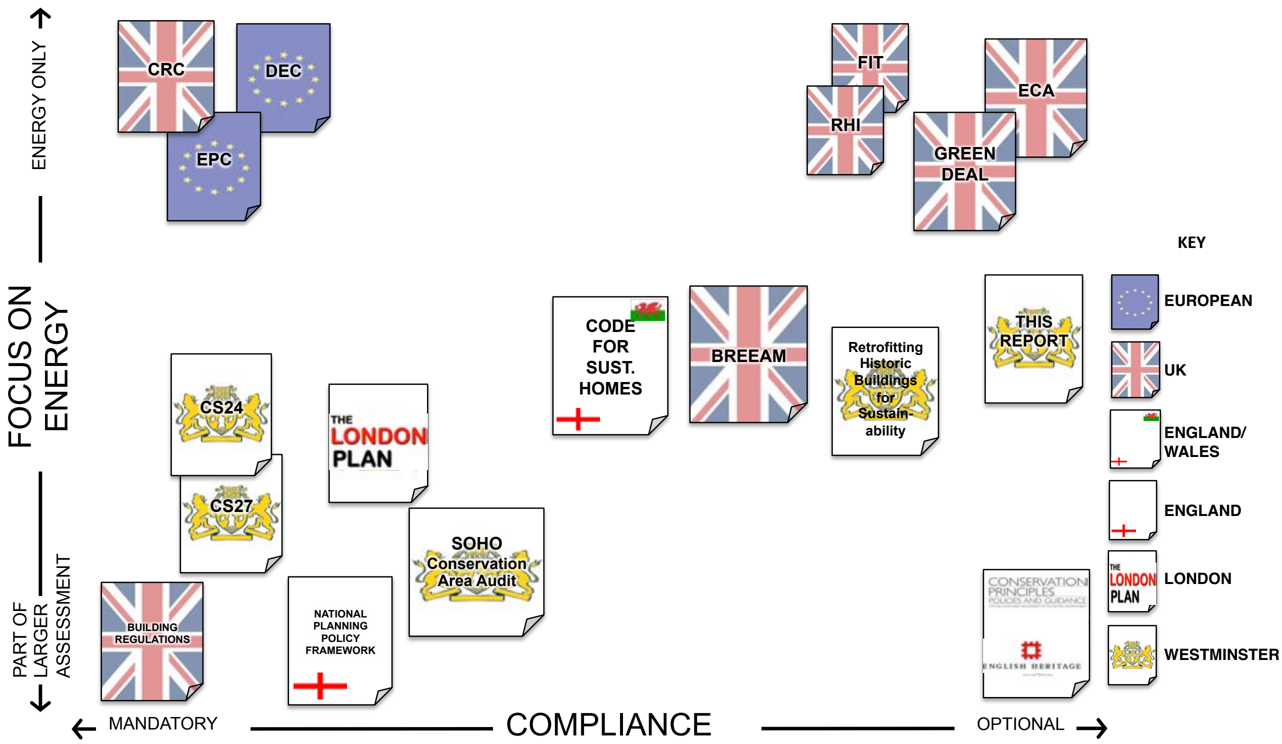
Related policies and initiatives have been introduced at European, national and regional level, with both mandatory requirements and voluntary standards (such as EcoHomes, BREEAM and LEED) used to benchmark the performance of individual buildings on both energy-specific and wider environmental criteria.

For example, Part L of the Building Regulations establishes minimum energy efficiency standards for all building types, and compliance is required whenever substantial building works are undertaken. However, if alterations that could lead to irreparable damage to historic buildings are required simply to comply with the standards, a Conditional Exemption can be granted[16].

Conditional exemptions do not release the building owner from all obligation to improve the performance of the building or to replace particular components, and local authorities may also require energy performance improvements. However they should ensure that building owners are not obliged to carry out works if a historic building specialist has confirmed that they would detract from the historic and aesthetic value of the building.

Figure 5 gives an illustrative categorisation of the major policies and initiatives along the two axes of (voluntary or mandatory) compliance and (energy-specific or wider environmental) focus.

Figure 5: initiatives and policies designed to encourage environmental improvements



Source: Sturgis Carbon Profiling

[16] English Heritage, 2011. Approved documents and other resources on the Building Regulations are available from the Planning Portal at www.planningportal.gov.uk

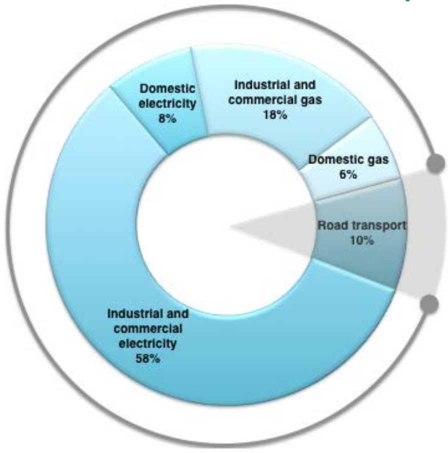
Nature and scale of the challenge

The Climate Change Act (2008) set legally binding targets for emission reductions in the UK, including a 34% reduction in annual emissions by 2020, rising to 80% by 2050 (based on 1990 levels).

The retrofitting of existing buildings will play an important part in achieving this target, as over two thirds of the buildings that will be in use in 2050 have already been built. Emissions associated with the operation of buildings are a highly significant source of potential reductions, with over 40% of total CO_2 emissions in the UK currently associated with the operation of commercial buildings[17].

In central urban locations, densely populated with intensively used domestic, retail and office buildings, the contribution of the building sector to overall CO_2 emissions can be even higher. For example, in Westminster as a whole, three quarters of the housing stock was built before 1915 (half before 1870). Buildings account for 90% of all carbon dioxide emissions, compared to the UK average of 40% (Figure 6).

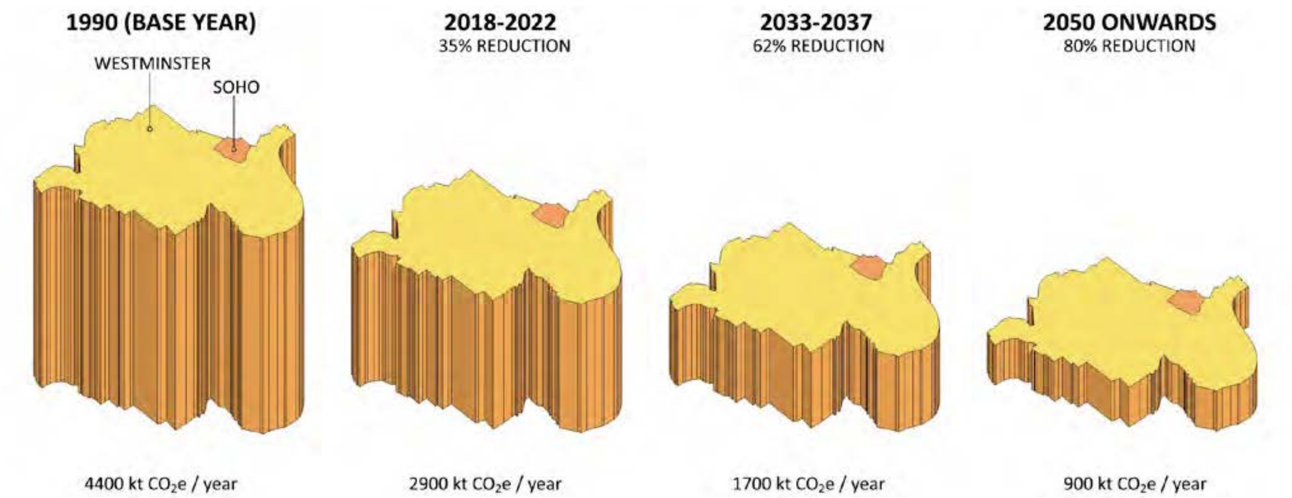
Figure 6: Westminster's carbon footprint



Source: Sturgis Carbon Profiling

Given the large number of historic buildings involved and the significantly high emissions, tackling this issue is clearly a high priority for the borough. In order to meet the targets set in the Act, annual emissions in Westminster will need to be reduced by 2,513,000 tonnes by 2050[18] (Figure 7).

Figure 7: The scale of the challenge for Westminster



Source: Sturgis Carbon Profiling

[17] Carbon Trust, 2012

[18] Assumes 1) 2008 annual emissions of 3395 kt (http://www.decc.gov.uk/en/content/cms/statistics/regional/regional.aspx) 2) Emissions in 2011 were the same as in 2008 and 3) Emissions in 1990 were 4400 kt, 23% higher than in 2008.

The business case for retrofitting

Although retrofitting buildings can offer many benefits from economic, environmental and heritage perspectives, the main benefits are as follows:

Economic benefits

- Reduced running costs;
- Reduced maintenance expenditures;
- Less exposure to increases in energy prices and insurance premiums;
- Increases in workforce productivity;
- Reduced void periods in re-letting buildings;
- Future-proofing against incoming legislative standards.

Environmental benefits

- Reduced carbon emissions;
- Greater biodiversity;
- Better use of water resources;
- Reduced dependence on fossil fuels;
- Reduced use of harmful chemicals in the environment;
- Better use of resources by managing waste;
- A more comfortable internal environment;
- Healthier homes and workplaces.

Heritage benefits

- Improving the aesthetic quality of individual buildings and neighbourhoods, benefiting the whole community;
- Restoring historic building elements, highlighting their importance as part of each building's unique historical journey;
- Creating a sense of place, enhancing the local community's sense of identity and distinctiveness;
- Re-connecting occupants to buildings and to their intrinsic values;
- Ensuring historic buildings can continue to make a positive contribution to the built environment and the local community into the future.

For a typical listed building with a floor area of 350msq (as shown in Figure 8), retrofitting could save about £750 a year on heating and electricity bills. Reduced running costs not only deliver immediate savings but also provide some level of insurance against future increases in energy prices.

Retrofitting can also enhance comfort levels for occupants, because it enables more control over the internal environment, allowing a comfortable temperature to be maintained and draughts and cold spots around windows and doors to be reduced or eliminated. Many of the measures applied to doors and windows will provide the added benefit of reducing exposure to external noise, and the reintroduction of window shutters also has the potential to improve the historic and aesthetic value of the building.

Figure 8: A typical listed building in Soho

Source: Sturgis Carbon Profiling

The introduction of the CRC Energy Efficiency Scheme[19] has provided businesses with additional incentives to undertake retrofitting measures. The scheme incentivises the pursuit of energy efficiency through a combination of financial and reputational penalties imposed on organizations that fail to reduce energy use. In addition to avoiding these penalties, reducing energy consumption by retrofitting property assets may enable businesses to gain competitive advantage through reduced

[19] Department of Energy & Climate Change, 2012

overheads and enhanced sustainability credentials.

Retrofitting also offers a way of improving buildings' Energy Performance Certificate (EPC) ratings. EPCs include generic recommended retrofitting measures and the anticipated resultant improvement in the EPC rating [20]. Identifying and implementing appropriate energy efficiency measures will become increasingly important for owners of properties with F or G ratings as 2018 approaches. As a result of the Energy Act 2011, owners of these properties face losing income after this date, as they will no longer be permitted to rent them out[21].

The benefits of retrofitting buildings extend beyond those experienced by building owners and occupants. Improving the environmental performance of buildings will reduce the need for power generation and for the use of imported oil, gas and coal. The reduced requirements for generation capacity and reduced reliance on overseas energy sources will benefit the UK's wider economy and society. Reduced energy consumption also reduces the amount of fossil fuels burnt and so contributes towards the UK's target for reducing CO_2 emissions.

Retrofitting historic buildings is also inherently sustainable as it conserves the embodied carbon resources used to build them and reduces the need to produce new materials, which in turn avoids the generation of more emissions. Reducing the need for additional new materials has many secondary environmental benefits, such as avoiding the associated damage to people, wildlife and plant species in areas where materials are extracted and manufactured.

---

20 The retrofiting recommendations provided on EPC certificates are generic and may not be appropriate for listed buildings as they may result in damage to historic fabric.

21 Department of Energy & Climate Change, 2011

Case studies

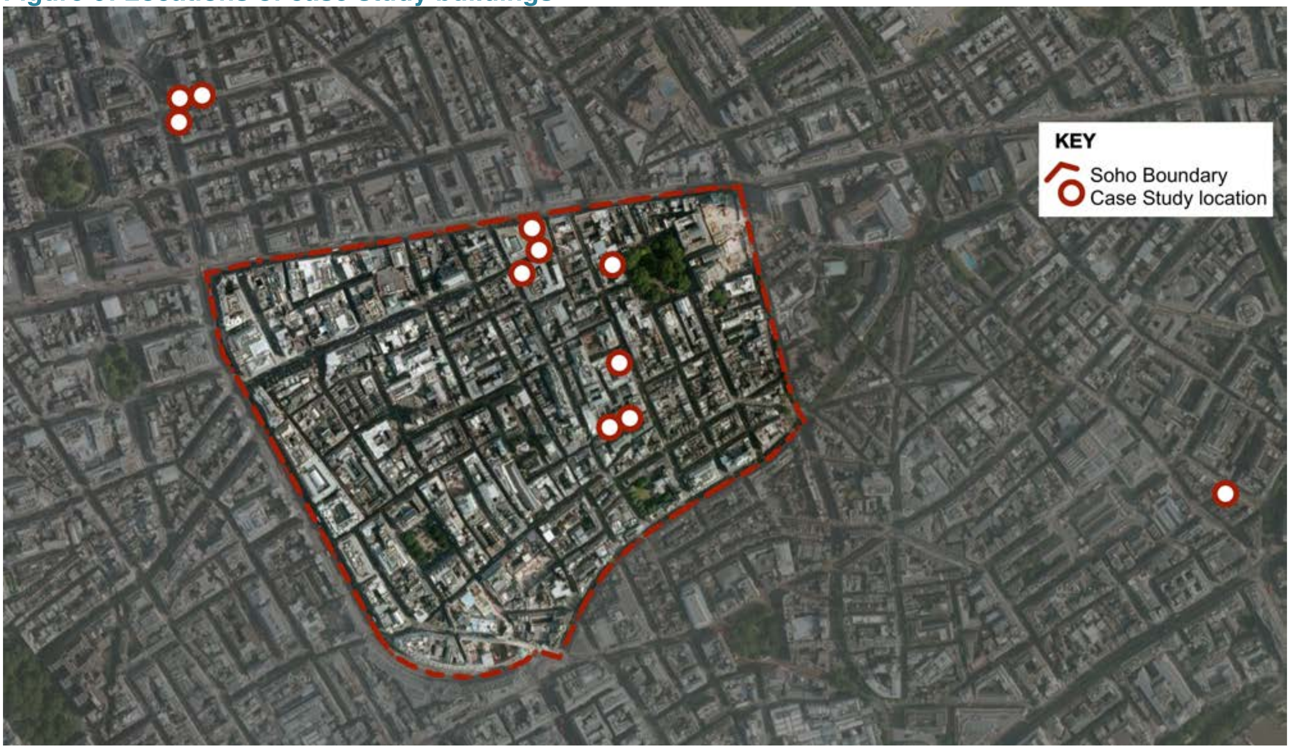
Overview

When looking to retrofit a historic building, it is best to develop a strategy for adapting the whole building if possible, which can involve the use of an Elemental Approach, such as the one set out in the next section. Historic buildings present particular issues when upgrading for improved environmental performance and a strategic approach ensures that these are tackled appropriately without inadvertently building in problems such as damp. This section provides an overview of the main building types in Soho, before setting out an exemplar strategy for retrofitting a historic building and detailing retrofitting strategies for six specific buildings.

Choosing the sample buildings highlighted the role that complexity of tenure can play in inhibiting the retrofitting of buildings, especially when combined with the misalignment of incentives between landlords and tenants. Buildings in a dense inner city area such as Soho often have many distinct holdings within one building envelope – a typical mixed use Soho building will have around five. These holdings are often managed by agents meaning that the owner can have a remote association with their property which may not be conducive to overcoming split incentives or developing an appropriate building strategy.

Although some of the buildings are located outside the Soho Conservation Area itself, they possess many of the characteristics typical of buildings in the area. The measures suggested demonstrate a strategy for the individual building so may not be suitable for all buildings. The range of occupancy, use type and combination of these factors demonstrated by the sample buildings provides the foundations for understanding the adaptation requirements for Soho more widely, giving context for the more general guidance in later sections.

Figure 9: Locations of case study buildings



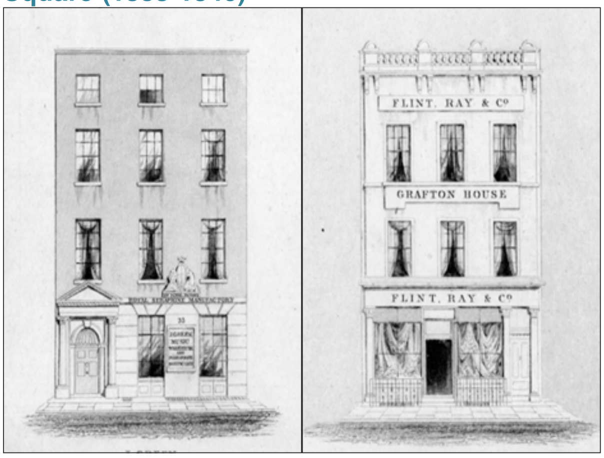
Source: Sturgis Carbon Profiling

Building types in Soho

18th and 19th century housing

These brick built terraces usually have three to four storeys and a basement, linked by vaults under street level. In many cases, brick extensions have been built to the rear. Railed-off light wells separate the front of the buildings from the street and also allow light into the basements. Internally, many of these buildings retain some original panelling, cornices and fireplaces, and the timber sash windows to the front (consisting of multiple panes to the top and bottom sashes).

Figure 10: Extract from Tallis' view of Soho Square (1838-1840)



Source: Westminster Archives Centre

19th century office buildings

These mostly consist of offices on the upper floors with shops at ground level. They tend to have a mixture of brick and stone cladding, with stone faced reveals and one- and two-storey mansards. Many have original timber sash windows. The internal fittings are mostly modern fit-out with plastered walls, suspended ceilings and carpeted floors.

Figure 11: Paramount House

Source: Sturgis Carbon Profiling

20th century office buildings

These mostly consist of concrete or steel framed, faced in stone, with some more decorative glazed brick to some rear facades. Most consist of office space on the upper floors, with the ground floor containing shops. In most cases they are fitted with metal windows with some secondary glazing. The internal fit-out is generally modern with plastered walls and suspended ceilings.

Figure 12: 33 Soho Square

Source: Sturgis Carbon Profiling

Developing a Whole Building Retrofit Strategy

In order to achieve the long-term, cost-effective, environmental performance improvement of a historic building, it is best to consider the building as a whole and develop a strategy for upgrading or adapting it as follows:

Step 1 – Understand the building

Assess and evaluate the following elements of the building:

- its heritage values/significance;
- condition of its fabric and services;
- its energy use relative to occupation and operation;
- the energy performance of the building envelope and its services;
- behaviour of the building fabric in response to heat and moisture; and
- the user requirements and needs.

Step 2 - Identify opportunities

Once you have a good understanding of how the building functions and what parts of it have what type of heritage significance, you can more readily identify what opportunities there are to improve energy efficiency and sustainability, and devise energy conservation measures.

Step 3 - Evaluate effectiveness and value

A range of possibilities may present themselves for improving the environmental performance of the building. The Elemental Approach set out in the later section may have identified several options for action. This step of the strategy involves considering how effective each of those measures will be both in terms of achieving the improvement and providing appropriate value for money.

Step 4 - Assess impact on heritage values/significance

Once you understand why the building is considered to have heritage values/significance it will be easier to assess which measures to take to improve its environmental performance. If a building is listed because of its association with a notable historical figure then original historic features may all be invested with historical as well as aesthetic heritage value meaning that potential for adaptation may be more limited or require more care. Often in conservation areas, a premium is placed on uniformity of external appearance and so adaptations to interiors will be more appropriate. Soho is a more varied conservation area offering a wide range of potential solutions and rewarding careful consideration of the needs of each building.

Step 5 - Assess the technical risks (e.g. increased risk of condensation).

It is essential to avoid creating problems and cost when retrofitting. One of the most common concerns when adapting historic buildings is avoiding a lack of ventilation which can lead to condensation and damp problems. While solutions such as trickle vents have been developed, these can end up being poorly maintained and add to the difficulties and expense of adaptation, when a good assessment of the technical risks would have avoided the need for them in the first place. Understanding when and where to insulate and not to overdo solutions i.e. by draught-proofing windows and putting secondary glazing on them, will avoid this concern.

Step 6 – Implementation and Monitoring

Once the above steps have been taken, an optimum strategy for the adaptation of the historic building will present itself. It is recommended that this is adopted and monitored so that any inefficiency can be improved upon overtime. Monitoring will also ensure that the critical element of maintenance is also covered as this can be responsible for many areas of poor environmental performance such as draughts and leaks.

Permissions and specialist advice

The need for planning permission, listed building consent and specialist advice is considered for each of the retrofitting measures reviewed in this section. However, building owners considering retrofitting measures should always seek advice specific to their own situation, rather than relying solely on general guidance.

Measures affecting the external appearance of the building from the street often require planning permission in Conservation Areas (such as the entire Soho area), but may be regarded as permitted development in other areas. Again, building owners are advised to seek advice relevant to their own situation.

Case study 1	5 Meard Street

Building Description

Designation: Grade II* Listed

Year built: 1734

Three-bay wide four-storey building with basement and three vaults, two under the street in front of the building and one under the yard behind.

Heritage Significance

Evidential and Historical Value

Evidential value is proportional to the age of the material and increases significantly when one of the few or the only record of some aspect of the past. 5 Meard Street derives evidential value from the fact that it and the surrounding buildings are amongst the few remaining examples of the houses people lived in during a specific time in the area's history, hence its status as a II* listed building. Its interior is a rare surviving example of a plan form that holds evidence of the class structures and economic climate prevailing at the time of its construction. As such it could be said to possess Historical Value (and Evidential Value due to its rarity), derived from the ways in which past people, events and aspects of life can be connected through a place to the present.

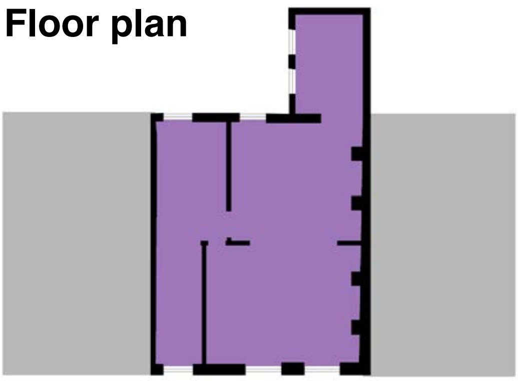
Aesthetic Value

The aesthetic value of the building lies in original features such as extensive areas of panelling and skirting, fireplaces and soffits.

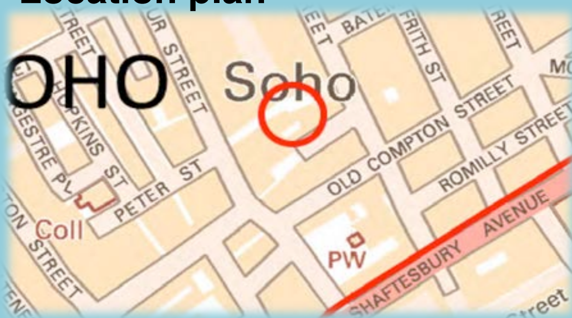
Communal Value

The charming aesthetics of Meard Street, to which the building contributes, and its calmness, relative to the busy roads it connects to, contribute to the communal value inherent in Soho as a whole.

Floor plan



Location plan



5 Meard Street		Impact assessment		
Element	**Retrofit option**	**Heritage value***	**Permission required**	**Advice required**
Roof	**Install improved roof insulation** Additional insulation could be fitted within the roof voids, to which access is already available.	No destruction of historic fabric need arise while installing new roof insulation. Care will need to be taken in the front roof space to avoid damage to the remains of the sleeping attic, comprising lath and plaster finishes and a tiny fireplace, all now in fragile condition.	Planning permission/ listed building consent not normally required unless changing external appearance or modifying structure of roof.	
Windows	**Fit secondary glazing** Secondary glazing could be fitted to the sliding sash windows and secured using the existing staff beads.	Although this would involve removal of the staff beads, the sashes have already been renewed in the 19th century. Even so, this change would require listed building consent.	Listed Building Consent Required. Generally acceptable subject to detailed design.	Architect
Doors	**Fit Insulating curtains to external doors** Insulating curtains could be fitted on portiere rods, helping to reduce draughts and to improve the insulation levels of the doors.	This measure would have little impact on the heritage value of the building.	Not required	
Ventilation and air-tightness	**Fit draught stripping to doors and windows** Self-adhesive compressible or blade draught seals could be fitted to external doors where not already fitted. Sliding sash windows could be improved by fitting brush seals to parting beads and to the top, bottom and meeting rails of sashes.	This will involve minimal alteration to the historic joinery but does not usually require listed building consent. Note: Do not undertake together with secondary glazing to avoid building in damp problems	Not likely to require listed building consent but seek advice for especially important windows.	Architect/ Joiner

5 Meard Street		Impact assessment		
Element	**Retrofit option**	**Heritage value***	**Permission required**	**Advice required**
Ventilation and air-tightness	**Seasonal blocking of flues** Seasonal blocking of the flues would allow ventilation in summer, and prevention in winter could be achieved by inserting balloons into the flues.	Insertion of a chimney balloon would have no impact on the historic fabric.	Not required	
	A hinged register plate may be more convenient where a fireplace is used from time to time in winter.	As this would require slight alteration to the historic fabric of the building, listed building consent would be required.	Listed Building Consent	Architect/ Specialist builder
Low and zero carbon energy	**Install solar panels** Either photovoltaic for generating electricity, which will gain from the feed-in tariffs, or thermal panels for pre-heating water, may be considered.	Listed building consent will be required and will generally be acceptable in discreet locations where not visible from surrounding properties. In this case, the south-facing slope of the central valley is the only suitable installation site.	Listed Building Consent	Architect
Low and zero carbon energy	**Install ground source heat pump** Ground source heat pumps would provide a significant reduction in CO_2 emissions, and the equipment could be placed in the sub-pavement vaults. For efficiency of scale, an installation should be made jointly with adjoining owners.	Listed building consent would be required.	Listed Building	Architect

5 Meard Street		Impact assessment		
Element	**Retrofit option**	**Heritage value***	**Permission required**	**Advice required**
Lighting	**Replace existing light fittings with more energy-efficient LED (light-emitting diode) lighting**	If the existing wiring routes and light fitting positions were retained, then no loss of historic fabric would result. Close consideration of the position of some fittings may, in fact, allow some existing interventions to historic fabric to be reversed.	Listed Building Consent	Electrician
Heating and hot water	**Install new boiler and heating controls** Installation of a modern high efficiency boiler coupled with advanced heating control could reduce energy consumption	This measure should have little impact on the heritage value of the building. If any additional pipework needs to be installed or any alteration to the fabric of the building (such as a flue) is required then Listed Building consent should be sought.	Listed Building Consent may be required	M&E Engineer

Case study 2

82 Mortimer Street

Building Description

Designation: Grade II Listed

Year built: c.1900

A former dentist's surgery, now disused. Brick with stone facing and figures on front façade at first floor level. Four stories with a shop at ground floor, mansard roof and basement.

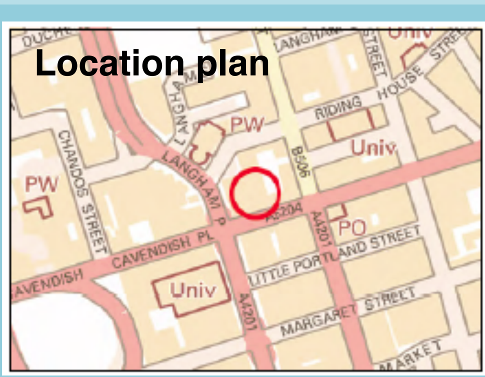
Heritage Significance

Historical and Evidential Value
The ornate detailing of the stone façade is typical of the turn of the century, as is the combination of commercial space on the ground floor with residential accommodation on the upper floors.

The building has many original internal features, including the cast iron grate in the ground floor fireplace, the slate floor in the ground floor lobby, floor-to-ceiling timber framed windows to the front façade on the first floor and timber framed casement windows on the second and third floors.

Aesthetic and Communal Value
The stone façade adds richness and diversity to the predominantly brick-fronted building line. However, the aesthetic value of the building is compromised by the unused shopfront at ground floor level whist the building is vacent during its redevelopment. Bringing the building back into active use would also potentially offer communal value.

Floor plan



82 Mortimer Street		Impact assessment		
Element	**Retrofit option**	**Heritage value***	**Permission required**	**Advice required**
Roof	**Install improved roof insulation** Improved insulation can be fitted in the roof void to the upper part of the mansard, and to the steeper lower part. The latter will involve removal and refixing of either internal finishes or external slating and, from an economic standpoint, should be combined with other refurbishment works.	The existing suspended ceilings make it impossible to say whether there will be any loss of historic fabric in giving access to the main roof void. However, from a pragmatic standpoint it would be highly beneficial to create roofspace access if it does not already exist.	Planning permission/ listed building consent required if changing external appearance or modifying roof structure.	
Walls	**Insulation to all external walls** Much of the internal wall plaster is in poor condition, and there is no panelling. A number of cornices remain, as do door and window architraves. While it would be possible to apply thin insulation to the inside face of the external walls, any improvement will sadly be marginal, and on balance this is not recommended.	The negative impact on the heritage value of the building would outweigh the improvement gained by this measure and it is not recommended.		
Windows	**Fit secondary glazing** Already fitted in some windows, secondary glazing could be extended throughout the building, set within the frames of the casement windows to the front and the positions of the staff beads to the rear.	This change would require Listed Building Consent. Generally acceptable subject to detailed design.	Listed Building Consent	Architect

82 Mortimer Street		Impact assessment		
Element	**Retrofit option**	**Heritage value***	**Permission required**	**Advice required**
Ventilation and air-tightness	**Fit draught stripping to doors and windows** Self-adhesive compressible or blade draught seals can be fitted to external doors and casement windows where not already fitted. Sliding sash windows can be improved by fitting brush seals in place of existing parting beads and to the top, bottom and meeting rails of sashes.	Listed building consent would not be required for work to external doors and casement windows where self-adhesive seals are added. Fitting seals to sash windows will involve (minimal) alteration to the historic joinery but does not usually require listed building consent. Note: do not undertake together with secondary glazing to avoid building in damp problems.	Not required Not likely to require listed building consent but seek advice for especially important windows.	Architect/ Joiner
Ventilation and air-tightness	**Seasonal blocking of flues** Summer ventilation through redundant fireplaces and chimneys could be controlled in winter by inserting balloons. The high level vents fitted in some rooms should have hit-and-miss cover plates installed, attached to the existing timber surrounds.	Insertion of chimney balloons would have no impact on the historic fabric and therefore would not need listed building consent. A hinged register plate would require some slight alteration to the historic fabric. Listed building consent not usually required but depends what is proposed.	Listed Building Consent may be required	Architect/ Specialist Builder
Low and zero carbon energy	**Install solar panels** Possible but subject to ensuring they are positioned in a descreet location.		Listed Building Consent required. Will be acceptable in a discreet location, where not visible from surrounding properties.	Architect

82 Mortimer Street		Impact assessment		
Element	**Retrofit option**	**Heritage value***	**Permission required**	**Advice required**
Low and zero carbon energy	**Install ground source heat pump** Ground source heat pumps would provide a significant reduction in CO_2 emissions, and the equipment could be placed in the sub-pavement vaults. For efficiency of scale, an installation should be made jointly with adjoining owners.	Listed building consent would be required.	Listed Building Consent	Architect
Lighting	**Replace existing light fitting with more energy-efficient LED lighting** This could be combined with removal of the suspended ceilings on the upper floors, which would be an improvement.	If the existing wiring routes were retained, there would be no loss of historic fabric.	Not required	Electrician
Heating and hot water	**Install new boiler and heating controls** A modern high efficiency boiler and advanced heating control could reduce energy consumption.	This should have little impact on the heritage value of the building. If additional pipework or any alteration to the fabric of the building is required (such as a flue), Listed Building consent should be sought.	Listed Building Consent may be required	M&E Engineer/ Architect
Façade	**Install new shop front** This could improve both thermal performance and heritage value. Ideally, and depending upon the next use of the building, it could be combined with refurbishment of the existing entrance lobby and upgrading the glazed roof to the first floor lobby.	Detailed planning and listed building consent would be required.	Planning Permission and Listed Building Consent required	Architect

Case study 3

17 Meard Street

Building Description

Designation: Grade II* Listed

Year built: 1722

A private single family residence. The original dog-leg stairs remain and have been refurbished. The rear elevation has been refaced with 19th century brick. The top (third) floor is a later addition and there is a flat roof above. A single vault under the road is accessed from the front of the house; another seems to have been lost.

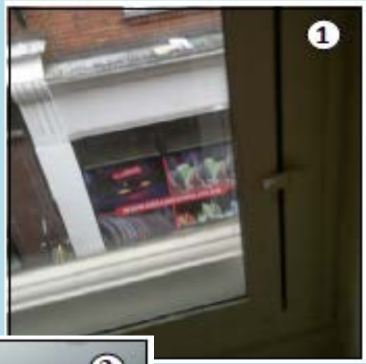
Heritage Significance

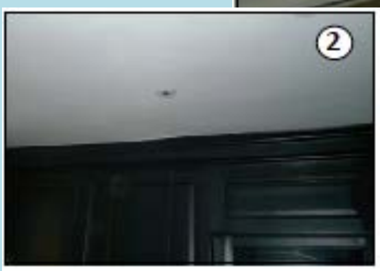
Historical and Evidential Value

This row of terraces built by the carpenter John Meard are amongst the earliest surviving buildings in London. In the 19th century, this building is believed to have been occupied by several families, including 36 persons in all. It was later used as a brothel in the 20th century until purchased by its present owner.

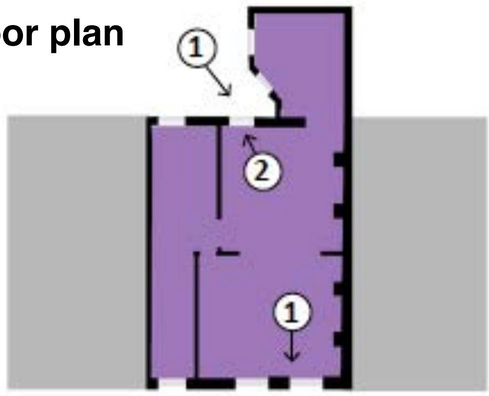
Aesthetic and Communal Value

The aesthetic value derives partly from the uniform regularity of the terrace and high standards of maintenance. Small pedestrianised streets also have great aesthetic and communal value in heavily trafficked areas.

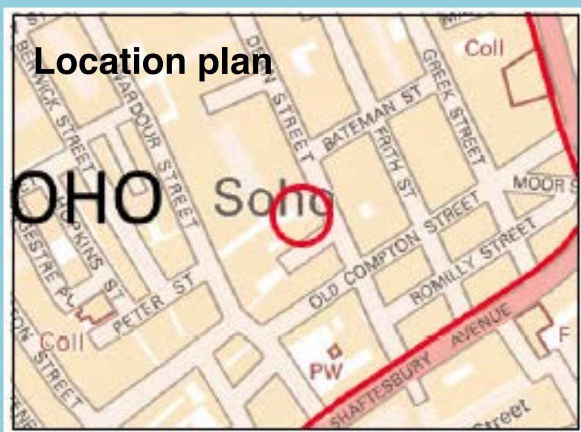




Floor plan



Location plan



17 Meard Street		Impact assessment		
Element	**Retrofit option**	**Heritage value***	**Permission required**	**Advice required**
Roof	**Install improved roof insulation** Improved insulation can be fitted in the roof voids, to which access is already available.	No destruction of historic fabric will arise from this work, although care will need to be taken in the front roof space to avoid damage to the remains of the sleeping attic, comprising lath and plaster finishes and a tiny fireplace, all now in fragile condition.	Planning permission/ listed building consent not normally required unless altering roof appearance or structure.	Architect/ Specialist Builder
Windows	**Fit secondary glazing** Secondary glazing can be fitted within the position of the staff beads to the sliding sash windows, where this has not already been done.	While this will involve the removal of the staff beads, it should be noted that the sashes have already been renewed in the 19th century. This change would require listed building consent.	Listed Building Consent required. Generally acceptable subject to detailed design.	Architect/ Joiner
Doors	**Fit insulating curtains to doors** These can be fitted on portiere rods and will help reduce draughts as well as improving the insulation levels of the doors. Depending on the choice of curtain fabric, they can also be highly decorative.	This measure would have little impact on the heritage value of the building	Not required	
Lighting	**Replace existing light fitting with more energy-efficient LED (light-emitting diode) lighting**	If existing wiring routes and light fitting positions were retained, no loss of historic fabric would result. Careful positioning of some fittings may, in fact, allow the reversal of some existing interventions to historic fabric.	Listed Building Consent required	Electrician

17 Meard Street		Impact assessment		
Element	**Retrofit option**	**Heritage value***	**Permission required**	**Advice required**
Ventilation and air-tightness	**Fit draught stripping to doors and windows** Self-adhesive compressible or blade draught seals can be fitted to external doors and casement windows where not already fitted. Sliding sash windows can be improved by fitting brush seals in place of the existing parting beads and to the top, bottom and meeting rails of the sashes.	Listed building consent would not be required for work to external doors and casement windows where self-adhesive seals are added Fitting seals to sash windows will involve (minimal) alteration to the historic joinery but does not generally require listed building consent. Note: Not together with secondary glazing to avoid damp problems	Unlikely to require Listed Building Consent, but seek advice for especially important windows.	Architect/ Joiner
Ventilation and air-tightness	**Seasonal blocking of flues** Allowing ventilation in summer, and preventing it in winter, could be achieved by inserting balloons into the flues of unused fireplaces and chimneys. A hinged register plate may be a more convenient alternative where a fireplace is used from time to time during the winter.	Insertion of chimney balloons would have no impact on the historic fabric and therefore would not need listed building consent. A hinged register plate would require some slight alteration to the historic fabric of the building. Listed building consent not usually required but depends on what is proposed.	Listed Building Consent may be required	Architect/ Specialist Builder
Low and zero carbon energy	**Install solar panels** Either photovoltaic or thermal panels could be installed. The former would perhaps be easier to install and, by generating electricity, would deliver benefits from feed-in tariffs. The latter would be used for pre-heating water.	Listed building consent would be required, and would only be granted for those in a discreet location and not visible from surrounding properties. In this case, this may be difficult to achieve with the modern flat roof.	Listed Building Consent required and will be acceptable in a discreet location where not visible from surrounding properties.	Architect

17 Meard Street		Impact assessment		
Element	**Retrofit option**	**Heritage value***	**Permission required**	**Advice required**
Low and zero carbon energy	**Install ground source heat pump** Ground source heat pumps would provide a significant reduction in CO_2 emissions, and the equipment could be placed in the sub-pavement vaults. For efficiency of scale, an installation should be made jointly with adjoining owners.	Listed building consent would be required.	Listed Building Consent required	Architect
Heating and hot water	**Install new boiler and heating controls** A modern high efficiency boiler and advanced heating control could reduce energy consumption.	This measure should have little impact on the heritage value of the building. If any additional pipework needs to be installed or any alteration to the fabric of the building is required (such as a flue) then Listed Building consent should be sought.	Listed Building Consent may be required	M&E Engineer/ Architect

Case study 4

36-38 Tavistock Street

Building Description

Designation: Grade II Listed

Year built: 1733

Mid-terrace properties of typical late 18th and early 19th century appearance, consisting of basement, ground floor and three upper storeys. The upper floors have been re-planned so they are all accessed off the staircase in no 36. The basement, ground floor and rear part of the first floor are used as a restaurant.

Heritage Significance

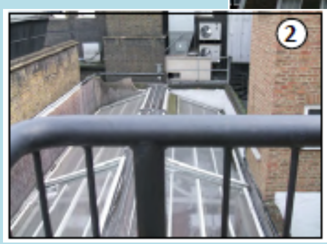
Historical and Evidential Value

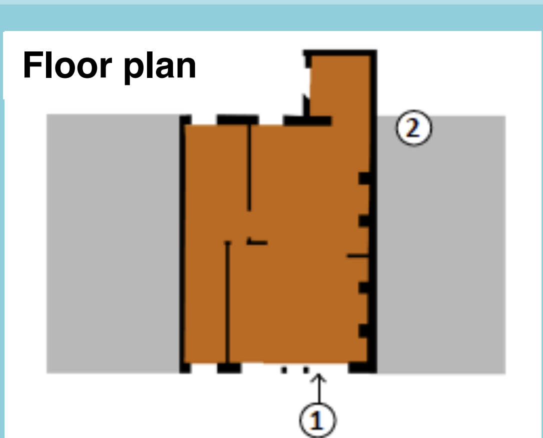
The blue plaque on the façade of this building indicates that Thomas de Quincey (1785-1859) wrote his celebrated novel, *Confessions of an English Opium Eater*, while lodging at No. 36.

Original internal features include panelling on walls of the staircase and timber sash windows.

Aesthetic Value

The consistent harmonious line of the terrace, together with the diversity of ground floor commercial uses, is the main source of aesthetic value. This area benefits from a wide selection of small shops and restaurants housed in buildings of a similar type, and this feature helps to sustain the importance of the area as a tourist attraction and its value to the wider community.





36-38 Tavistock Street		Impact assessment		
Element	**Retrofit option**	**Heritage value***	**Permission required**	**Advice required**
Roof	**Install improved roof insulation** Between rafters or joists supporting the roof, especially around the rebuilt roof of the third floor flat and in the roof terrace, which also acts as the roof to the second floor rear extension. Would require removal of internal finishes, and should be left until major refurbishment planned.	No destruction of historic fabric need take place when roof insulation is installed, although internal finishes will need to be replaced.	Listed Building Consent may be required	
Roof	**Replace glazed roof to restaurant first floor** Fully openable double glazing (which will still require space heating in winter), or a heavily insulated solid roof with limited double glazed openings would improve performance. May make air conditioning redundant.	Either of these approaches will require listed building consent and, possibly, planning permission; however, the new roof could be designed to meet all present and planned requirements of the building regulations. Note that noise concerns may lead to a condition for sealed windows.	Planning permission/ listed building consent needed if altering external appearance or modifying	Architect
Basement	**Improve air circulation** By bringing cool air in from front and rear areas. Natural ventilation aided by an extractor fan would be preferable to an air-conditioning unit.	Installing a fan may, depending upon location, require planning and listed building consent as well as an acoustic report.	Listed Building Consent & Planning Permission may be needed	Architect
Basement (kitchen)	**Install system for heat recovery from kitchen** A system of this type could provide heating for the upper floor flats in winter, or hot water throughout the year.	A heat recovery system will need specialist design and, depending on the scale and location of the plant, may require listed building and planning consent, as well as an acoustic report.	Listed Building Consent & Planning Permission may be needed	Architect

36-38 Tavistock Street		Impact assessment		
Element	**Retrofit option**	**Heritage value***	**Permission required**	**Advice required**
Basement (kitchen)	**Induction hobs** May create less heat in kitchens and generate less CO_2 than the present gas hobs, and should be fitted when kitchen is next refurbished.	This measure should have no impact on the historic fabric of the building	Not required	
Lighting	**Replace existing light fittings with more energy efficient LED (light-emitting diode) lighting**	No loss of historic fabric if existing wiring routes and light fitting positions are retained. Careful positioning of some fittings may allow reversal of existing interventions to historic fabric.	Listed Building Consent may be needed	
Low and zero carbon energy	**Install solar panels** May be possible on south-facing slopes not visible from street or rear (in this case, the south-facing slope to the central valley). Either photovoltaic cells, generating electricity and feed-in tariffs, or thermal panels to heat water.	Listed building consent would be required and would only be granted for installations in a discreet location where not visible from surrounding properties.	Listed Building Consent	Architect
Low and zero carbon energy	**Install ground source heat pump** This would significantly reduce CO2 emissions, and could be installed at basement level. Well suited to the scale of the building and could be optimised further by working with adjoining owners.	Listed building consent would be required.	Listed Building Consent required.	Architect

Case study 5

Albany House, 314-326 Regent Street

Building Description

Designation: Grade II Listed

Year built: 1925

A seven-storey corner office block with a shop at ground level and an adjoining five-storey block in Mortimer Street. Brick built with a section of glazed white bricks to the rear stairwell. Modern office fit-out throughout. Stone facing to street elevations, double mansard with dormers and slate coverings to corner block, and asphalt-covered flat roofs above. Metal framed windows to corner block, large sliding sashes to Mortimer Street block. We only visited a typical upper floor in the corner block.

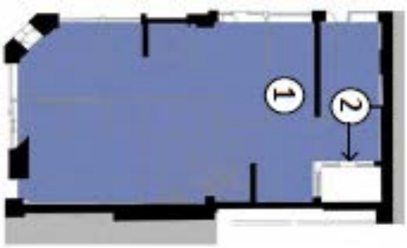
Heritage Significance

Historical and Evidential Value
This building is typical of the early 20th century commercial developments around Oxford Street and, like other buildings in the area, evokes the splendour and confidence of the era. Built in a classical style with Beaux Arts details, it has retained elements of pilaster frames under entablature features on the ground floor despite the introduction of more modern shopfronts.

Aesthetic and Communal Value
Corner sites play an important role in defining the townscape and creating landmarks to help people navigate their way around unfamiliar parts of the city. Having a distinctive building at this junction therefore has a communal as well as an aesthetic function.

Ground floor commercial activities also have communal value, providing an active street frontage as well as services to visitors and local residents.

Floor plan



Location plan

Albany House		Impact assessment		
Element	**Retrofit option**	**Heritage value***	**Permission required**	**Advice required**
Roof	**Install improved roof insulation to the mansard and dormers** Insulation should be fitted into the gaps between the rafters forming the structure, and should be combined with renewal of the roof coverings, when next required.	No destruction of the historic fabric will result from this measure.	Planning Permission/ Listed Building Consent required only if altering external appearance or roof structure.	
Roof	**Improve insulation to flat roofs** This is probably best done at the same time as renewing asphalt coverings, using a rigid insulation, laid to falls.	Since this would raise the roof level slightly, the access doors will need alteration, and so listed building consent would be required.	Listed Building Consent required.	Architect/ Specialist Builder
Windows	**Install secondary glazing** Installed within the depth of the plastered linings to the openings, where not already fitted to the stairwell.		Listed Building Consent required. Generally acceptable subject to detailed design.	Architect/ Specialist Builder
Lighting	**Install LED lighting** Combined with removal of the modern suspended ceilings, which would also permit enjoyment of the proper ceiling height within the rooms.	There would be no loss of historic fabric if existing wiring routes and light fitting positions are retained.	Listed Building Consent may be required	
Heating and hot water	**Install new boiler and heating controls** Installation of a modern high efficiency boiler and advanced heating control could reduce energy consumption.	Listed building consent would be required for alterations to the fabric such as a flue.	Listed Building Consent may be required	M&E Engineer/ Architect

Albany House		Impact assessment		
Element	**Retrofit option**	**Heritage value***	**Permission required**	**Advice required**
Ventilation and air tightness	**Draught stripping doors and windows** Self-adhesive compressible or blade draught seals can be fitted to external doors and casement windows where not already fitted. Sliding sashes in the Mortimer Street block can be improved by fitting brush seals in place of parting beads and to the top, bottom and meeting rails of sashes.	Listed building consent would not be required to fit draught seals. Fitting brush seals to sliding sashes will involve minimal alteration to the historic joinery, but does not usually require listed building consent. Note: do not undertake together with secondary glazing to avoid building in damp problems	Listed building consent not usually required but seek advice for especially important windows	Joiner
Low and zero carbon energy	**Install ground source heat pump** This would significantly reduce CO2 emissions, and could be installed at basement level. The scale of the building is well suited to such an installation, and might be optimised further by working with adjoining owners.	Listed building consent would be required.	Listed Building Consent required.	Architect
Ventilation and air tightness	**Remove free-standing air-conditioning units** This will do much to reduce CO2 emissions. Better ventilation (making windows easier to open, possibly using desk and ceiling fans, and increasing ceiling height by removing suspended ceilings), and reducing solar gain (installing better blinds), may be needed to create a comfortable working environment.	None of these changes will require listed building consent.		

Case study 6

42 Tavistock Street

Building Description

Designation: Grade II Listed

Year built: 1830-40

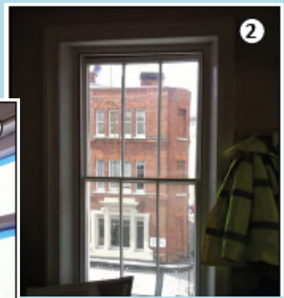
A corner site at the end of a terrace. The upper floors of the building (first, second, third and fourth floor mansard attic room) were converted from Residential use to Offices in 2011. The ground floor is used as a café, with kitchens and stores in the basement. It has been replanned to leave a single room per floor.

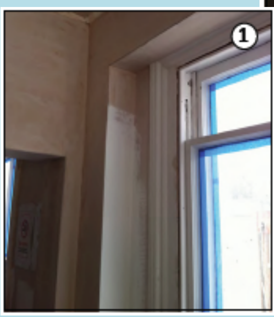
Heritage Significance

Historical and Evidential Value
The building features an original wooden shop front with a panelled and glazed door flanked by display windows and returned, with pilasters carrying entablature-fascia with projecting cornice. The upper floors have recessed glazing bar sashes in stucco architraves.

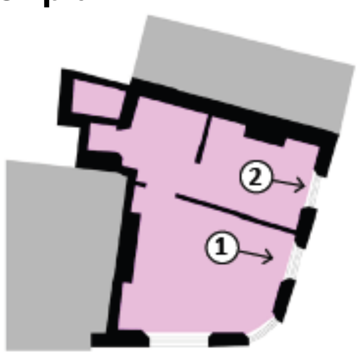
Aesthetic and Communal Value
Corner sites play an important role in defining the townscape and creating landmarks to help people navigate their way around unfamiliar parts of the city. Having a distinctive building at this junction therefore has a communal as well as an aesthetic function.

Ground floor commercial activities also have communal value, providing an active street frontage as well as services to visitors and local residents.





Floor plan



Location plan

42 Tavistock Street		Impact assessment		
Element	**Retrofit option**	**Heritage value***	**Permission required**	**Advice required**
Roof	**Install improved roof insulation** Improved insulation can be fitted within the roof voids, to which access is already available.	No destruction of the historic fabric will result from this.	Not required unless altering external appearance or structure.	
Windows	**Install secondary glazing** Secondary glazing can be fitted within the position of the staff beads to the sliding sash windows, where not already done.	While this will involve the removal of staff beads, the sashes have already been renewed in the 19th century. Listed building consent required.	Listed building consent required. Generally acceptable subject to detailed design.	Joiner
Lighting	**Change to more energy-efficient LED (light-emitting diodes) lighting**	No loss of historic fabric if existing wiring routes and light fitting positions are retained. Consideration of the position of some fittings may even allow some existing interventions to historic fabric to be reversed.	Listed Building Consent may be required	
Ventilation and air tightness	**Seasonal blocking of flues** Inserting balloons into flues would allow ventilation in summer, and prevent it in winter. A hinged register plate may be more convenient where a fireplace is used at times in winter.	Chimney balloons would have no impact on the historic fabric. A hinged plate would require some slight alteration to the historic fabric of the building, It is unlikely to require listed building consent but depends on what is proposed.	Listed Building Consent may be required	Architect/ Specialist Builder
Windows	**Double glazing for café windows** Existing joinery should remain intact except for any deepening of rebates needed to hold sealed units.	Listed building consent would, be required. Double glazing not generally acceptable.	Listed Building Consent will be required and likely to be controversial.	Joiner

42 Tavistock Street		Impact assessment		
Element	**Retrofit option**	**Heritage value***	**Permission required**	**Advice required**
Low and zero carbon energy	**Install solar panels** Photovoltaic panels for generating electricity, which will gain from the feed-in tariffs, or thermal panels for pre-heating water could be used. The former may be easier to install.	Listed building consent will be required, and will only be granted for installations in a discreet location where not visible from surrounding properties.	Listed Building Consent required	Architect
Ventilation and air tightness	**Draught stripping doors and windows** Self-adhesive compressible or blade draught seals can be fitted to external doors where not already fitted, and brush seals to the parting beads and to the top, bottom and meeting rails of the sashes of sliding sash windows.	This will involve minimal alteration to the historic joinery, but does not usually require listed building consent. Note: do not undertake together with secondary glazing to avoid building in damp problems	Not usually required but seek advice for especially important windows.	Joiner
Low and zero carbon energy	**Install ground source heat pump** This would provide a significant reduction in CO_2 emissions, and the equipment could be placed in the sub-pavement vaults. For efficiency of scale, an installation should be made jointly with adjoining owners.	Listed building consent would be required.	Listed building consent required.	Architect/ M&E Engineer
Ventilation and air tightness	**Install draught lobby at ground floor level** This should be planned to serve both the upper floor offices and the café, to enable energy savings in winter.	This will require listed building consent, and careful design to suit the existing historic joinery without requiring its alteration.	Listed Building Consent required	Architect

Guidance: The Elemental Approach

Overview

This section of the guidance looks at each of the following elements of building fabric and services in turn:

- Building Envelope
- Walls
- Floors
- Roof
- Windows
- Water
- Metering
- Cooling
- Ventilation
- Heating & Hot Water
- Power
- Lighting
- Biodiversity

For each element, a 'base case' is specified, against which the energy and financial performance of various retrofitting options are evaluated (an example is given in Figure 13).

Some measures are technically complex and require specialist advice. For example, an archaeological investigation and ground conditions survey would be needed before installing a ground source heat pump. This technology is most effective when combined with underfloor heating and large radiators, and so may need to form part of a wider programme of refurbishment works. Insulation and draught proofing involves some relatively simple measures, but reduces the permeability of the building envelope and can lead to condensation and mould if carried out without specialist advice.

Other measures involve physical constraints that may make them unsuitable for certain buildings. For example, rainwater harvesting requires a substantial area of roofspace, while solar panels need to be mounted on a suitable surface and, on Listed Buildings, so as to avoid any damage to historic fabric.
The properties of building fabric components vary widely between buildings and so the savings achievable for specific buildings may differ from those quoted here.

Subsidies

Appendix 1 gives further details of subsidies available, although most only apply in specific circumstances. The availability and level of subsidies can both change rapidly, being dependent on government policy and, in the case of some schemes, the amount of funds remaining in the scheme's subsidy budget.

The Warm Front Scheme provides up to £3,500 for people living on benefits in badly insulated homes or without working central heating. Funding may cover measures such as improved loft insulation, draught proofing and high efficiency heating and hot water. Warm Front Assessors decide upon the most suitable measures on an individual basis.

The *Feed In Tariff Scheme* provides a 'generation tariff' for each unit of electricity generated through solar photovoltaic cells or micro CHP units (of 2kW or less), and an extra 'export tariff' for each unit exported to the National Grid. Although the level of tariff for PV cells was reduced in April 2012, the Energy Savings Trust has estimated that the typical domestic system could earn £570 per year even under the lower tariff.

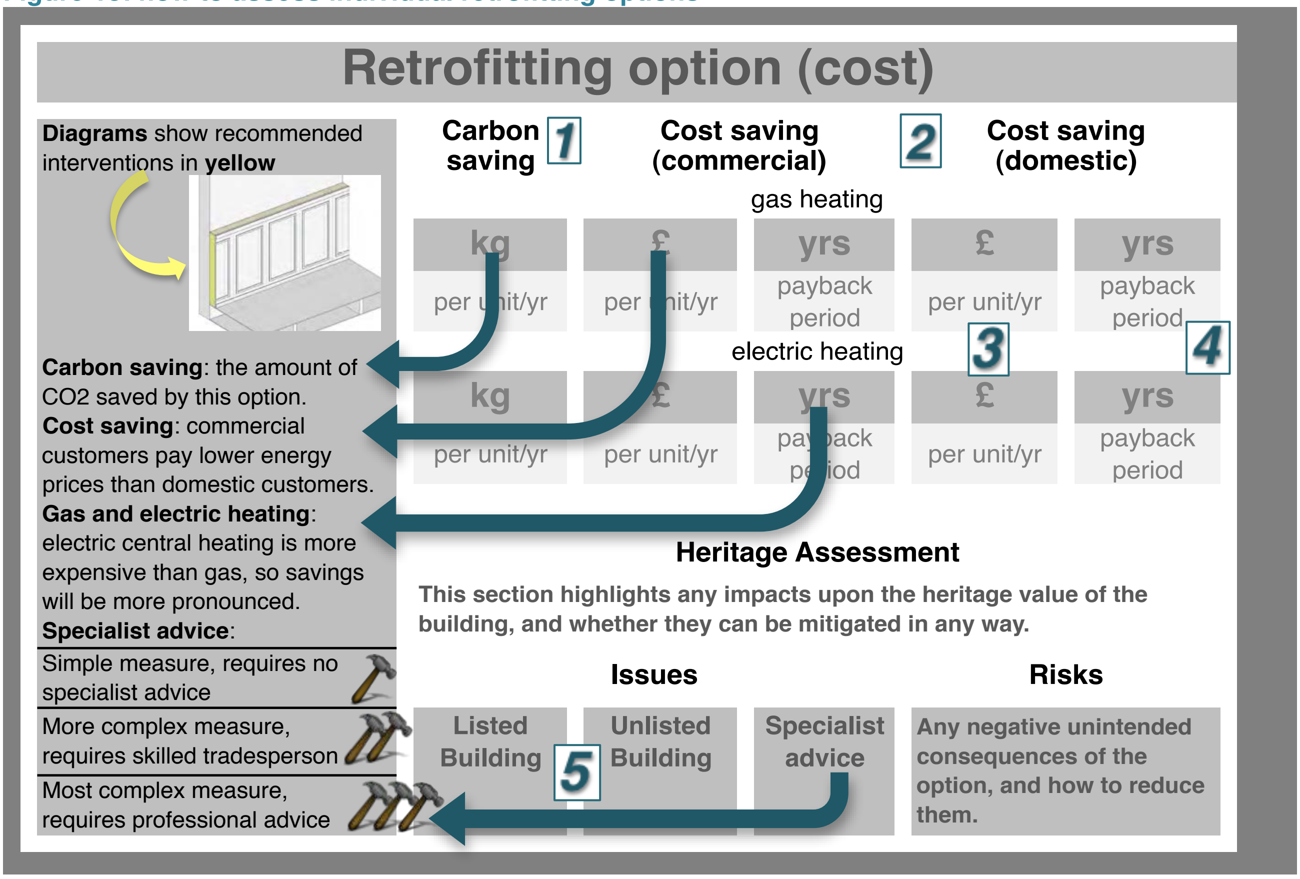
Under the *Enhanced Capital Allowance*, businesses can write off their capital investment in plant and machinery (such as new heating and hot water systems) against taxable profits. This may help to shorten payback periods and improve cash flow.

The *Green Deal*, expected in Autumn 2012, will allow private companies to offer energy efficiency improvements and recoup the costs through energy bills.
Renewable Heat Premium Payments are provided for solar thermal panels (£300) and heat pumps (£850-£1,250), but the latter do not apply where gas central heating is used. Both also attract *Renewable Heat Incentive* payments (similar to the Feed In Tariff).

Figure 13 illustrates how the indicative costs and benefits of each option are presented, based on a typical building with total internal floor area of 350 square metres (msq) over five floors. Specific points to note are:

1. For each measure, carbon savings are based on the amount of gas or electricity saved, using standard conversion factors to calculate the associated carbon dioxide emissions (the conversion factors are recommended by DEFRA and are 0.206kgCO2e/kWh for gas and 0.591kgCO2e/kWh for electricity);
2. Cost savings also depend upon whether the heating system uses gas or electricity, and on whether a commercial or a domestic tariff applies. The calculations in this report are based on assumed prices for gas of £0.08/kWh (domestic) and £0.05/kWh (commercial), and for electricity of £0.15/kWh (domestic) and £0.12/kWh (commercial). Gas central heating is significantly cheaper than electric, and commercial tariffs are lower than domestic ones. In both instances, the cost savings achievable from retrofitting measures is more pronounced in the more expensive case;
3. Costs and benefits are given per unit (in most cases, per square metre) and year, so that building owners can make specific calculations relevant to their own case; *Inclusions* – Materials, labour, temporary works, making good, sub contractor management, energy bill savings *Exclusions* – Indirect costs such as loss of lettable area, costs of disruption whilst carrying out works and subsidies due to their variable nature, ongoing maintenance costs.
4. The payback period is the total cost divided by the annual cost savings;
5. Issues associated with planning permission, Listed Building Consent and heritage impact are considered here.

Figure 13: how to assess individual retrofitting options



Source: Sturgis Carbon Profiling

Further details of the modelling process used to quantify costs and benefits are provided in Appendix 3. Costs are 2011 estimates.

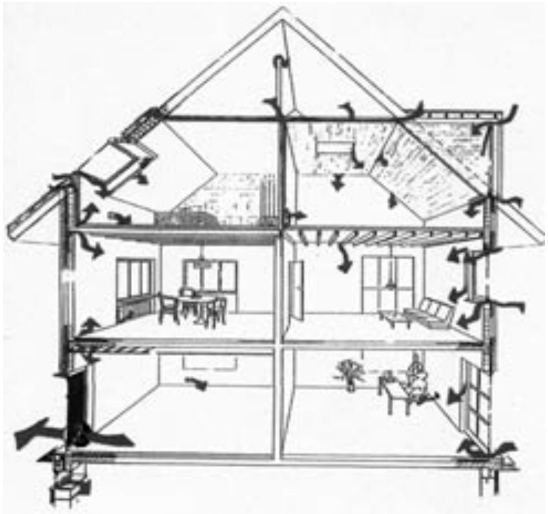
Grid decarbonization will impact on these figures by reducing the carbon savings and making the financial savings larger.

Base case: A typically non draught proofed building

Draughts can cause up to 20% of the total heat lost in older homes, and can also lead to health problems for occupants.

Draught proofing is one of the cheapest and most cost-effective ways of improving energy performance. It requires little or no specialist skills or equipment.

If draught proofing is only partially complete, air leakage will just increase from the untreated areas to cancel out the effects of the improvements elsewhere. To prevent this occuring, a complete package of draught proofing measures should be carried out simultaneously.



Removing draughts should be the first measure to consider in retrofitting historic buildings.

Issues			Risks
Listed Building	Unlisted Building	Specialist advice	Draughty buildings can lead to health problems such as chills and are often felt to be cold and uncomfortable.

Draught proofing (cost £30-£50/msq)

(may qualify for Warm Front Scheme)

Draught proofing measures should include:

- closing existing holes in building walls (including those covered by internal panelling) with insulant and draught stripping all apertures;
- closing up any holes around pipes coming into the building;
- closing up any holes in the roof or eaves (maintaining background ventilation to these areas);
- draught stripping loft hatches;
- closing up gaps in suspended wooden floors over the ground;
- controlling air leakage from the chimney.

	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	11.25kg per msq/yr	£2.18 per msq/yr	18.3yrs payback period	£2.73 per msq/yr	14.7yrs payback period
electric heating	29.08kg per msq/yr	£5.90 per msq/yr	6.8 yrs payback period	£7.38 per msq/yr	5.4 yrs payback period

Heritage Assessment

Draught proofing has very little impact on the heritage value of the building if the materials used are similar to the existing materials.

Issues			Risks
Listed Building none	Unlisted Building none	Specialist advice none	Reduced air permeability can lead to mould growth. Ensure background ventilation to all voids is retained.

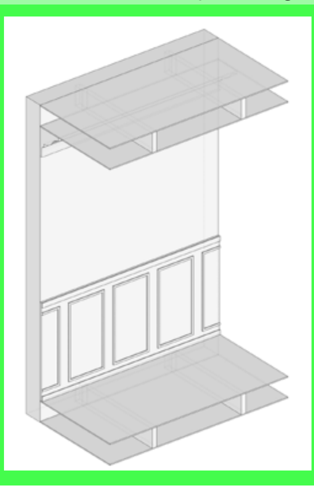
Examples

			Complexity	Suggestion
Testing: Discovering where the draughts are should be the first priority. Smoke or air pressure tests are recommended.			Simple.	Buy a smoke pencil to find out where the draughts are. This can be done as a DIY measure. Cost c.£30.
Walls: Closing up holes around pipework, sockets, lights and cable entry points.			Simple.	Repeat air or smoke tests when major holes have been closed as others will then be visible.
Chimney: Install chimney balloon or closing baffles			Simple.	DIY
Windows: Fit brush seals around sashes and ensure architraves are sealed to walls			Requires a joiner or sash window refurbishment company to install.	Avoid using adhesive strips. Brush seals incorporated as part of the staff beads provide the best performance.
Roof: Access hatches and eaves			Simple.	DIY

Base case: single skin London Stock brick

The base case is a brick wall, about 9-15 inches thick (22-38cm). It may be rendered externally and have panelling or plaster finishes internally.

Single skin walls are typical of 18th and 19th century buildings.



Examples of typical walls in Soho

Issues			Risks
Listed Building	Unlisted Building	Specialist advice	Uninsulated single skin walls are a major source of heat loss from buildings.

Option 1: Insulation behind existing panelling (cost £110-£160/msq) (may qualify for Warm Front Scheme)

Install mineral wool batten 50mm thick where possible behind existing panelling.

A modest amount of dismantling and reinstatement of existing panelling is required.

	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	5.23kg per msq/yr	£1.02 per msq/yr	133yrs payback period	£1.27 per msq/yr	106yrs payback period
electric heating	13.5kg per msq/yr	£2.75 per msq/yr	49yrs payback period	£3.44 per msq/yr	39yrs payback period

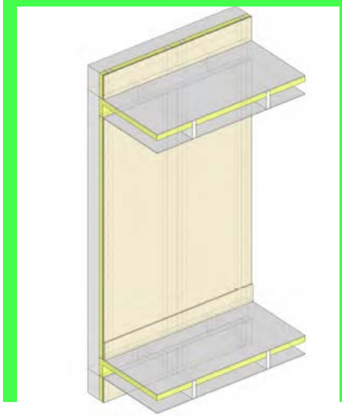
Heritage Assessment

This option has the least impact on the building and could be undertaken at the same time as draught proofing measures. All due care must be taken in disassembling the panelling to avoid damaging original fabric.

Issues			Risks
Listed Building Approval required	Unlisted Building Approval not required	Specialist advice Joiner	Careful disassembly of panelling is recommended to avoid damaging historic features.

Option 2: internal insulation, high efficiency rigid (cost £80-£100/msq) (may qualify for Warm Front Scheme)

High efficiency ridged polyurethane boards (60mm deep), built out with studs and plastered over. The floor joist end should also be treated, and insulation run through the floors and back along party walls to prevent cold bridging.



	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	6.3kg per msq/yr	£1.22 per msq/yr	73 yrs payback period	£1.53 per msq/yr	59 yrs payback period
electric heating	16.3kg per msq/yr	£3.31 per msq/yr	27 yrs payback period	£4.14 per msq/yr	22 yrs payback period

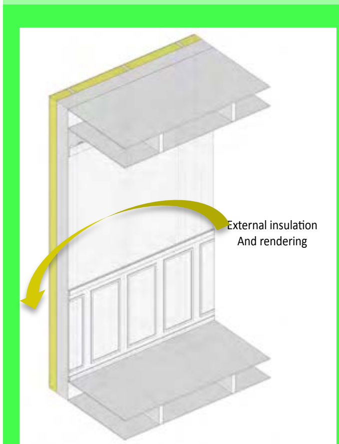
Heritage Assessment

Various historical, evidential and aesthetic impacts need to be considered with reference to the surface being covered and damage by fixings to the original walls behind. Only recommended where most internal original features have been lost.

Issues			Risks
Listed Building Approval required	**Unlisted Building** Approval not required	**Specialist advice** Architect	Extra care is needed around thermal bridges (eg windows) to avoid damp and rot problems.

Option 3: External insulation (cost £95-£165/msq) (may qualify for Warm Front Scheme)

External insulation of 70mm depth and rendering of secondary non original facades such as rear and side elevations.



	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	6.41kg per msq/yr	£1.24 per msq/yr	104 yrs payback period	£1.56 per msq/yr	84 yrs payback period
electric heating	16.55kg per msq/yr	£3.36 per msq/yr	39 yrs payback period	£4.20 per msq/yr	31 yrs payback period

Heritage Assessment

This option has the advantage of allowing the internal finishes of the building to be retained. However it would have significant heritage impacts on the external value of buildings with features of merit that are currently not rendered, and is recommended only for existing rendered rear facades.

Issues			Risks
Listed Building Approval unlikely	**Unlisted Building** Planning permission required in most cases	**Specialist advice** Architect Party wall	Extra care is needed around weathering details, sills and copings, to avoid water ingress

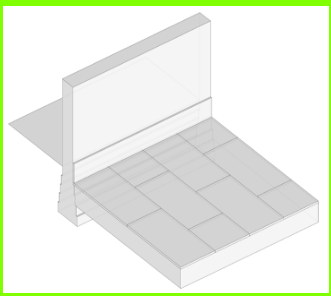
Examples

		Complexity:	Suggestion:
Option 1: Insulation behind existing panelling		Great care needed not to damage existing historic fabric when undertaking removal and reinstatement. Listed building consent would be required where applicable. 	A survey of the panelling may help owners to understand the complexity of panelling disassembly before beginning work.
Option 2: Internal insulation, high efficiency rigid		The complexity of the works depends a great deal on the number of window and door openings, as these will need to be relined as a consequence of the walls being built out. Listed building consent approval unlikely except where finishes already lost 	Some manufacturers can measure up the walls and carry out cutting and painting off-site to speed up installation and reduce mess.
Option 3: External insulation		This will require an external scaffold to be installed and careful detailing around windows, eaves and the ground to minimise cold bridging and water ingress. 	This option is best considered alongside periodic maintenance works, such as repainting, in order to keep costs as low as possible.

Base case A: solid stone or concrete floor

Solid stone or concrete floors, built off the earth with no insulation above or beneath, conduct heat away from the building and can account for as much as 20% of total heat loss.

Retrofitting can also help treat existing problems with damp, mould and fungal infections.



York stone sets

Concrete and screed floor

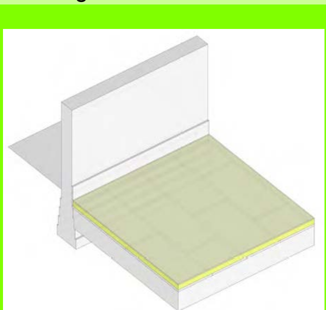
Issues			Risks
Listed Building	Unlisted Building	Specialist advice	Damp and mould are unsightly, smell unpleasant, create health problems and can damage historic fabric.

Option 1: Foam sheet underlay and carpet (cost £25-£35/msq)

Install a good quality foam sheet underlay with moisture barrier and carpet above.

This is an easy basic option that can be installed without any specialist advice or help. However it may cause difficulties in closing doors by raising the height of the floor.

Total height loss 10mm



	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	2.58kg per msq/yr	£0.50 per msq/yr	60 yrs payback period	£0.63 per msq/yr	48 yrs payback period
electric heating	6.62kg per msq/yr	£1.34 per msq/yr	22 yrs payback period	£1.68 per msq/yr	18 yrs payback period

Heritage Assessment

A simple measure which avoids damaging or altering historic fabric. Carpet grippers should be adhesive or loose rather than nailed, to prevent any damage to the floor.

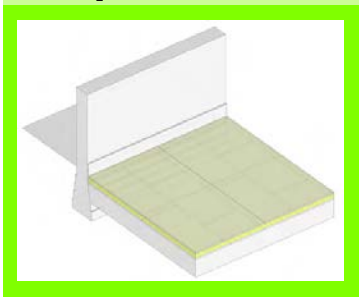
Issues			Risks
Listed Building: none	Unlisted Building: none	Specialist advice: none	Improvement in thermal performance is low and so damp and condensation risks are also low.

Option 2: Floating timber floor (cost £55-£70/msq)

This option is suitable for either concrete or existing stone floors.

The build up consists of 40mm polyurethane board with two 12mm sheets of plywood cross laid above. The high U-value of the polyurethane creates an insulating effect. Existing skirtings can be retained if they are of merit, although the impact on skirtings and closure of doors can be a problem. It may be necessary to plane the door down and rehang it.

Total height loss 60mm



	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	5.64kg per msq/yr	£1.10 per msq/yr	57 yrs payback period	£1.37 per msq/yr	46 yrs payback period
electric heating	14.6kg per msq/yr	£2.96 per msq/yr	21 yrs payback period	£3.71 per msq/yr	17 yrs payback period

Heritage Assessment

Raising the floor of these rooms will change the proportions of the spaces, the impact of which should be considered against the historical contribution they make to the overall heritage asset. The value of existing skirtings and wall finishes affected will also need to be assessed.

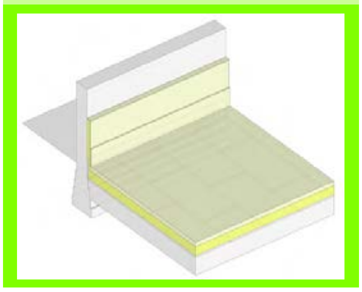
Issues			Risks
Listed Building	Unlisted Building	Specialist advice	
Approval required	none	Builder	Ensure ply sheets are firmly fixed through to each other otherwise the floor may sag in places.

Option 3: New screed floor (cost £85-£100/msq)

Remove screed, install new 100mm polyurethane insulation layer lapped up walls behind new skirtings with 50mm screed above.

This complex and invasive option should only be considered when the existing floor is a modern concrete and screed slab. Mixing screed can be messy and disruptive to occupants.

Total height loss 120mm



	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	6.57kg per msq/yr	£1.28 per msq/yr	72 yrs payback period	£1.60 per msq/yr	58 yrs payback period
electric heating	16.96kg per msq/yr	£3.44 per msq/yr	27 yrs payback period	£4.31 per msq/yr	21 yrs payback period

Heritage Assessment

Raising the floor of rooms will change the proportions of the spaces, the impact of which should be considered against the historical contribution they make to the overall heritage asset. The value of existing skirtings and wall finishes affected also needs to be assessed.

Issues			Risks
Listed Building	Unlisted Building	Specialist advice	
Approval required	none	Architect	Lapping insulation up walls helps limit the potential for cold bridging and condensation.

Base case B: suspended timber floor

This base case is a suspended timber floor with dirt under and no insulation.

This type of floor became very common in the 18th and 19th centuries, and original timbers can add greatly to the heritage value of the building.

The traditional method of preventing condensation under this type of floor is to create natural cross ventilation between external walls, using airbricks or similar vents. However, this increases heat loss significantly and creates considerable draughts. Rising damp can be a problem if the floor below is bare earth, as is common in 18th and early 19th century buildings.

Wooden floor

Floor beneath

Issues			Risks
Listed Building	Unlisted Building	Specialist advice	Damp can be unsightly, create unpleasant smells, cause health problems and damage historic fabric.

Option 1: Foam sheet underlay and carpet (cost £25-£35/msq)

Install a good quality foam sheet underlay with moisture barrier and carpet above.

This is an easy basic option that can be installed without any specialist advice or help. However it may cause difficulties in closing doors by raising the height of the floor.

Total height loss 10mm

	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	2.58kg per msq/yr	£0.50 per msq/yr	60 yrs payback period	£0.63 per msq/yr	48 yrs payback period
electric heating	6.62kg per msq/yr	£1.34 per msq/yr	22 yrs payback period	£1.68 per msq/yr	18 yrs payback period

Heritage Assessment

A simple measure which avoids damaging or altering historic fabric. Carpet grippers should be adhesive or loose rather than nailed, to prevent any damage to the floor.

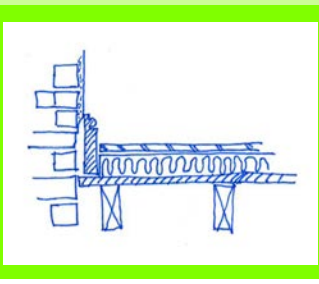
Issues			Risks
Listed Building none	Unlisted Building none	Specialist advice none	Improvement in thermal performance is low and so damp and condensation risks are also low.

Option 2: Floating timber floor over retained floor (cost £55-£70/msq)

The floor build up consists of 40mm polyurethane board with two 12mm sheets of plywood cross laid above. The high U-value of the polyurethane creates an insulating effect.

Existing skirtings can be retained if of merit. However the raised floor height can cause problems with closing doors, which may need to be planed down and rehung.

Total height loss 60mm



Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating				
5.64kg per msq/yr	£1.10 per msq/yr	57 yrs payback period	£1.37 per msq/yr	46 yrs payback period
electric heating				
14.6kg per msq/yr	£2.96 per msq/yr	21 yrs payback period	£3.71 per msq/yr	17 yrs payback period

Heritage Assessment

Raising the floor of rooms will change the proportions of these spaces, the impact of which should be considered against the historical contribution they make to the overall heritage asset. The value of existing skirtings and wall finishes affected will also need to be considered.

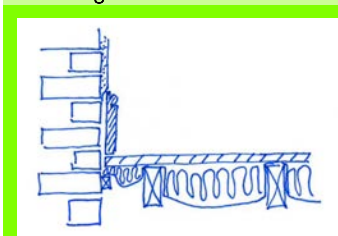
Issues			Risks
Listed Building	Unlisted Building	Specialist advice	
Approval may be required	none	Architect	Ensure ply sheets are firmly fixed through to each other otherwise floor may sag in places.

Option 3: Install insulation in floor void (cost £25-£30/msq)

Add 250mm mineral wool in the void under the floor. Access is gained through existing access to the floor void or basement.

If access is available, this allows the appearance of existing exposed wooden floors to be retained. However, if raising floorboards is needed, costs will be higher, the work will be far more disruptive and there is a risk of losing the original floor.

Total height loss 0mm



Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating				
6.57kg per msq/yr	£1.28 per msq/yr	5 yrs payback period	£1.60 per msq/yr	4 yrs payback period
electric heating				
16.96kg per msq/yr	£3.44 per msq/yr	2 yrs payback period	£4.31 per msq/yr	2 yrs payback period

Heritage Assessment

A simple measure which avoids damaging or altering historic fabric if void is accessible. Not recommended if void is not accessible and floor is original.

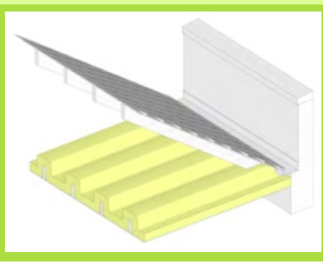
Issues			Risks
Listed Building	Unlisted Building	Specialist advice	
Approval may be required	none	Joiner (if raising floor)	Improvement in thermal performance is low and so damp and condensation risks are also low.

Base case: slate roof, no insulation in void

Option 1: improved insulation of roof void (cost £25-£35/msq)

As with floors and walls, the roof can be a major source of heat loss.

Installing 200-250mm of mineral wool in the roof void, covering ceiling rafters and beams, is a very simple and effective insulation measure. Shallower layers are largely ineffective.



	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	6.78kg per msq/yr	£1.32 per msq/yr	23 yrs payback period	£1.65 per msq/yr	18 yrs payback period
electric heating	17.49kg per msq/yr	£3.55 per msq/yr	8 yrs payback period	£4.44 per msq/yr	7 yrs payback period

Heritage Assessment

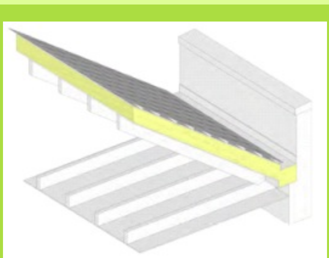
A simple measure which avoids damaging or altering historic fabric.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
Not normally required	none	none	Improvement in thermal performance is low and as a consequence damp and condensation risks are also.

Option 2: new roof and insulation (cost £175-£225/msq)

This involves removing the existing slate tiles and battens, and building up the roof with rigid polyurethane (100mm) above the rafters, followed by mineral wool installed between the new roof (100m) and tiles above.

If there is no parapet, new barge boards and gutters will be needed. This substantially changes the appearance of the building and is not recommended for Listed Buildings.



	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	6.92kg per msq/yr	£1.34 per msq/yr	149 yrs payback period	£1.68 per msq/yr	119 yrs payback period
electric heating	17.91kg per msq/yr	£3.64 per msq/yr	55 yrs payback period	£4.54 per msq/yr	44 yrs payback period

Heritage Assessment

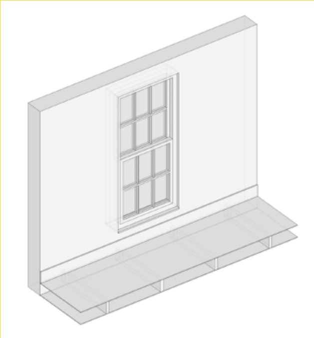
Care is needed to avoid increasing the height of the roof eaves line as well as the careful selection of re-roofing materials.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
Approval required	Planning Permission	Architect	Careful detailing is needed to ensure ventilation to roof void beneath is maintained and to avoid cold bridging.

Base case: poorly fitting single glazed sash and casement windows

Although a much loved and widespread feature of 18th and 19th century buildings, poorly fitting single glazed windows contribute to a high air infiltration rate.

Calculations assume a window size of 1.36msq (0.8mx1.7m)

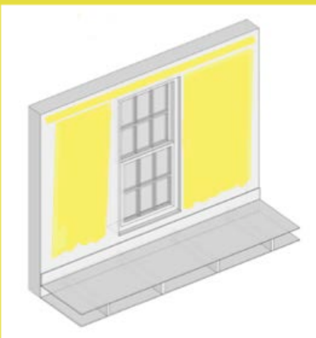


Issues			Risks
Listed Building	Unlisted Building	Specialist advice	Wooden windows are also vulnerable to condensation, rot, insect attacks and need frequent re-painting.

Option 1: thick curtains (cost £125-£150)

Well fitting curtains which hang beneath the window sills and cover the sides of the windows can help to prevent draughts and heat loss. Lined and full length curtains of thick materials are the most effective.

Cost savings could not be modelled and may be limited.



	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating					
	per window/yr	per window/yr	payback period	per window/yr	payback period
electric heating					
	per window/yr	per window/yr	payback period	per window/yr	payback period

Heritage Assessment

Limited impact.

Issues			Risks
Listed Building	Unlisted Building	Specialist advice	
none	none	none	Avoid damaging architraves and timber work around windows when installing rails.

Option 2: Tape fixed secondary glazing (cost £100-£120 per window)

A tape-fitted secondary glazing fitting alongside the existing window sash bead is an easy and non-invasive measure.

The disadvantage is that windows cannot be opened while it is installed, and so it needs to be removed and stored during summer.

	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	16.64kg per window/yr	£3.23 per window/yr	36 yrs payback period	£4.04 per window/yr	27 yrs payback period
electric heating	42.97kg per window/yr	£8.72 per window/yr	12 yrs payback period	£10.91 per window/yr	10 yrs payback period

Heritage Assessment

This is a good way of upgrading window performance as long as secondary glazing profiles are concealed behind existing window staff beads.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
none	none	none	Condensation and damp can arise from not opening windows. Removing fittings can damage windows.

Option 3: Independent secondary glazing (cost £110-£120 per window although some high end windows can be £250)

A new secondary glazed window sitting inside the existing sash. This can be opened in order to open the external window.

This allows existing joinery, architraves, staff beads and window boxes to be retained undamaged.

	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	21.63kg per window/yr	£4.20 per window/yr	26 yrs payback period	£5.25 per window/yr	21 yrs payback period
electric heating	55.85kg per window/yr	£11.34 per window/yr	10 yrs payback period	£14.18 per window/yr	8 yrs payback period

Heritage Assessment

Installing fixed secondary glazing can cause negative impacts if not carried out with senstivity and care. Profiles should not be visible from outside. Not recommended when the building has existing window shutters.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
Approval needed	none	Architect	Allow space between windows to be ventilated through trickle vents otherwise mould will grow.

Option 4: Reinstate window shutters (cost £200-£250 per window)

This option can involve either original or replacement shutters. It should be planned to incorporate the complete refurbishment of existing windows to include improved draught stripping, seals and weights.

	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	24.51kg per window/yr	£4.76 per window/yr	47 yrs payback period	£5.95 per window/yr	38 yrs payback period
electric heating	63.3kg per window/yr	£12.85 per window/yr	17 yrs payback period	£16.07 per window/yr	14 yrs payback period

Heritage Assessment

Re-introducing window shutters enhances the contribution that historic buildings make to their surroundings by strengthening the historic and aesthetic values they provide to occupants and the community.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
Approval needed	None	Architect	Care needs to be taken to avoid damaging surrounding elements of historic fabric.

Option 5: Replacement double glazed window (cost £365-£425 per window)

This is recommended where the existing windows are poor quality replacements (for example badly fitting single glazed casements) and are not on the front facades.

Using replacement sash windows in the place of other non-original styles can also increase the heritage value of buildings.

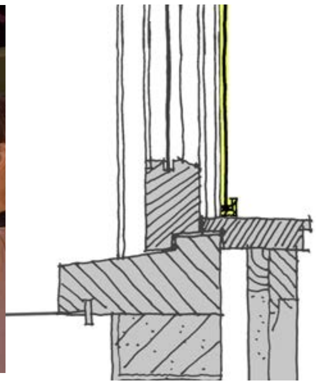
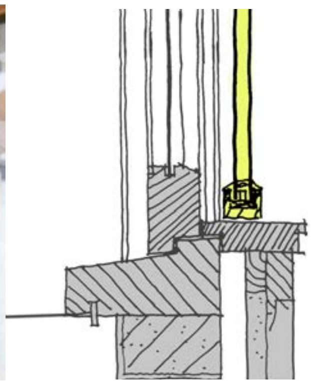
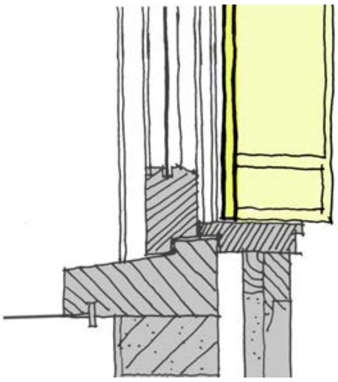
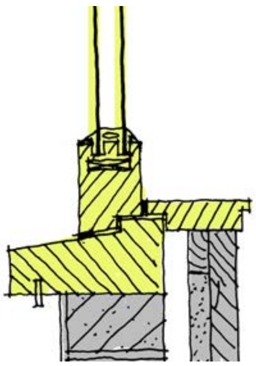
	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	27.4kg per window/yr	£5.32 per window/yr	74 yrs payback period	£6.65 per window/yr	59 yrs payback period
electric heating	70.74kg per window/yr	£14.36 per window/yr	27 yrs payback period	£17.96 per window/yr	22 yrs payback period

Heritage Assessment

Replacing existing original historic windows will generally represent a loss of value for any building. However the reintroduction of double glazed timber sashes into rear facades which have been previously altered may be seen to enhance the value of these assets.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
Approval unlikely	Planning perm. may be required.	Architect	Allow space between windows to be ventilated through trickle vents otherwise mould will grow.

Examples

		Detail	Complexity:
Option 2: Tape fixed secondary glazing			Simple. However this might damage the paint to existing window beads. The window cannot be opened once the glazing is installed. 
Option 3: Independent secondary glazing			The load bearing condition of the window stool needs to be checked. There may be some disruption to internal finishes, but no external work will be required. 
Option 4: Reinstate window shutters			Possible disruption to internal finishes, but no external work will be required. 
Option 5: Replacement double glazed window			High compexity. Will require an external scaffold to be installed. Careful detail around windows will be needed to minimise cold bridging and water ingress. 

WATER

Base case: Standard water fittings from mains supply

Unintended consequences

Londoners use 167 litres of water per day, compared to the average for England & Wales of 150 litres. Excessive water use contributes to water shortages and droughts, and to wider ecological damage.

Option 1: install low water use fittings (cost £145-£170)

Calculations are per sanitary ware fitting. Costs saved are on water bills.

Carbon saving	Cost saving (commercial) gas or electric heating		Cost saving (domestic)	
3.24kg per fitting/yr	£9.73 per fitting/yr	16 yrs payback period	£9.73 per fitting/yr	16 yrs payback period

Heritage Assessment

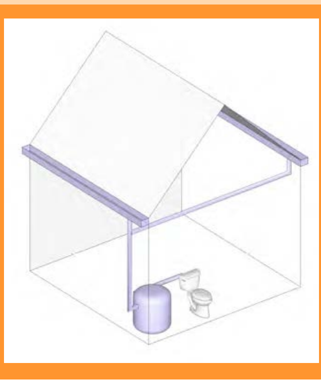
Negligible impact.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
none	none	none	None

Option 2: Rainwater recovery (cost £1,500-£3,000)

Cost is per installation. These systems collect rainwater for use in flushing toilets.

The overall benefits depend on the number of users in the building and the type of fittings used to discharge water.



Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
	gas or electric heating			
3.6kg	£10.79	209 yrs	£10.79	209 yrs
per system/yr	per system/yr	payback period	per system/yr	payback period

Heritage Assessment

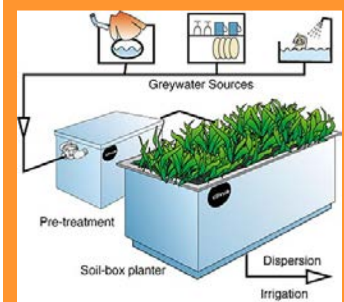
Negligible impact.

Issues			Risks
Listed Building Approval required	Unlisted Building none	Specialist advice Architect	The location of water storage tanks needs to be considered carefully.

Option 3: Greywater recovery (cost £1,500-£3,000)

Cost is per installation. These systems collect rainwater and waste water from sinks and showers for use in flushing toilets.

The overall benefits depend on the number of users in the building and the type of fittings used to discharge water.



Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
	gas or electric heating			
3.6kg	£10.79	209 yrs	£10.79	209 yrs
per system/yr	per system/yr	payback period	per system/yr	payback period

These are minimum figures and, as for rainwater above, the scope for additional savings depends on the relative water use of sinks and toilets.

Heritage Assessment

Negligible impact.

Issues			Risks
Listed Building Approval required	Unlisted Building none	Specialist advice Architect	The location of water storage tanks needs to be considered carefully.

Base case: metering of energy use by end users

Unintended consequences

Traditional metering systems provide no information on the energy use associated with specific equipment and behaviour patterns, and so do not help building occupants to reduce energy consumption.

Option 1: Smart meters (cost £300-£500)

Cost savings quoted assume that 5% savings are possible through an improved metering strategy using smart meters.

The national roll-out of smart meters to all properties is planned to start in late 2014.

Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
		gas heating		
72.91kg per meter/yr	£14.16 per meter/yr	28 yrs payback period	£17.70 per meter/yr	23 yrs payback period
		electric heating		
209.2kg per meter/yr	£42.47 per meter/yr	9 yrs payback period	£53.09 per meter/yr	7 yrs payback period

Heritage Assessment

Negligible effect on heritage value of historic building.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
Approval not required	none	Electrician	None

Option 2: In usage energy display (£75-£125)

The cost savings quoted assume 5% energy savings.

These systems are commercially available, and are aimed to help consumers make informed decisions on energy spending by analysing their energy use.

Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
		gas heating		
72.91kg per meter/yr	£14.16 per meter/yr	28 yrs payback period	£17.70 per meter/yr	6 yrs payback period
		electric heating		
209.2kg per meter/yr	£42.47 per meter/yr	2 yrs payback period	£53.09 per meter/yr	2 yrs payback period

Heritage Assessment

Negligible effect on heritage value of historic building.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
Approval not required	none	none	None

Option 3: Intelligent meters

These meters maximize energy performance by learning occupier habits. They are not yet commercially available but have been tested in the 'Retrofit for the Future' demonstration projects.

Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
c.150kg per meter/yr	c.£30 per meter/yr	? payback period	c.£40 per meter/yr	? payback period

Base case: Standard split air conditioning

Unintended consequences

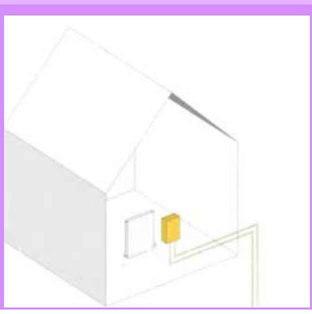
Air conditioning is a major source of energy use and, as temperatures rise with future climate change, will become increasingly expensive and ineffective. The base case assumes a Coefficient of Performance (the ratio of energy output to input) of 2:0.

Option 1: Reversible ground source heat pump (cost £ 9-17,000)

(Renew able Heat Premium Payment & Renew able Heat Incentive available)

Some types of heat pump can be reversed to also provide cooling. These systems are not a practical solution to the cooling needs of a small retail outlet or office but may be worth investigating for complete buildings with large cooling demands. The heat pile could be sited in the street vaults of the building, to avoid disruption and damage to the building fabric. Highways consent is needed if works obstruct the road and/or pavement.

Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating				
Not Appropriate for Cooling				
per unit/yr	per unit/yr	payback period	per unit/yr	payback period
electric heating				
Not Appropriate for Cooling				
per unit/yr	per unit/yr	payback period	per unit/yr	payback period



Heritage Assessment

The location of the heat pile will determine the impact on the building's heritage value. If the pile does not damage historic features, this option should have a negligible effect.

Issues			Risks
Listed Building Approval required	**Unlisted Building** May need planning perm.	**Specialist advice** M & E / Architect	None

Other options

- Air Source Heat Pumps have not been modelled as they are essentially the same as split air-conditioning units (the base case), although they can be used for heating and hot water.
- Solar glazing and blinds could be used to reduce heat gains: the effectiveness of this measure would depend on the location, orientation and design of the building, and it would therefore need to be modelled on a case by case basis.
- Reverting to natural ventilation is a simple, low cost yet effective means of reducing energy consumption. However, occupant comfort may suffer if insufficient natural ventilation exists and careful consideration should be given as to whether this option is appropriate.

Natural Ventilation

Heritage Assessment

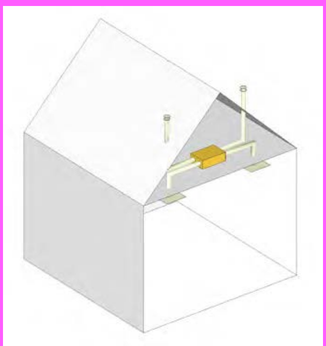
Removing air conditioning units and reverting to natural ventilation contributes positively to the heritage value of an area by removing uncharacteristic features. It also reduces noise and vibration, which may benefit occupiers of neighbouring buildings.

Issues			Risks
Listed Building Approval not required	**Unlisted Building** none	**Specialist advice**	None

Base case: Natural ventilation with extractor fans in kitchen and WC

Option 1: mechanical ventilation and heat recovery (cost £1,550-£2,000)

These systems are costly but very effective, particularly in new buildings where high permeability rates can be achieved. They reduce the need for additional heating by bringing warm air being expelled from the building into indirect contact via a heat exchanger with cooler air being brought in.



	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	**420.2kg** per system/yr	**£81.60** per system/yr	**22 yrs** payback period	**£102.00** per system/yr	**17 yrs** payback period
electric heating	**420.2kg** per system/yr	**£244.80** per system/yr	**7 yrs** payback period	**£306.00** per system/yr	**6 yrs** payback period

Heritage Assessment

Negligible effect on heritage value of historic building.

Issues			Risks
Listed Building Approval required	**Unlisted Building** none	**Specialist advice** Architect 	Care needs to be taken to ensure damage to fabric does not occur with new duct routes

Option 2: install vent in bricked up fireplace (cost £35-£55)

This is a simple and cheap option, which also helps ventilate the existing chimney flue, and so prevents damp and rot.

Cost is per air brick, assuming the chimney top is open. Impacts could not be modelled.

During winter months, increased air flow as a consequence of higher heat losses will probably offset any ventilation benefits experienced during the summer.

Heritage Assessment

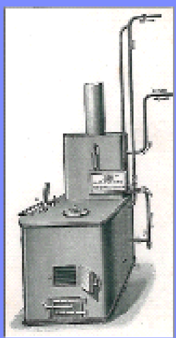
Negligible effect on heritage value of historic building.

Issues			Risks
Listed Building Approval required	**Unlisted Building** none	**Specialist advice** 	Care needs to be taken to ensure damage to fabric does not occur with new duct routes

Base case: Electric or gas heating and hot water

For gas central heating, calculations are based on an inefficient non-condensing gas fired boiler installed before 1995, with standard efficiency fans and pumps, and no thermostatic valves on radiators.

Older gas fired boilers are only about 50-60% efficient, producing far less heat for the energy consumed than modern boilers.



Unlagged pipes allow heat to escape into voids and can also create uncomfortable 'hot spots' on floors.

Electric radiators are an expensive means of heating a building and 'carbon inefficient'.

Issues			Risks
Listed Building	Unlisted Building	Specialist advice	Leaving a building un-retrofitted exposes owners and tenants to future energy and climate change risks

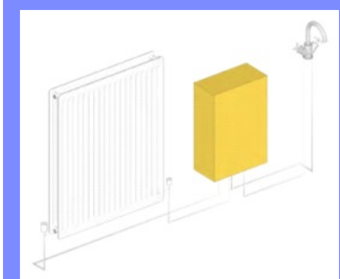
Option 1: High efficiency gas heating and hot water (cost £2,400-£2,750)

(may qualify for Warm Front Scheme)

High efficiency gas heating and hot water can be achieved through the installation of a modern gas fired boiler, which is more than 90% efficient.

The cost and cost savings quoted are per installation (assuming a domestic scale of less than 9kW, serving one floor). If installation is for the entire building, payback periods will be much less.

	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	324.4kg per system/yr	£62.99 per system/yr	41 yrs payback period	£78.74 per system/yr	33 yrs payback period
electric heating	1801kg per system/yr	£211.39 per system/yr	12 yrs payback period	£293.22 per system/yr	9 yrs payback period



Heritage Assessment

Negligible effect on heritage value of historic building but approval may be needed for any flue or other internal alterations necessary.

Issues			Risks
Listed Building may be required	Unlisted Building flue may need planning per.	Specialist advice Plumber	none

Option 2: Remove radiator in common parts (cost £75-£100 per radiator)

This measure is not recommended as it poses a risk to historic fabric. Leaving areas of historic buildings unheated over a long period of time results in the building fabric cooling down in these areas, making them susceptible to damp, rot and mould.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
none	none	none	Many

Option 3: install thermostatic radiator valves (cost £65)

Thermostatic valves enable greater control over indivdual room temperature, by regulating the flow of water through each radiator in response to the air temperature in the room.

The cost given is per radiator: savings are estimated and will depend upon how the occupant uses the valves.

	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	30.43kg per radiator/yr	£5.91 per radiator/yr	11 yrs payback period	£7.39 per radiator/yr	9 yrs payback period
electric heating	per radiator/yr	per radiator/yr	payback period	per radiator/yr	payback period

Heritage Assessment

Negligible effect on heritage value of historic building.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
none	none	none	None

Option 4: Ground source heat pump (cost £9,000-£17,000)

(Renewable Heat Premium Payment & Renewable Heat Incentive available)

Cost is per system, serving one floor. The heat pump can be located in the building's street vaults. Provides low grade heat and works most effectively with underfloor heating at basement level and oversized radiators.

If the pump serves the whole building, payback periods will be much shorter.

Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating				
544kg per system/yr	£350.69 per system/yr	37 yrs payback period	£173.15 per system/yr	75 yrs payback period
electric heating				
per system/yr	per system/yr	payback period	per system/yr	payback period

Heritage Assessment

The location of the heat pile will determine the impact on heritage value. If the pile does not damage historic features, this option should have a negligible effect.

Issues			Risks
Listed Building Approval required	**Unlisted Building** Planning per. may be needed	**Specialist advice** M & E / Architect	Existing radiators may not distribute enough heat - combine works with improving building fabric thermal performance.

Option 5: Air source heat pump (cost £6,000-£10,000)

(Renewable Heat Premium Payment & Renewable Heat Incentive may be available)

These pumps extract heat from external air, compress it to increase its temperature and deliver it to heating and hot water circuits. They can be combined with underfloor heating and are most effective in well insulated and draught-proofed properties. The pump needs to be installed on an external wall, surrounded by acoustic screening.

If the pump serves the whole building, payback periods will be much shorter.

Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating				
129.5kg per system/yr	£245.48 per system/yr	33 yrs payback period	£88.99 per system/yr	90 yrs payback period
electric heating				
per system/yr	per system/yr	payback period	per system/yr	payback period

Heritage Assessment

This option would have several impacts on the heritage value of the building and would potentially result in a loss of amenity for neighbouring residents. Other options would be preferable.

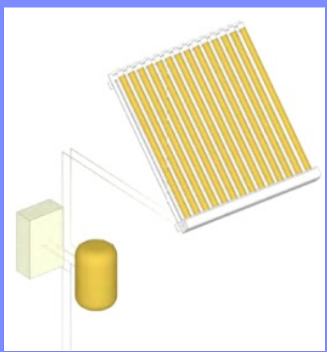
Issues			Risks
Listed Building Approval required	**Unlisted Building** Planning Per. may be req.	**Specialist advice**	Condensation on pipework can cause damp problems. Pumps are noisy and costs depend on electricity prices.

Option 6: solar thermal panels (cost £4,500-£5,500)

(Renewable Heat Premium Payment & Renewable Heat Incentive available)

Solar thermal panels use the warmth of the sun to heat water, which is stored for subsequent use. They can be supplemented by a conventional boiler or immersion heater.

On Listed Buildings, a ballast secured system can be used to install panels, with no fixings to existing fabric. The calculations assume 4msq of panels.



	Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating	**329.6kg** per system/yr	**£64.00** per system/yr	**86 yrs** payback period	**£80.00** per system/yr	**69 yrs** payback period
electric heating	**945.6kg** per system/yr	**£64.00** per system/yr	**78 yrs** payback period	**£80.00** per system/yr	**62 yrs** payback period

Heritage Assessment

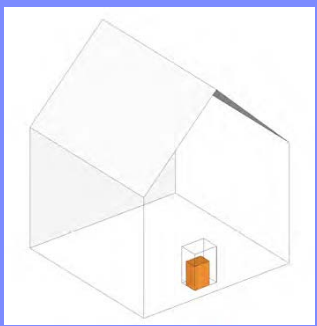
Solar panels can have a negative impact on the aesthetic value of heritage assets: on Listed Buildings, their location needs careful consideration to avoid being visible from the street or overlooked by neighbours.

Issues			Risks
Listed Building Approval required	**Unlisted building** may be permitted development	**Specialist advice** None	Care needs to be taken to ensure damage to fabric does not occur with new service routes

Option 7 (gas only): install high efficiency central heating pumps (cost £200-£300)

Replacing existing central heating pumps with new, high-efficiency, ones reduces energy wastage. This is a cheap, easy and cost-effective measure which should have no impact on historic building fabric.

Calculations are per system for a 350msq building.



Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating				
133.6kg	£9.04	28 yrs	£11.30	22 yrs
per system/yr	per system/yr	payback period	per system/yr	payback period
electric heating				
per system/yr	per system/yr	payback period	per system/yr	payback period

Heritage Assessment

Negligible effect on heritage value of historic building.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
none	none	none	None

Option 8 (gas only): heat metering (cost £300-£500)

Install sub-meters for hot water and heating provided by landlord to tenants' areas. Cost savings quoted assume a saving of 5% per floor.

This option allows accurate bills to be produced for separate areas. It could be combined with the introduction of leases making tenants responsible for fuel bills.

Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating				
145.8kg	£28.32	14 yrs	£35.39	11 yrs
per system/yr	per system/yr	payback period	per system/yr	payback period
electric heating				
per system/yr	per system/yr	payback period	per system/yr	payback period

Heritage Assessment

Negligible effect on heritage value of historic building.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
none	none	none	None

POWER

Base case: electricity from grid and mains gas

Unintended consequences

Relying on mains gas and electricity leaves building owners and occupiers vulnerable to future price rises, particularly in the case of electricity as commercial tariffs are predicted to rise sharply to fund the government's decarbonisation programme.

Option 1: Photovoltaic panels (£13,000-£15,000)

(Feed In Tariffs available)

Photovoltaic panels convert sunlight into electricity. Panels can be mounted on roofs or walls.

The calculations assume an average domestic set up of 19.2msq panels installed using a ballast secured system with no fixings to the existing fabric.

Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
gas heating				
1,005kg per 20msq/yr	£68.00 (£567.00)*	206 yrs (25 yrs)*	£85.00 (£584.00)*	165 yrs (24 yrs)*
electric heating				
1,005kg per 20msq/yr	£68.00 per 20msq/yr	206 yrs payback period	£85.00 per 20msq/yr	165 yrs payback period

Heritage Assessment

PV panels can have a negative impact on the aesthetic value of heritage assets: on Listed Buildings, they should not be visible from the street or overlooked by neighbours. May be permitted development in many unlisted buildings.

Issues			Risks
Listed Building Approval required	**Unlisted Building** See above	**Specialist advice**	Care needs to be taken to ensure damage to fabric does not occur with new service routes

*Income from the Feed In Tariff (21p/kWh for electricity generated and an extra 3.1p/kWh for electricity supplied to the National Grid) could increase the cost saving by £499 per year, for a south-facing roof in Soho with a 40 degree pitch. This will reduce the payback period considerably if the Tariff continues to be available.

Option 2: Domestic CHP unit (£4,000-£5,000)

(Feed In Tariffs may be available)

Domestic combined heat and power (CHP) units are usually gas-fuelled and of a similar size to household boilers but also generate electricity as a byproduct. They are commercially available and can be installed to meet the power and heating needs of the premises. They are not compatible with electric heating systems. Payback periods are variable and depend on each buildings energy demand profile

Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
one unit per floor (multi-tenanted building)				
459kg per system/yr	£143.46 per system/yr	31 yrs payback period	£287 per system/yr	16 yrs payback period

Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
one unit per building (private house)				
2,295kg per system/yr	£717.30 per system/yr	5 yrs payback period	£1,433 per system/yr	3.2 yrs payback period

Heritage Assessment

Negligible effect on heritage value of historic building. Flues and other internal alterations will require consent. Unlisted buildings may be permitted development.

Issues			Risks
Listed Building Approval for flue.	**Unlisted Building** See above	**Specialist advice**	Care needs to be taken to ensure damage to fabric does not occur with new service routes

*Feed In Tariffs (11p/kWh for electricity generated and 3.1p/kWh for electricity supplied to the National Grid) are available for the first 30,000 domestic CHP units (less than 2kW in size) installed, on a pilot basis. A unit producing 5,000 kWh of electricity and exporting 50% to the Grid would produce an income of £627.50 per year). The generation tariff is expected to increase to 12.5p/kWh per year from October 2012.

Base case: Mostly existing filament lamps, with 5% low energy fittings

Unintended consequences

Lighting accounts for about 8% of the typical household energy bill, and is a source of easy and inexpensive retrofitting improvements.

Option 1: LED lighting (cost £30-£40)

Light-emitting diodes are far more energy-efficient than traditional light bulbs.

The cost is per fitting, based on a comparison between 60W GLS and 10W high quality LED lighting operating for three hours per day

Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
	gas or electric heating			
31.6kg	£6.41	5 yrs	£8.01	4 yrs
per fitting/yr	per unit/yr	payback period	per unit/yr	payback period

Heritage Assessment

Fittings may need to be changed but, with the careful choice of fittings, this measure should have negligible effect on the heritage value of historic buildings.

Issues			Risks
Listed Building	Unlisted Building	Specialist advice	None
Approval not required	none		

Option 2: PIR sensors (cost £85-£105)

Passive infra-red sensors can be installed to control lighting in all common parts areas, so that lighting is only activated when the area is occupied.

The calculations assume a saving on 60W GLS of one hour per day.

Carbon saving	Cost saving (commercial)		Cost saving (domestic)	
	gas or electric heating			
12.6kg	£2.56	37 yrs	£3.20	30 yrs
per unit/yr	per unit/yr	payback period	per unit/yr	payback period

Heritage Assessment

Fittings may need to be changed but, with the careful choice of fittings, this measure should have negligible effect on the heritage value of historic buildings.

Issues			Risks
Listed Building	Unlisted Building	Specialist advice	None
Consent may be required	none	Planner	

Option 1: green roof (£120-£300/msq)

Green roofs can be an effective way of providing green space in dense urban areas. Various types are available. Some (such as extensive sedum roofs) require very little maintenance. Intensive roofs are capable of holding a traditional garden and usually have a much greater depth.

Green roofs not only encourage biodiversity but also provide the building with insulation, absorb rainwater and so reduce surface water run off, and help to reduce the urban heat island effect.

Although there are no direct carbon savings associated with green roofs, they can make an important contribution to air quality and mitigating heat island effects across a wider area. The insulating effect may result in indirect cost savings for occupants.

Heritage Assessment

When introduced into existing flat roofs which are not visible from the street, the heritage impacts will be small. Extensive roofs are more likely to be suitable for listed buildings, as their load-bearing requirements are lower than those of intensive roofs.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
Approval required	Approval may be required	Architect	Additional loading may affect the structure. Care is needed to avoid damaging roof ventilation.

Option 2: brown roof (£55-£185/msq)

Brown roofs offer a habitat in dense urban areas for insects and birds that usually find homes on disused building sites.

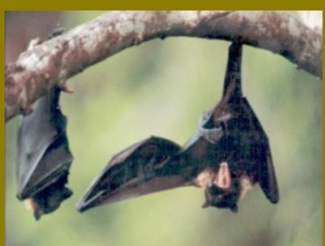
Heritage Assessment

When introduced into existing flat roofs which are not visible from the street, the heritage impacts will be small.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
Approval required	Approval may be required	Architect	Additional loading may affect the structure. Care is needed to avoid damaging roof ventilation.

Option 3: bat/bird box (cost £25-£135per box)

Bat and bird boxes are a simple and cheap way of encouraging biodiversity.



Heritage Assessment

This measure has negligible impact if located with sensitivity on the rear façade or on the roof.

Issues: Listed Building	Issues: Unlisted Building	Issues: Specialist advice	Risks
Approval required	Generally no approval	None	None

Guidance by building typology

Overview

This section of the guidance demonstrates how cost savings and enhanced environmental performance could be achieved for five building types typical of the Soho Conservation Area:

- Restaurant With Flats Above
- Residential Redevelopment
- Shop With Office Above
- Shop With Office Redevelopment
- All-Residential Building (House)

For each building type, the optimum suite of retrofitting measures is presented, based on the options introduced in **The Elemental Approach** above. Issues associated with planning permission, Listed Building Consent and heritage impact are also considered, together with other issues and constraints that may be commonly experienced within specific building types. Costs, savings and payback periods of each measure are given, together with a graph comparing the relative cost-effectiveness of different measures.

Building types were identified on the basis of the initial case study investigations documented in this guidance. The modelling process used to quantify costs, savings and payback periods is as used for the previous section and is described in Appendix 3.

The reader is reminded that these figures are indicative of typical buildings in Soho. As the characteristics of building fabric and energy demand in individual cases may differ from the archetype used to derive these figures, so too will the actual potential for savings. Consequently, specific buildings under similar use and ownership may be capable of higher or lower savings than those quoted in this guidance.

Incentive misalignment problems can act as a barrier, discouraging building owners and occupiers from investing in retrofitting measures. These problems include:

- *Landlord / tenant issues* – improvements installed by the landlord deliver benefits to the tenants (for example, through reduced energy bills and enhanced comfort levels), and the developer may not be able to capitalize these benefits in rents;

- *Allocation of risk* – energy savings generated can be subject to heavy discounting due to uncertainties surrounding policy initiatives (for example, whether subsidies will continue to be available) and energy markets (for example, future changes in energy prices), which may not align with the risk profile of the building's owner;

- *Developer / Resale issues* – capacity installed by the project's developer may not result in capitalization in the building's value at sale, if it involves additional complexity in facilities management.

These misalignments suggest that the barriers to implementing retrofitting measures will be least either when the entire building is occupied by a single tenant or owner, or when a comprehensive refurbishment and redevelopment is being carried out to increase rental values. In either case, costs can be reduced by combining retrofitting measures with other works.

Payback periods and annual saving figures

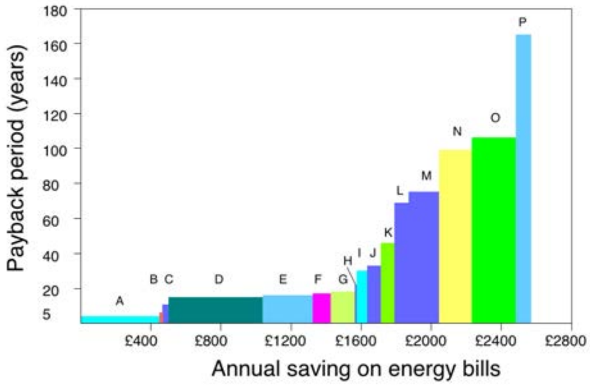
The payback periods presented in this section, as with the previous section on building elements, have been calculated by dividing the installed cost in 2011 of each measure by the resulting estimated non-discounted annual savings on energy bills.

The cost savings and payback periods given do not take account of subsidies, as many of these are only available in specific circumstances. They are based on the assumption that the property currently has gas central heating.

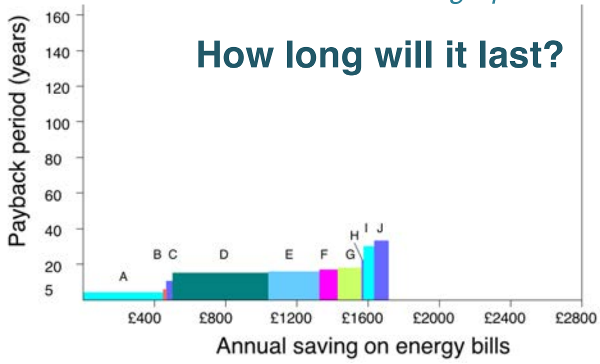
An example of the graphs showing annual savings and payback periods for each building type is shown in Figure 14. The accompanying text explains how the graphs should be used to identify the most effective retrofitting measures by gradually filtering out less effective ones.

Figure 14: how to interpret the graphs

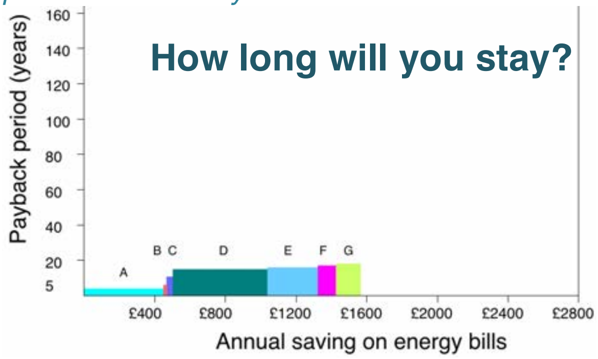
The measures are ranked by how quickly they repay their cost (payback period). The width of the bars shows the annual savings from each measure. The values on the horizontal axis show the cumulative savings from implementing all measures to the left.



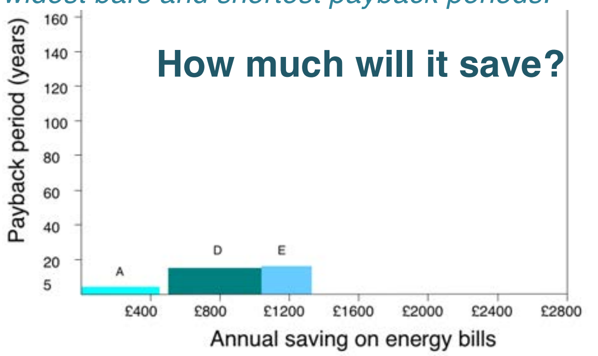
Any measure with a payback period of over 40 years is unlikely to repay its cost within its lifetime and can be ruled out on this basis (without a source of funding that could make it financially viable, such as the £3,500 grants available through the Warm Front scheme for those on income-related benefits). These have been removed from the next graph.



Then decide for how long you are likely to have an interest in the building and rule out measures that do not pay back in this time. In the next graph, measures with a payback period of over 20 years have been removed.

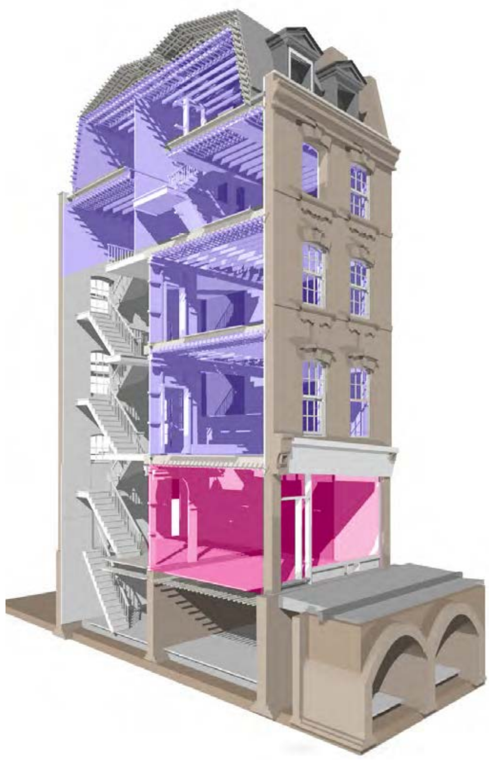


The widest bars should deliver the greatest cost savings (although, as actual savings in specific cases may differ, the width of the bars compared to each other is more significant than their absolute width). The last graph only shows measures with the widest bars and shortest payback periods.



Source: Sturgis Carbon Profiling

RESTAURANT WITH FLATS ABOVE



Overview

Description and Heritage Value

These buildings are the predominant typology in the Soho Conservation Area and pose some of the greatest challenges for retrofitting, given their size and the variety of plan forms and energy demands of their users. However they also contribute a great deal by providing accommodation and business premises for a wide range of residents and businesses. This vitality and diversity creates the quintessential charm and character of the area, safeguarding Soho as one of few residential areas remaining in central London. The heritage value of these buildings is diverse and generated by their small scale, intimate street patterns and established communities.

Landlord tenant issues

The options proposed in this section reflect the limitations of working with occupied historic buildings. Each option described can be undertaken independently of other tenancies in the building. However, if sharing energy demand loads can be acheived, significant savings are possible. The key issues driving this are that larger plant installations are more energy efficient. Combining commercial and residential heating loads is particularly efficient, as it balances out the respective daytime and evening peaks in demand.

Statutory Implications

Planning Permission - check with local authority planning dept.
Party walls - check with a surveyor
Building Control - check with local authority planning dept.
(please refer to contact details in Appendix 1)

Restaurant areas (115.83msq) Flats areas (231.67msq)

Water and Drainage

Location	Measure	Cost	Justification
	Low flush fittings and aerated mixer taps	Taps £30-£200+	A simple measure that does not impact on other tenants.

Biodiversity

Location	Measure	Cost	Justification
	Window boxes, ensuring they are securely fixed to the window sill	Low	Contributes to the character of the area and improves biodiversity

Recycling

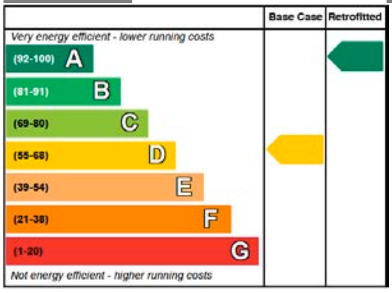
Location	Measure	Cost	Justification
	Segregate waste and recycling	None	Reduces the damage from landfill and saves depleting resources
	Food waste, composting and / or collection for anaerobic digestion.	None	Food contains enormous amounts of energy and can be converted into fuel to heat homes and businesses

Minimise other environmental impacts

Location	Measure	Cost	Justification
	Retaining historic fabric and restoration uses up less resources than building anew.	Low	Materials account for about half of the whole life carbon impacts of a building.
	Replacing carpet floor finishes with more durable materials such as timber generates significant embodied carbon savings over the lifetime of the building	Low	Materials account for about half of the whole life carbon impacts of a building.

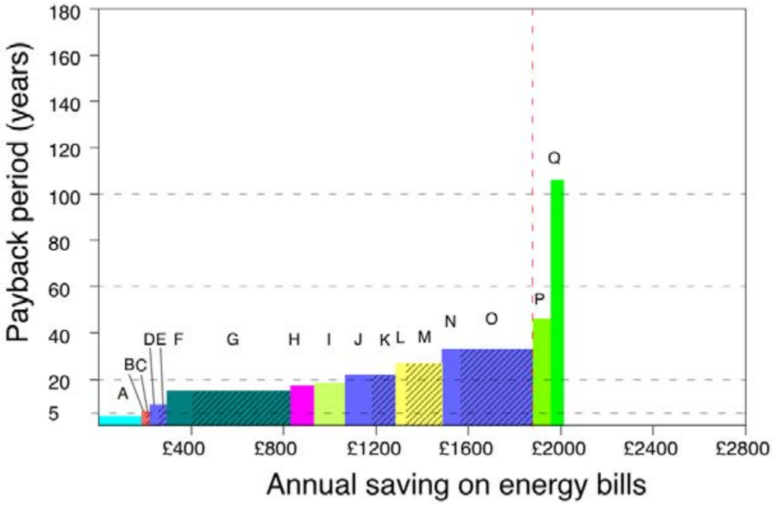
Operational Energy and Carbon

EPC



CO2 reduction	12.5 t/year

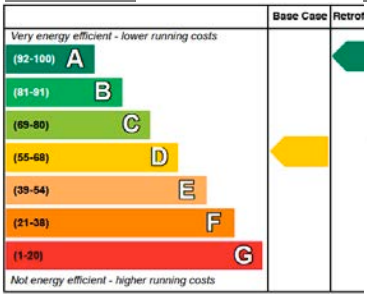
Graph of measures



Location	Measure	Cost	Saving	Payback
	Flats: floor 1-4			
METERING	Install in-use energy display (C)	£100	£18	6
HEATING/ HOT WATER	Install thermostatic radiator valves (E)	£325	£37	9
ENVELOPE	Draught proofing (G)	£6,296	£430	15
ROOF	Improved insulation of roof void (I)	£2,465	£135	18
HEATING/ HOT WATER	High efficiency fans and pumps (J)	£250	£11	22
WINDOWS	Secondary glazing - fixed (L)	£2,442	£159	27
HEATING/ HOT WATER	High efficiency gas heating/hot water (O)	£10,300	£315	33
	Restaurant: Ground floor & basement			
LIGHTING	LED lighting (A)	£805	£184	4
METERING	Install in-use energy display (B)	£100	£18	6
HEATING/ HOT WATER	Install thermostatic radiator valves (D)	£325	£37	9
ENVELOPE	Draught proofing (F)	£1,574	£107	15
VENTILATION	MVHR (H)	£1,775	£102	17
HEATING/ HOT WATER	High efficiency fans and pumps (K)	£250	£11	22
WINDOWS	Secondary glazing - fixed (M)	£610	£40	27
HEATING/ HOT WATER	High efficiency gas heating/hot water (N)	£2,575	£79	33
FLOORS	Floating timber floor over poly. board (P)	£3,620	£79	46
WALLS	Insulation behind existing panelling (Q)	£5,312	£50	106

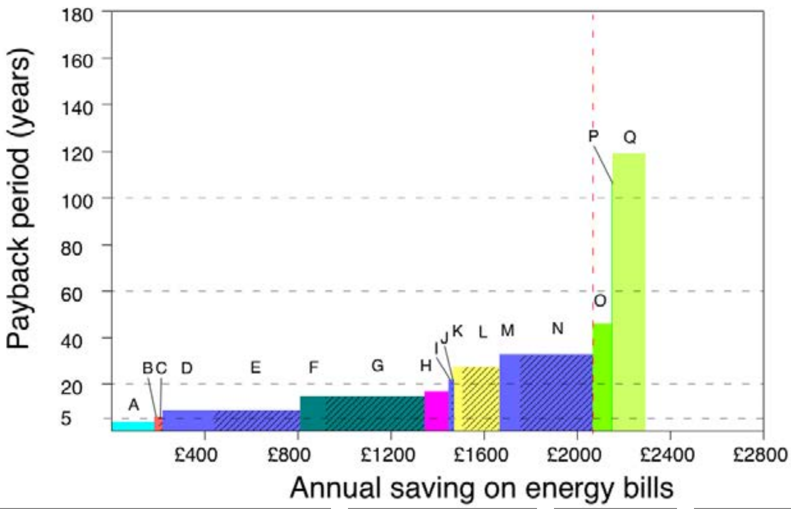
Operational Energy and Carbon

EPC

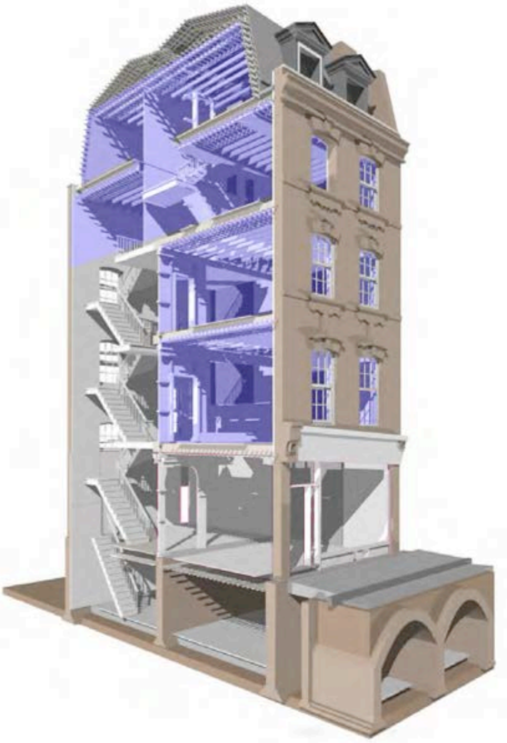


CO2 reduction	12.5 t/year

Graph of measures



Location	Measure	Cost	Saving	Payback
	Flats: floor 1-4			
METERING	Install in-use energy display (C)	£100	£18	6
HEATING/ HOT WATER	Install thermostatic radiator valves (E)	£325	£37	9
HEATING/ HOT WATER	High efficiency fans and pumps (J)	£250	£11	22
ENVELOPE	Draught proofing (G)	£6,296	£430	15
WINDOWS	Secondary glazing - fixed (L)	£2,442	£159	27
HEATING/ HOT WATER	High efficiency gas heating / hot water (N)	£10,300	£315	33
ROOF	New roof deck and insulation (Q)	£16,436	£138	119
	Restaurant: Ground floor and basement			
LIGHTING	LED lighting (A)	£805	£184	4
METERING	Install in-use energy display (B)	£100	£18	6
HEATING/ HOT WATER	Install thermostatic radiator valves (D)	£195	£22	9
ENVELOPE	Draught proofing (F)	£1,574	£107	15
VENTILATION	MVHR (H)	£1,775	£102	17
HEATING/ HOT WATER	High efficiency fans and pumps (I)	£250	£11	22
WINDOWS	Secondary glazing - fixed (K)	£610	£40	27
HEATING/ HOT WATER	High efficiency gas heating / hot water (M)	£2,575	£79	33
FLOORS	Floating timber floor over poly. board (O)	£5,136	£113	46
WALLS	Insulation behind existing panelling (P)	£5,312	£50	106



Overview

Description and Heritage Value

The extensive refurbishment of existing buildings offers many opportunites for sustainable retrofitting and improving the heritage value of Soho. Original features can be reintroduced at the same time as installing more efficient plant and improving the energy efficiency of the building fabric. The refurbishment of buildings to high sustainability standards also offers the opportunity to future-proof these assets as London's climate changes over the coming years. In addition the cost of incorporating these changes as part of a larger scope of works is often marginal, and significant savings can be achieved over the headline costs quoted here. For listed buildings these works will also be VAT-exempt.

Landlord tenant issues

Optimal provision of retrofit measures can be achieved where buildings are unoccupied during refurbishment. It is also recommended that additional future-proofing measures (such as potential for connection to CHP networks, pipework for greywater recycling, conduits for solar PV panels on the roof, and slots for window blinds) should be considered as and when they become financially viable.

Statutory Implications

Planning Permission - Check with local authority planning department
Party walls - check with a surveyor
Building Control - Check with local authority planning department
(please refer to contact details in Appendix 1)

Area of flats (231.67msq)

Water and Drainage

Location	Measure	Cost	Justification
	Low flush fittings and aerated mixer taps	Taps £30-£200+	Replacing taps and toilet flushes is simple and cost-effective
	Rainwater recycling in its simplest form could involve installing a water butt to collect water from a downpipe to help water the garden in dry months. More complex methods could involve collecting rainwater and water from sinks for reuse in flushing toilets (seek architectural advice on the risk to historic fabric).	Water butt c.£50. The cost of other solutions varies widely.	Water butts are simple to install. Reusing water internally is more compex, but is worth considering when carrying out an overhaul of an existing plumbing system.
	Sustainable Urban Drainage Systems (SUDS) minimise water entering sewers to help reduce the risk of flash floods in urban areas. In dense historic cores the best solutions are permeable surfaces and filter drains (seek architectural advice as these may cause damp issues).	Polymer bound permeable gravel surfaces c.£35/msq	These are simple to install as part of garden redesign or repaving areas.
	Greywater recycling is potentially the most complicated measure as it involves re-plumbing both the drainage and the water supply pipework of the house (seek architectural advice on the risk to historic fabric and tank space storage requirements).	Wide range of costs	This is worth considering when carring out an overhaul of an existing plumbing system.

Biodiversity

Location	Measure	Cost	Justification
	Green or brown roof (these measures are not suitable for all buildings, and specialist structural and planning advice is needed) or removal of hard landscaping in existing garden areas	50mm thick green roof £50 / 200mm thick £225/msq	Green roofs provide a range of other environmental benefits, such as insulation and reduced drainage)
	Bat boxes, bird boxes and habitat walls	£10-30	These simple measures provide homes for a range of birds and insects.

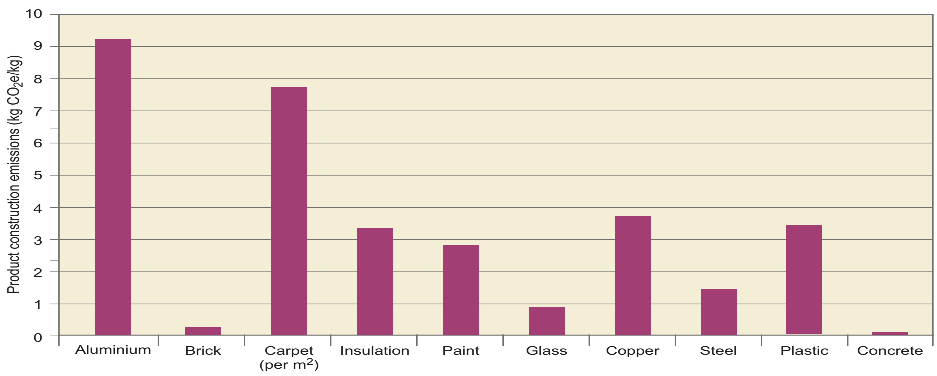
Recycling

Location	Measure	Cost	Justification
	Segregate waste and recycling	none	Reduces the damage from landfill and saves depleting more of the world's resources.
	Food waste, composting and / or collection for anaerobic digestion.	none	Food contains enormous amounts of energy and can be converted into fuel to heat homes and businesses.

Minimise other impacts from buildings

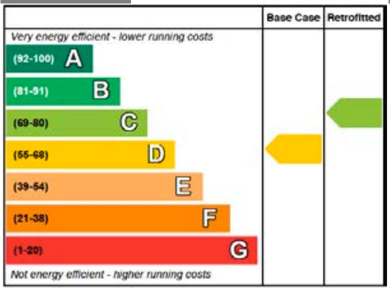
Location	Measure	Cost	Justification
	Retaining and restoring historic building fabric uses less resources than new development.	low	Materials account for about half of the whole life carbon impacts of a building.
	Careful selection of materials during refurbishment and upgrading, such as FSC rated timber, and avoiding the use of non-natural products such as plastics and resins.		FSC timber is sustainably sourced, with forests replanted. The manufacture of plastics usually creates toxic byproducts.
	Replacing carpet floor finishes with more durable materials such as timber generates significant embodied carbon savings over the lifetime of a building.	low	Materials account for about half of the whole life carbon impacts of a building.

Examples - Low embodied carbon materials

Cement	Ordinary Portland Cement generates a large amount of carbon dioxide during manufacture. Alternative products such as Fly Ash and Ground Granulated blast furnace slag (GGBS) have similar strength properties but much less embodied carbon. For example, for every kilogramme of GGBS used instead of ordinary Portland Cement, carbon dioxide emissions are reduced by 780g.	
Timber	Timber has the capacity to store carbon by absorbing it from the atmosphere during the growth of the tree. This benefit however can easily be lost if the land is not well managed, with new trees planted to replace those cut down. As a consequence, timber can be transformed from a net saver of carbon into a polluter. For every kilogramme of sustainably sourced (FSC) timber, carbon dioxide emissions are redued by 120g.	100% FSC www.fsc.org RECYCLED Made from recycled material FSC® C014189
Various		

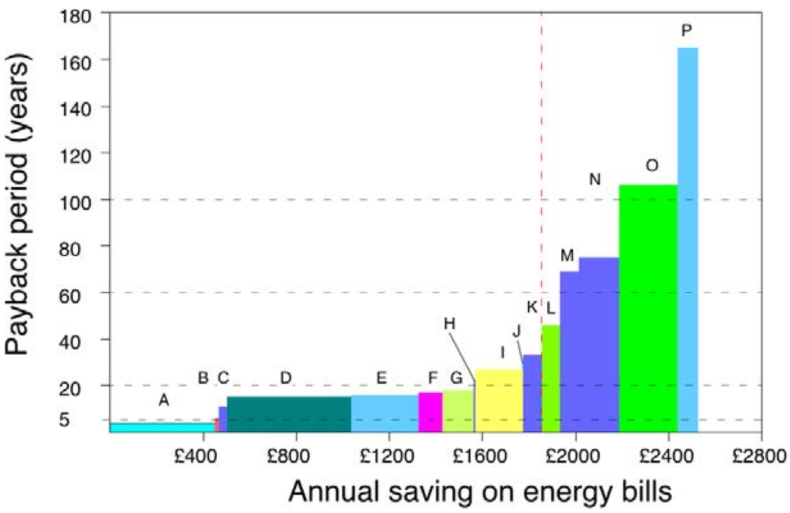
Operational Energy and Carbon

EPC



CO2 reduction	19.5 t/year

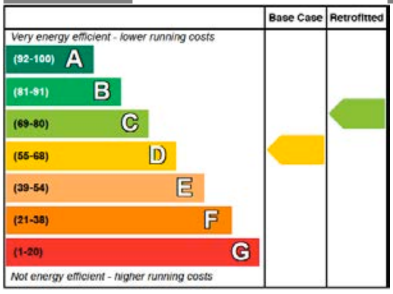
Graph of measures



Location	Measure	Cost	Saving	Payback
LIGHTING	LED lighting (A)	£1,960	£449	4
METERING	In usage energy display (B)	£100	£18	6
HEATING/ HOT WATER	Heat metering (C)	£400	£35	11
ENVELOPE	Draught proofing (D)	£7,870	£537	15
POWER	Domestic CHP unit (E)	£4,500	£287	16
VENTILATION	MVHR (F)	£1,775	£102	17
ROOF	Improved insulation of roof void (G)	£2,465	£135	18
HEATING/ HOT WATER	High efficiency fans and pumps (H)	£250	£11	22
WINDOWS	Secondary glazing - fixed (I)	£3,052	£198	27
LIGHTING	PIR sensors (J)	£190	£6	30
HEATING/ HOT WATER	High efficiency gas heating / hot water (K)	£2,575	£79	33
FLOORS	Floating timber floor over poly. board (L)	£3,620	£79	46
HEATING/ HOT WATER	Solar Thermal Panels (M)	£5,500	£80	69
HEATING/ HOT WATER	Ground Source Heat Pump (N)	£13,000	£173	75
WALLS	Insulation behind existing panelling (O)	£26,561	£250	106
POWER	Solar PV (P)	£14,000	£85	165

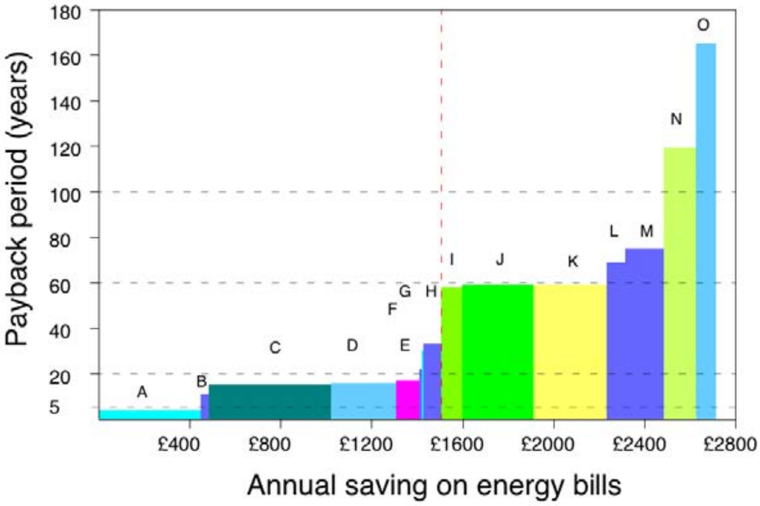
Operational Energy and Carbon

EPC



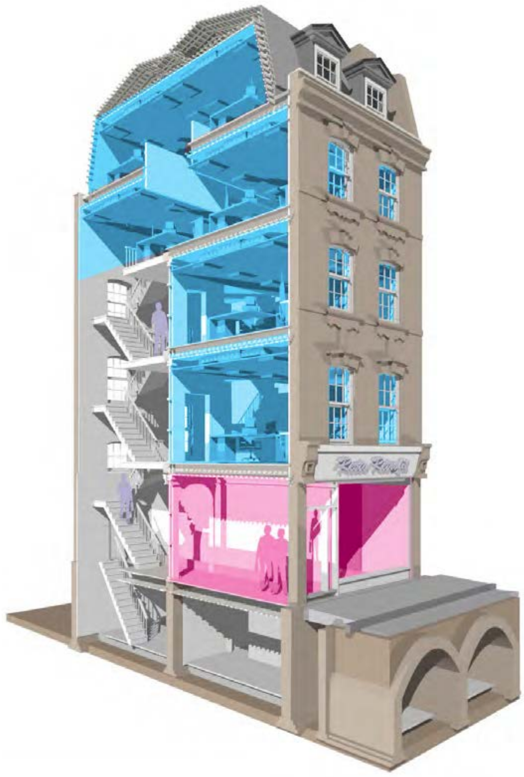
CO2 reduction	19.8 t/year

Graph of measures



Location	Measure	Cost	Saving	Payback
LIGHTING	LED lighting (A)	£1,960	£449	4
HEATING/ HOT WATER	Heat metering (B)	£400	£35	11
ENVELOPE	Draught proofing (C)	£7,870	£537	15
POWER	Domestic CHP unit (D)	£4,500	£287	16
VENTILATION	MVHR (E)	£1,775	£102	17
HEATING/ HOT WATER	High efficiency fans and pumps (F)	£250	£11	22
LIGHTING	PIR sensors (G)	£190	£6	30
HEATING/ HOT WATER	High efficiency gas heating/hot water (H)	£2,575	£79	33
FLOORS	Install new screed topped insulation layer (I)	£5,357	£92	58
WALLS	Internal insulation - high efficiency rigid (J)	£17,708	£301	59
WINDOWS	Replacement double glazed window (K)	£19,379	£326	59
HEATING/ HOT WATER	Solar Thermal Panels (L)	£5,500	£80	69
HEATING/ HOT WATER	Ground Source Heat Pump (M)	£13,000	£173	75
ROOF	New roof deck and insulation (N)	£16,436	£138	119
POWER	Solar PV (O)	£14,000	£85	165

SHOP WITH OFFICE ABOVE



Overview

Description and Heritage Value

These buildings are also a very common typology in the Soho Conservation Area and pose many challenges for retrofitting, given their size and the variety of plan forms. The advantage they have over flats is that they usually share more common services such as boilers, and landlords are able to play a greater role in delivering retrofitting improvements. These buildings provide a diversity of accommodation types, making them particularly attractive to the creative industries that give Soho its vibrancy and energy today.

Landlord tenant issues

The options proposed in this section reflect the limitations of working with existing and occupied historic buildings. Each retrofitting option described can be undertaken independently of other tenancies in the building. However, if sharing energy demand loads can be achieved then significant savings are possible. The key issues driving this are that larger plant installations are more energy efficient. Un-correlated energy demands can result in plant working at optimum efficiencies for longer periods. Finally, one tenant's waste energy may be another's energy demand.

Statutory Implications

Planning Permission - Check with local authority planning department
Party walls - check with a surveyor
Building Control - Check with local authority planning department (please refer to contact details in Appendix 1)

Shop areas (115.83msq) Office areas (231.67msq)

Water and Drainage

Location	Measure	Cost	Justification
	Low flush fittings and aerated mixer taps.	Taps £30-£200+	A simple measure that does not impact on other tenants.

Biodiversity

Location	Measure	Cost	Justification
	Window boxes, ensuring that they are securely fixed to window sills.	low	A simple measure that contributes to the character of the area and improves biodiversity.

Recycling

Location	Measure	Cost	Justification
	Segregate waste and recycling	none	Reduces the damage from landfill and avoids depleting resources.
	Food waste, composting and / or collection for anerobic digestion.	none	Food can be converted into fuel to heat homes and businesses.

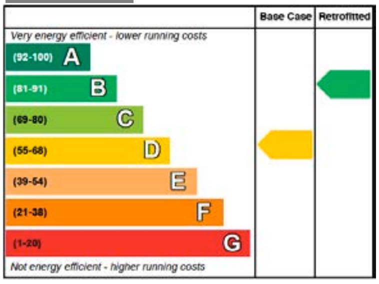
Minimise other impacts from buildings

Location	Measure	Cost	Justification
	Retaining and restoring historic building fabric uses less resources than building new.	low	Materials account for about half of the whole life carbon impacts of a building.
	Replacing carpet floor finishes with more durable materials such as timber generates significant embodied carbon savings over the lifetime of a building.	low	Materials account for about half of the whole life carbon impacts of a building.

Operational Energy and Carbon

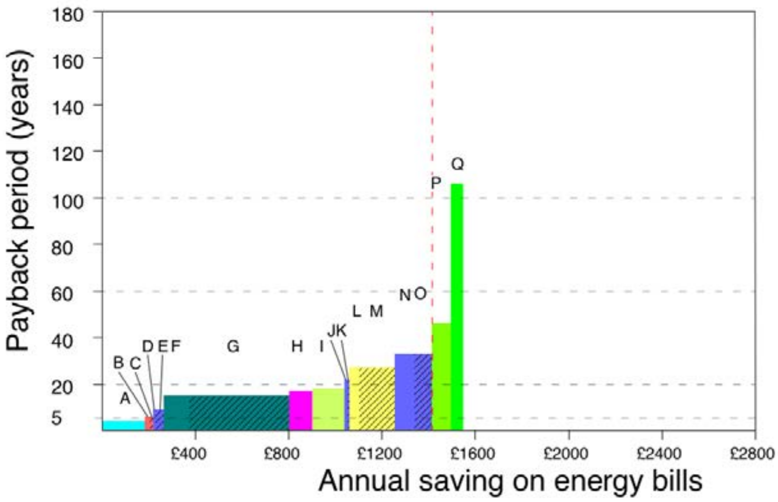
SHOP WITH OFFICE ABOVE (Listed)

EPC



CO2 reduction	14.0 t/year

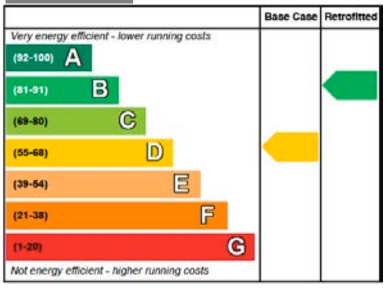
Graph of measures



Location	Measure		Cost	Saving	Payback
	Office space: floor 1-4				
METERING	In use energy display (C)		£100	£18	6
HEATING/ HOT WATER	Thermostatic radiator valves (E)		£325	£37	9
ENVELOPE	Draught proofing (G)		£6,296	£430	15
ROOF	Improved insulation of roof void (I)		£2,465	£135	18
HEATING/ HOT WATER	High efficiency fans and pumps (K)		£250	£11	22
WINDOWS	Secondary glazing - fixed (M)		£2,442	£159	27
HEATING/ HOT WATER	High efficiency gas heating / hot water (M)		£2,575	£79	33
	Shop: ground floor and basement				
LIGHTING	LED lighting (A)		£805	£184	4
METERING	In use energy display (B)		£100	£18	6
HEATING/ HOT WATER	Thermostatic radiator valves (D)		£65	£7	9
ENVELOPE	Draught proofing (F)		£1,574	£107	15
VENTILATION	MVHR (H)		£1,775	£102	17
HEATING/ HOT WATER	High efficiency fans and pumps (J)		£250	£11	22
WINDOWS	Secondary glazing - fixed (L)		£610	£40	27
HEATING/ HOT WATER	High efficiency gas heating / hot water (N)		£2,575	£79	33
FLOORS	Floating timber floor over poly. board (P)		£3,620	£79	46
WALLS	Insulation behind existing panelling (Q)		£5,312	£50	106

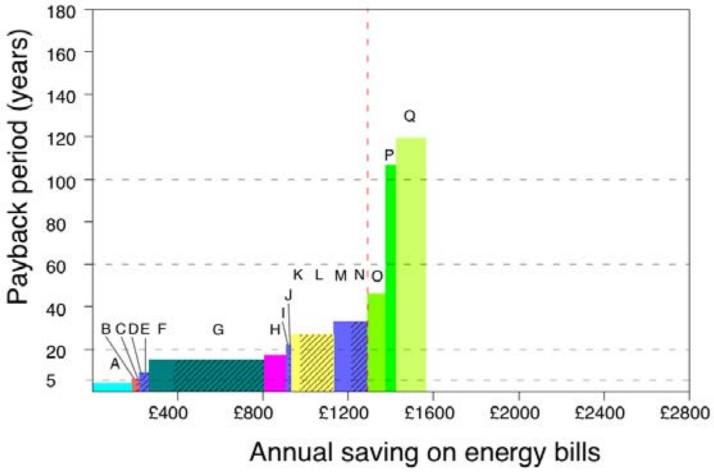
Operational Energy and Carbon

EPC



CO2 reduction	14.0 t/year

Graph of measures



Location	Measure	Cost	Saving	Payback
	Office space: Floor 1-4			
METERING	In use energy display (C)	£100	£18	6
HEATING/ HOT WATER	Thermostatic radiator valves (E)	£325	£37	9
ENVELOPE	Draught proofing (G)	£6,296	£430	15
HEATING/ HOT WATER	High efficiency fans and pumps (J)	£250	£11	22
WINDOWS	Secondary glazing - fixed (L)	£2,442	£159	27
HEATING/ HOT WATER	High efficiency gas heating/hot water (N)	£2,575	£79	33
ROOF	New roof deck and insulation (Q)	£16,436	£138	119
	Shop: ground floor and basement			
LIGHTING	LED lighting (A)	£805	£184	4
METERING	In use energy display (B)	£100	£18	6
HEATING/ HOT WATER	Thermostatic radiator valves (D)	£65	£7	9
ENVELOPE	Draught proofing (F)	£1,574	£107	15
VENTILATION	MVHR (H)	£1,775	£102	17
HEATING/ HOT WATER	High efficiency fans and pumps (I)	£250	£11	22
WINDOWS	Secondary glazing - fixed (K)	£610	£40	27
HEATING/ HOT WATER	High efficiency gas heating/hot water (M)	£2,575	£79	33
FLOORS	Floating timber floor over poly. board (O)	£3,620	£79	46
WALLS	Insulation behind existing panelling (P)	£5,312	£50	106

Overview

Description and Heritage Value

These buildings are mostly of a larger scale and located around the perimeter of Soho on Oxford Street, Charing Cross Road, Shaftesbury Avenue and Regent Street. Most are unlisted, although they have much to contribute to the character of the Conservation Area. In terms of the scope of works, most office redevelopment or refurbishment poses considerable challenges of working within the constraints of existing celluar historic fabric whilst integrating modern servicing requirements. The recommendations of this report offer some new ways of approaching these problems, by working in an integrated manner, improving the heritage value of the building fabric whilst improving levels of comfort for prospective tenants.

Landlord tenant issues

Optimal provision of retrofitting measures can be achieved where buildings are unoccupied during refurbishment. It is also recommended that future-proofing measures (such as the potential for connecting to CHP networks, pipework for greywater recycling, conduits for solar PV panels on the roof, slots for window blinds) should be considered as and when they become financially viable.

Statutory Implications

Planning Permission - Check with local authority planning department
Party walls - check with a surveyor
Building Control - Check with local authority planning department
(please refer to contact details in Appendix 1)

Office areas (231.67msq)

Water and Drainage

Location	Measure	Cost	Justification
	Low flush fittings and aerated mixer taps	Taps £30-£200+	Replacing taps and toilet flushes is simple and cost-effective
	Rainwater recycling in its simplest form could involve installing a water butt to collect water from a downpipe to help water the garden in dry months. More complex methods could involve collecting rainwater and water from sinks for reuse in flushing toilets (seek architectural advice on the risk to historic fabric).	Water butt c.£50. The cost of other solutions varies widely.	Water butts are simple to install. Reusing water internally is more compex, but is worth considering when carrying out an overhaul of an existing plumbing system.
	Sustainable Urban Drainage Systems (SUDS) minimise the volume of water entering sewers to help reduce the risk of flash floods in urban areas. In dense historic cores the best solutions are permeable surfaces and filter drains (seek architectural advice as these may cause damp issues).	Polymer bound permeable gravel surfaces c.£35/msq	These are simple to install as part of garden redesign or repaving areas.
	Greywater recycling is potentially the most complicated measure as it involves re-plumbing both the drainage and the water supply pipework of the house (seek architectural advice on the risk to historic fabric and tank space storage requirements).	Wide range of costs	This is worth considering when carring out an overhaul of an existing plumbing system.

Biodiversity

Location	Measure	Cost	Justification
	Green or brown roof (these measures are not suitable for all buildings, and specialist structural and planning advice is needed) or removal of hard landscaping in existing garden areas	50mm thick green roof £50 / 200mm thick £225/msq	Green roofs provide a range of other environmental benefits, such as insulation and reduced drainage)
	Bat boxes, bird boxes and habitat walls	£10-30	These simple measures provide homes for a range of birds and insects.

Recycling

Location	Measure	Cost	Justification
	Segregate waste and recycling	none	Reduces the damage from landfill and saves depleting resources.
	Food waste, composting and / or collection for anaerobic digestion.	none	Food can be converted into fuel to heat homes and businesses.

Minimise other impacts from buildings

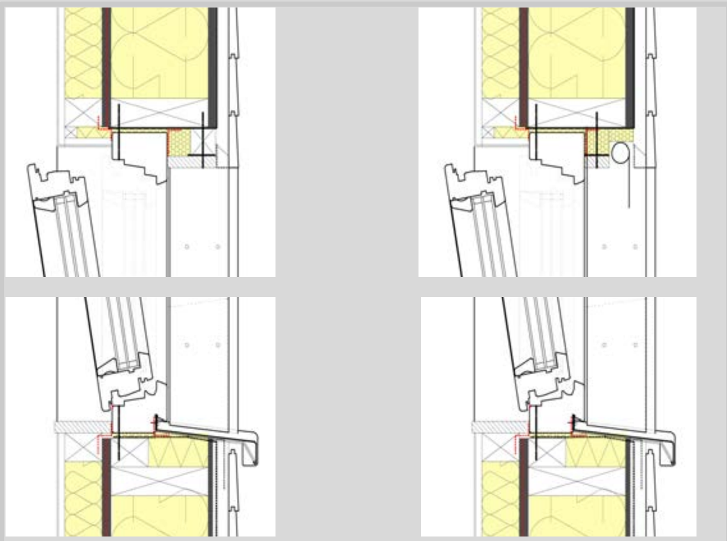
Location	Measure	Cost	Justification
	Retaining and restoring historic building fabric uses less resources than new development.	low	Materials account for about half of the whole life carbon impacts of a building.
	Careful selection of materials during refurbishment and upgrading, such as FSC rated timber, and avoiding the use of non-natural products such as plastics and resins.		FSC timber is sustainably sourced, with forests replanted. The manufacture of plastics usually creates toxic byproducts.
	Replacing carpet floor finishes with more durable materials such as timber generates significant embodied carbon savings over the lifetime of a building.	low	Materials account for about half of the whole life carbon impacts of a building.

Examples - Futureproofing Climate Change

		Heating	Electricity
Assess your risk?	Historic buildings with large cooling loads will be most at risk from global warming. Asset types such as offices and restaurants will be most exposed.	Demand will generally diminish	Demand will generally increase

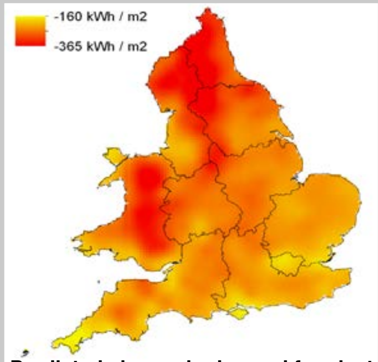
The impact of future climate change upon the non-domestic building stock is covered in detail in a forthcoming report by Sturgis Carbon Profiling for RICS (2012), *Non Domestic Real Estate Climate Change Model.*

Possible futureproofing solutions to respond to global warming include night-time purge venting and external blinds.

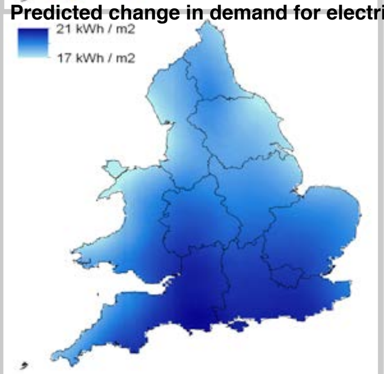


(Source: Bere Architects)

Predicted change in demand for heating



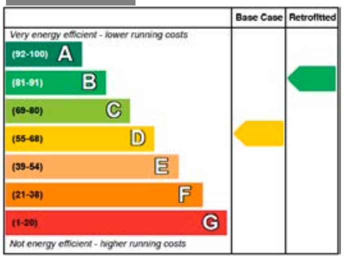
Predicted change in demand for electricity



(Source: Sturgis Carbon Profiling)

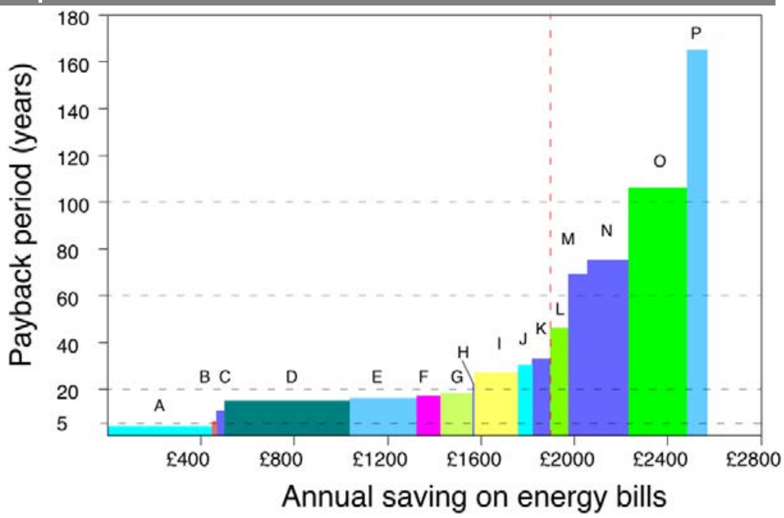
Operational Energy and Carbon

EPC



CO2 reduction	15.9 t/year

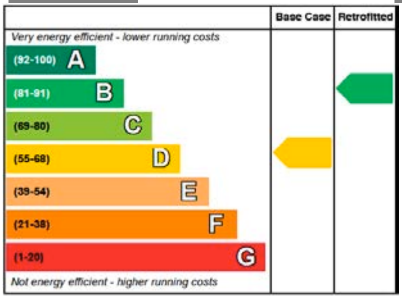
Graph of measures



Location	Measure	Cost	Saving	Payback
LIGHTING	LED lighting (A)	£1,960	£449	4
METERING	In usage energy display (B)	£100	£18	6
HEATING/ HOT WATER	Heat metering (C)	£400	£35	11
ENVELOPE	Draught proofing (D)	£7,870	£537	15
POWER	Domestic CHP unit (E)	£4,500	£287	16
VENTILATION	MVHR (F)	£1,775	£102	17
ROOF	Improved insulation of roof void (G)	£2,465	£135	18
HEATING/ HOT WATER	High efficiency fans and pumps (H)	£250	£11	22
WINDOWS	Secondary glazing - fixed (I)	£3,052	£198	27
LIGHTING	PIR sensors (J)	£190	£6	30
HEATING/ HOT WATER	High efficiency gas heating/hot water (K)	£2,575	£79	33
FLOORS	Floating timber floor over poly. board (L)	£3,620	£79	46
HEATING/ HOT WATER	Solar thermal panels (M)	£5,500	£80	69
HEATING/ HOT WATER	Ground source heat pump (N)	£13,000	£173	75
WALLS	Insulation behind existing panelling (O)	£26,561	£250	106
POWER	Solar PV (P)	£14,000	£85	165

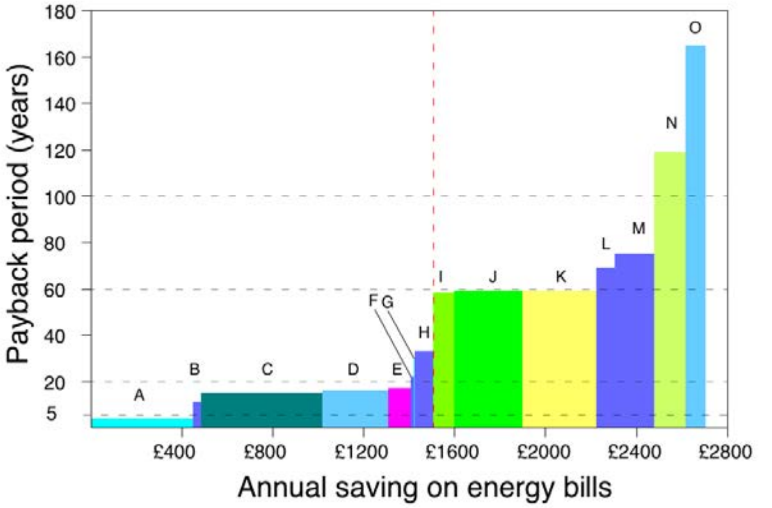
Operational Energy and Carbon

EPC



CO2 reduction	17.9 t/year

Graph of measures



Location	Measure	Cost	Saving	Payback
LIGHTING	LED lighting (A)	£1,960	£449	4
HEATING/ HOT WATER	Heat metering (B)	£400	£35	11
ENVELOPE	Draught proofing (C)	£7,870	£537	15
POWER	Domestic CHP unit (D)	£4,500	£287	16
VENTILATION	MVHR (E)	£1,775	£102	17
HEATING/ HOT WATER	High efficiency fans and pumps (F)	£250	£11	22
LIGHTING	PIR sensors (G)	£190	£6	30
HEATING/ HOT WATER	High efficiency gas heating/hot water (H)	£2,575	£79	33
FLOORS	Install new screed topped insu. layer (I)	£5,357	£92	58
WALLS	Internal insulation - high efficiency rigid (J)	£17,708	£301	59
WINDOWS	Replacement double glazed window (K)	£19,379	£326	59
HEATING/ HOT WATER	Solar thermal panels (L)	£5,500	£80	69
HEATING/ HOT WATER	Ground source heat pump (M)	£13,000	£173	75
ROOF	New roof deck and insulation (N)	£16,436	£138	119
POWER	Solar PV (O)	£14,000	£85	165

HOUSE

Overview

Description and Heritage Value

These buildings are rare even in Soho, as most original 17th Century single family homes have been either converted into multiple accommodation units or demolished and replaced by larger properties. They provide evidence of the character of the area in the past, through original features and plan forms. They will need to be retrofitted with sensitivity to avoid damaging this valuable historic legacy. The most significant retrofitting oportunities are likely to be in improvements to central plant and alternative means of meeting energy demands through renewable technologies.

Landlord tenant issues

Most of these buildings are owner-occupied, which is beneficial as the split incentive issues which arise in the case of multi-tenanted buildings do not occur. This may encourage some occupiers to consider measures with longer payback periods, given the greater security they have of being able to capitalise these measures over longer periods.

Statutory Implications

Planning Permission - Check with local authority planning department
Party walls - check with a surveyor
Building Control - Check with local authority planning department
(please refer to contact details in Appendix 1)

Residential (347.5 msq)

Water and Drainage

Location	Measure	Cost	Justification
	Low flush fittings and aerated mixer taps	Taps £30-£200+	Replacing taps and toilet flushes is simple and cost-effective
	Rainwater recycling in its simplest form could involve installing a water butt to collect water from a downpipe to help water the garden in dry months. More complex methods could involve collecting rainwater and water from sinks for reuse in flushing toilets (seek architectural advice on the risk to historic fabric).	Water butt c.£50. The cost of other solutions varies widely.	Water butts are simple to install. Reusing water internally is more compex, but is worth considering when carrying out an overhaul of an existing plumbing system.
	Sustainable Urban Drainage Systems (SUDS) minimise the volume of water entering sewers to help reduce the risk of flash floods in urban areas. In dense historic cores the best solutions are permeable surfaces and filter drains (seek architectural advice as these may cause damp issues).	Polymer bound permeable gravel surfaces c.£35/msq	These are simple to install as part of garden redesign or repaving areas.
	Greywater recycling is potentially the most complicated measure as it involves re-plumbing both the drainage and the water supply pipework of the house (seek architectural advice on the risk to historic fabric and tank space storage requirements).	Wide range of costs	This is worth considering when carring out an overhaul of an existing plumbing system.

Biodiversity

Location	Measure	Cost	Justification
	Green or brown roof (these measures are not suitable for all buildings, and specialist structural and planning advice is needed) or removal of hard landscaping in existing garden areas	50mm thick green roof £50 / 200mm thick £225/msq	Green roofs provide a range of other environmental benefits, such as insulation and reduced drainage)
	Bat boxes, bird boxes and habitat walls	£10-30	These simple measures provide homes for a range of birds and insects.

Recycling

Location	Measure	Cost	Justification
	Segregate waste and recycling	none	Reduces the damage from landfill and saves depleting more of the world's resources.
	Food waste, composting and / or collection for anaerobic digestion.	none	Food contains enormous amounts of energy and can be converted into fuel to heat homes and businesses.

Minimise other impacts from buildings

Location	Measure	Cost	Justification
	Retaining and restoring historic building fabric uses less resources than new development.	low	Materials account for about half of the whole life carbon impacts of a building.
	Careful selection of materials during refurbishment and upgrading, such as FSC rated timber, and avoiding the use of non-natural products such as plastics and resins.		FSC timber is sustainably sourced, with forests replanted. The manufacture of plastics usually creates toxic byproducts.
	Replacing carpet floor finishes with more durable materials such as timber generates significant embodied carbon savings over the lifetime of a building.	low	Materials account for about half of the whole life carbon impacts of a building.

Examples - biodiversity

Bat box -Should be large enough to allow a maternity colony to cluster to conserve heat to keep the babies warm.

Bird boxes - Different sized holes attract different types of birds to nest

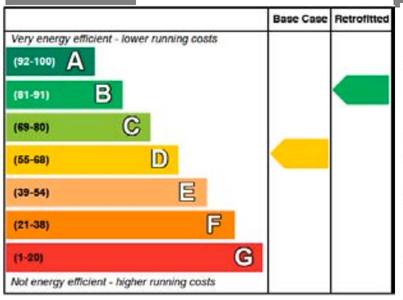
Habitat walls -These provide a simple way in garden walls to provide wintering spaces for insects.

Extensive Green Roof - Use of a sedum mat only requires a 50mm build up and has limited structural implications

Intensive Green Roof - Much thicker build up but can accommodate a wider variety of plant species

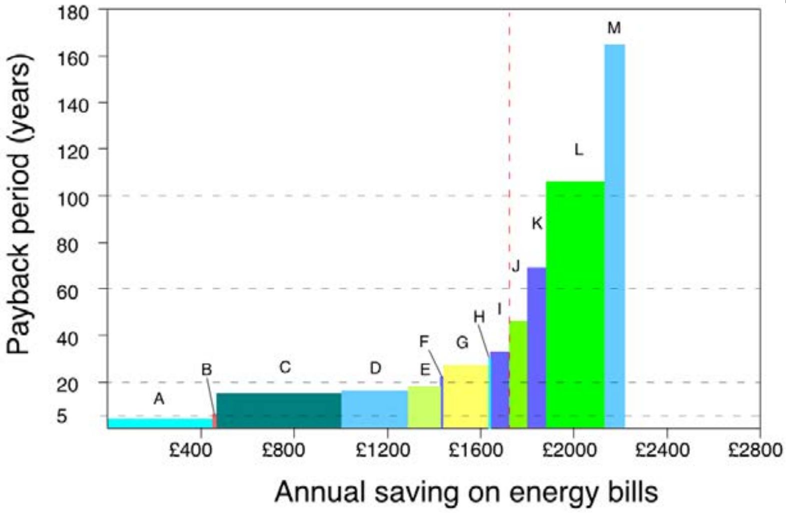
Operational Energy and Carbon

EPC



CO2 reduction	14,3 t/year

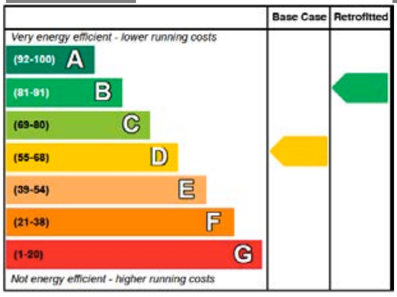
Graph of measures



Location	Measure	Cost	Saving	Payback
LIGHTING	LED lighting (A)	£1,960	£449	4
METERING	In usage energy display (B)	£100	£18	6
ENVELOPE	Draught proofing (C)	£7,870	£537	15
POWER	Domestic CHP unit (D)	£4,500	£287	16
ROOF	Improved insulation of roof void (E)	£2,465	£135	18
HEATING/ HOT WATER	High efficiency system (F)	£250	£11	22
WINDOWS	Secondary glazing - fixed (G)	£3,052	£198	27
LIGHTING	PIR sensors (H)	£190	£6	30
HEATING/ HOT WATER	High efficiency gas heating / hot water (I)	£2,575	£79	33
FLOORS	Floating timber floor over poly. board (J)	£3,620	£79	46
HEATING/ HOT WATER	Solar thermal panels (K)	£5,500	£80	69
WALLS	Insulation behind existing panelling (L)	£26,561	£250	106
POWER	Solar PV (M)	£14,000	£85	165

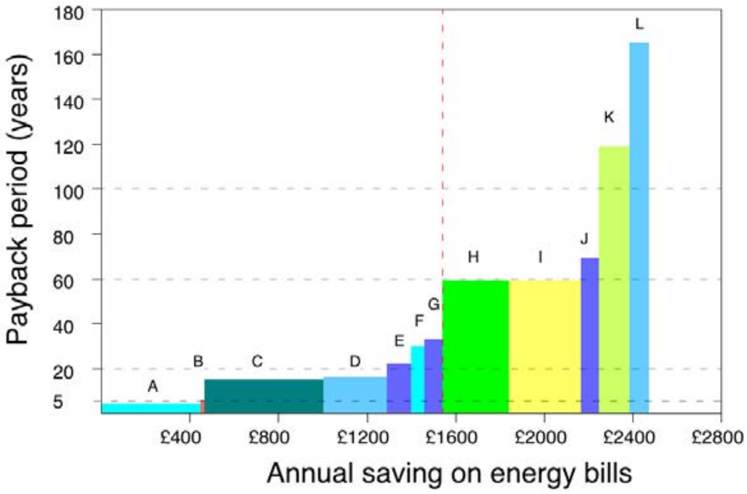
Operational Energy and Carbon

EPC



CO2 reduction	15.4 t/year

Graph of measures



Location	Measure	Cost	Saving	Payback
LIGHTING	LED lighting (A)	£1,960	£449	4
METERING	In usage energy display (B)	£100	£18	6
ENVELOPE	Draught proofing (C)	£7,870	£537	15
POWER	Domestic CHP unit (D)	£4,500	£287	16
HEATING/ HOT WATER	High efficiency fans and pumps (E)	£250	£11	22
LIGHTING	PIR sensors (F)	£190	£6	30
HEATING/ HOT WATER	High efficiency gas heating/hot water (G)	£2,575	£79	33
WALLS	Internal insulation - high efficiency rigid (H)	£17,708	£301	59
WINDOWS	Replacement double glazed window (I)	£19,379	£326	59
HEATING/ HOT WATER	Solar thermal panels (J)	£5,500	£80	69
ROOF	New roof deck and insulation (K)	£16,436	£138	119
POWER	Solar PV (L)	£14,000	£85	165

Community based interventions

Overview

Although focusing on interventions involving fewer stakeholders allows potential conflicts and complexity to be minimised, scaling up to community wide initiatives can offer many benefits, particularly through efficiencies in scale. This section examines how residents, businesses and Westminster City Council could co-operate to achieve low carbon retrofitting across the Soho conservation area. As such, it is intended as a starting point for local community and business groups to consider possible projects.

In some situations, one resident's energy problem can be another's energy solution: for example, waste heat from a restaurant's air conditioning units could be used to provide hot water for the flats above, if the two spaces were served by an integrated plant. Under these circumstances, both the restaurant and residents could achieve lower electricity bills as a result. Similarly, spare heat from retail units and offices could be used to heat flats and houses nearby.

Anaerobic digestors break down food waste and other biomass, releasing methane which can be used to generate heat and electricity or fed into the National Grid. They could provide a commercially viable source of energy in an area with large numbers of restaurants and other food outlets. They are eligible for subsidies from the Feed In Tariffs Scheme and the Renewable Heat Incentive, and for Renewables Obligation Certificates, and WRAP operates a loan scheme for plant, equipment and groundworks. Operators normally need an environmental permit from the Environment Agency, and planning permission from the minerals and waste planning authority (in London, the local authority)[1].

Figure 15: Restaurant with flats above

Source: Sturgis Carbon Profiling

To assess the potential of wider community based interventions to reduce carbon emissions, this section begins by estimating the total annual energy consumption and emissions in the area, and the potential savings available from retrofitting all buildings in the area on an individual basis.

The merit of installing combined heat and power (CHP) on a shared basis is then assessed using data from existing studies and projects. This methodology requires some high level assumptions in order to deal with the limitations of the data available. A more robust analysis would be needed to identify with any confidence the feasibility of particular options and to build a business case for specific projects. The financial viability and potential to reduce carbon emissions of different options is also sensitive to the price and carbon intensity of mainstream gas and electricity[2].

An illustration of how the widespread adoption of shared schemes might develop in the longer term is given in Appendix 4.

---

[1] The Official Information Source on Anaerobic Digestion (http://www.biogas-info.co.uk/)

[2] Figures assume gas and electricity prices of £0.05/kWh and £0.15/kWh, and carbon intensity of 0.206kgCO_2/kWh and 0.591kgCO_2/kWh respectively, unless otherwise stated.

Potential carbon savings from retrofitting individual buildings

To provide some context for assessing community based interventions, this section estimates the potential for savings in energy use, costs and carbon emissions from retrofitting individual buildings across the whole of the Soho area (based on figures modeled for the previous sections, for a building containing a ground floor retail unit and offices above). The methodology and data are given in Appendix 5.

Total annual energy usage for Soho was estimated to be 200,868 MWh, giving total annual emissions of 59,171 tCO_2. The potential annual savings were estimated for two scenarios: partial and complete uptake of the suggested retrofitting measures (70% and 100% of the building stock, respectively).

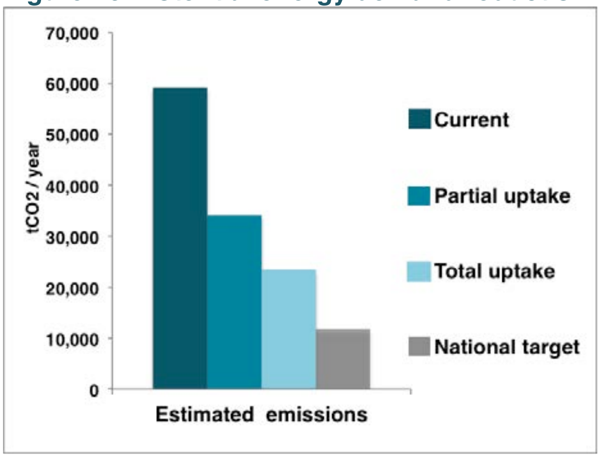
The potential reduction in energy demand across Soho (Figure 16) was estimated to be:

- 79,364 MWh per year (partial uptake);
- 113,377 MWh per year (total uptake);

leaving a residual demand of:

- 121,503 MWh per year (partial uptake);
- 87,490 MWh per year (total uptake).

Figure 16: Potential energy demand reduction



Source: Sturgis Carbon Profiling

The potential reduction in CO_2 emissions (Figure 17) was estimated at:

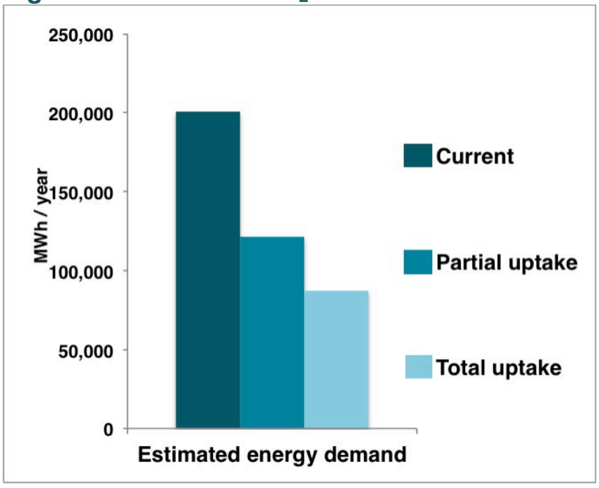
- 25,055 tCO_2 per year (partial uptake);
- 35,794 tCO_2 per year (total uptake);

reducing total emissions in Soho to:

- 34,115 tCO_2 per year (partial uptake);
- 23,377 tCO_2 per year (total uptake);

a fall of 50% to 60%, less than the UK target of 80% by 2050.

Figure 17: Potential CO_2 emissions reduction



Source: Sturgis Carbon Profiling

The aggregate cost savings to building owners would be:

- £6,229,361 per year (partial uptake);
- £8,899,088 per year (total uptake[3]).

These savings need to be viewed in the context of the repayment periods associated with retrofitting unlisted and listed buildings to the extent required to achieve these reductions.

---

[3] The partial uptake rate is given only to highlight the fact that complete uptake is almost certain to be unachievable. In practice, the uptake rate may be lower.

Combined heat and power at local and district levels

Introduction

District heating networks using combined heat and power (CHP) (and/or recovering and reusing waste heat) are a key element of the Mayor of London's Energy Strategy (2011)[4].

The most common types currently being developed in London are gas-fired CHP based schemes, although biomass-fuelled boilers are also being integrated into some schemes in conjunction with gas CHP. By utilising both heat and power, high total efficiencies and reductions in carbon emissions are being achieved, and such schemes are increasingly making an important contribution to delivering sustainable energy supplies across London. They can also contribute to reducing fuel poverty, by producing affordable energy for tenants on low-incomes.

Figure 18: CHP engine at Grosvenor Waterside, SW1

Source: Vital Energi (http://www.vitalenergi.co.uk/)

In many cases, new developments are also being designed to connect into future heat networks (where relevant) or to safeguard for running on alternative renewable fuels in the future. In the longer term, a large scale transition from natural gas to alternative lower carbon fuel sources is expected, with local and wider area heat networks playing a role in delivering heat from these sources.

[4] Mayor of London (2011)

To allow for the future development and expansion of district energy networks within Westminster, new developments and major refurbishments are expected by Westminster City Council to futureproof schemes for district energy connection where appropriate.

In most cases this will take the form of the development having one central energy centre providing heating and cooling to all the unit(s) within the scheme. This energy centre will be located within an area of the scheme that will allow for easy access and future connection to heating and or cooling pipes serving the district area. This may take the form of locating the energy centre in basement near to the public highway, or designing in conduit space for pipes and heat exchangers that can be retained for future pipes and connection to the district wide network.

CHP systems generate electricity on-site and use heat that would otherwise be wasted in the process in order to deliver heating and hot water to a building or a group of buildings (and/or separate units within individual buildings, depending on the size of the system). The buildings are connected by a network of pipes (a local heat network). The electricity generated can be supplied to buildings embedded within the scheme through private wire connections or sold via the National Grid (or a combination of the two). Moves are also under way to modify Electricity Supply Licensing laws to enable such schemes to retail electricity to consumers across local distribution networks.

Gas fired CHP is a mature technology and many case studies of its use throughout the UK and Europe can be cited. The financial viability of CHP schemes depends largely on the amount of heat utilisation and the value of the electricity generated in relation to the gas consumed. The financial viability of heat networks further depends on many factors including construction costs, the 'heat density' of the area (the amount of heat that can be sold per linear metre of investment in pipework) and the heat selling price, which is also a function of the alternative heat costs that potential customers have to pay (including the Carbon Reduction Commitment and Climate Change Levy for example). Densely populated areas within London such as Soho are generally considered to be potentially suitable, as the London Heat map indicates, although viability must always be established on a scheme-by-scheme basis due to the numerous local factors that can affect scheme economics.

Within London, the Energy Strategy identifies three levels of CHP project:

- *'Single site' schemes* – these would typically produce 0.3-3MW of electricity and a similar amount of heat, for up to 3,000 housing units, involving little or no district heating network. Construction costs would be in the order of £10million, with an expected payback period of five years (examples include Cranston Estate in Shoreditch, the National Sports Centre in Croydon, and Tachbrook Triangle in Pimlico);

Figure 19: Tachbrook Triangle, SW1

Source: Assael

- *'Multi-site mixed use' schemes* – these would typically produce 3-40MW of electricity and a similar amount of heat, for 3,000 to 20,000 housing units and neighbouring business users. They could involve the connection of several existing single-site schemes, thus benefiting from efficiencies of scale and income generation. Construction costs would be in the order of £100million, with an expected payback period of six to ten years (examples include Southwark MUSCO, the Olympic Site, Kings Cross Central, the linking of Whitehall to Pimlico DHU, and Greenwich Peninsula);

- *Area-wide schemes* – these would typically serve 100,000 or more housing units, linking electricity producers throughout the area. They could develop by a gradual process of linking multi-site schemes over the longer term. Capital costs would be in the order of £100m, with an expected payback period of 10-15 years and the potential to provide a stable source of energy and income generation (only one example is currently under discussion in London, the planned Thames Gateway Heating Network).

The 'single site' category is often used to refer to new build developments which, although they may include a number of buildings and several thousand housing units, have a coherent management structure that encompasses the whole of the design, planning and implementation/delivery process. This means that a self-contained CHP system can be designed and commissioned as an integral part of the overall development.

Feasibility of CHP schemes in Soho

Although new build developments on the scale described above are unlikely to come forward within the Soho area, CHP systems can also be installed within individual buildings/ sites on a smaller scale. Mini-CHP systems (requiring a footprint of about 6msq) are now commonly used in, for example, London Fire Brigade stations and some London hotels, and would also be suitable for other buildings on this scale with a relatively high and consistent demand for heating. Micro-CHP systems are about the size of a household boiler and could potentially be suitable for use by individual households. Both can be purchased and installed 'off-the-shelf' from UK-based suppliers, without the involvement of the local authority (although Listed Building Consent may be needed).

Figure 20: Many London Fire Brigade stations use mini-CHP systems

Source: Combined Heat & Power Association

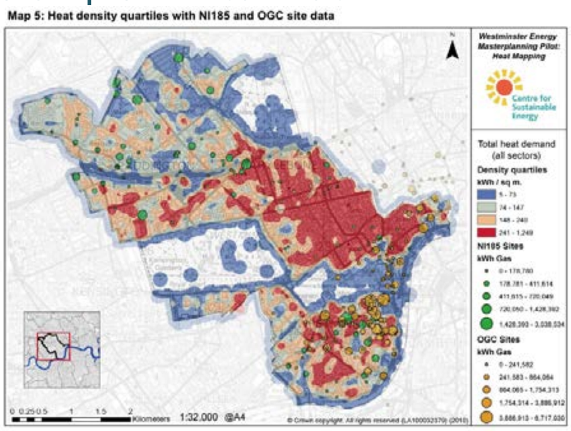
Schemes serving mixed-use developments (a group of buildings with a range of different uses) are potentially more efficient as the demand for heating and hot water can be more evenly balanced (with, for example, residential demand high in the mornings and evenings, and office demand high during the day). Buildings with inherently high heating/hot water demands (such as heated swimming pools and hotels) are particularly useful as 'anchor' clients for these systems, as they would guarantee a high and consistent heating load. However, larger schemes would involve laying pipes underneath the road, to connect the system to the buildings in the network, and hence would involve the local authority giving permission for road closures.

Energy Service Companies (ESCOs) have emerged over the last few years as providers of energy services to organisations such as local authorities, private developers and housing associations, offering a range of different functions at a variety of scales. A variety of models exist, covering design, construction, commissioning, operation and maintenance and in some cases ownership of the assets. Contracts normally extend as a minimum to cover an ESCO's responsibilities for delivering heat to buildings and for operation, maintenance and refurbishment of the system over a fixed concession period, typically 25 years.

In the longer term, the Mayor's Energy Strategy looks towards linking small cluster based schemes into wider area heat networks in order to benefit from efficiencies of scale, balance out localised variations in demand and supply and facilitate the transition from local heat networks using gas-fired CHP to larger scale heat networks capable of integrating alternative and multiple low carbon fuel and heat sources in order to facilitate the long-term decarbonisation of London's energy supply.

Two areas of on-going research are contributing to the knowledge base for this strategy. Firstly, the London Heat Map project has identified levels of demand for heating across London as a whole and within specific areas[5]. This will aid the identification of areas in which demand for heat is sufficiently dense to make district heating networks financially viable. Figure 21 overlays the map of heat demand in Westminster with local authority and central government consumers, which might provide suitably large 'anchor' heat loads for CHP schemes (Soho is within an area of high heat demand, although residential heat demand is low and the area contains only one small local authority site).

Figure 21: Heat demand density and gas consumption in Westminster



Source: Centre for Sustainable Energy

Secondly, a Design Manual for London[6], which aims to make sure that different systems are being designed to be technically

[5] Centre for Sustainable Energy, 2010

[6] Mayor of London, 2011b

compatible and suitable for future interconnection, is currently in preparation by the Greater London Authority.

To allow for the future development and expansion of district energy networks within Westminster, all new developments and major refurbishments in the borough will be expected to futureproof schemes for district energy connection where appropriate.

In most cases this will take the form of the development having one central energy centre providing heating and cooling to all the unit(s) within the scheme. This energy centre will be located within an area of the scheme that will allow for easy access and future connection to heating and or cooling pipes serving the district area. This may take the form of locating the energy centre in basement near to the public highway, or designing in conduit space for pipes and heat exchangers that can be retained for future pipes and connection to the district wide network.

The remainder of this section presents two hypothetical examples of CHP schemes that could be installed within the Soho area, providing indicative costs and savings based on similar projects implemented elsewhere in the country.

'Single development' scheme

This type of scheme would typically comprise a small group of new buildings on a single development site, and would be likely to include a mix of residential and commercial uses. The project developer (typically a private developer or housing association) would enter into a contract with an ESCO to design, construct (potentially own) and operate the scheme. The energy centre for this type of scheme would either be constructed as a new building on the site or be located within a basement plantroom of one of the developments. This decision would probably depend on the size of scheme. The costings given below assume construction within a basement plantroom of one of the developments.

The scheme would be funded by the developer or financed by an ESCO under an ESCO based ownership model. Tenants and leaseholders of the buildings connecting to the scheme would enter into heat supply agreements with the service provider. Electricity would typically be sold to customers within the development.

Local authority planning permission would be required for such a scheme, along with approval from the GLA under the terms of the London Plan. Local authority planning permission would need to include approval of the scheme's emissions, noise and visual impact. As noted above, however, Westminster City Council positively encourages such schemes.

Construction would be relatively easy for this type of scheme, in the absence of retrofitting complications and the need to lay heat networks in the public highway.

'Multi-site mixed-use' scheme

This type of scheme would typically be formed from a group of buildings with mixed uses, some of which would be existing and some of which could be new developments. The scheme would probably be centred around the largest heat user in the scheme (the 'anchor load').

This type of scheme would typically require a heat network to be constructed through the public highway. This would require approvals from the local authority and highways authority and could significantly increase construction costs, particularly in central London. Access across private land (if necessary) would also require permissions (wayleaves) from land owners. The energy centre for this type of scheme could be located in an existing building or structure (such as a hotel, local authority owned building, leisure centre or car park) or could be constructed as a new build energy centre on land purchased specifically for this purpose. (The costings below assume construction of a new build energy centre but exclude land purchasing costs or forfeited lease value).

Figure 22: Multi-site schemes could be based around large single buildings (Kemp House)

(Source: Sturgis Carbon Profiling)

Electricity could be sold to customers connected to the scheme (prior to the point of grid connection), with the surplus being sold to the grid or retailed under Ofgem's forthcoming Electricity Licence Lite proposals. Electricity selling arrangements would typically determine the size of such a scheme.

Local authority planning permission would be required for such a scheme. This would include approval of the scheme's emissions, noise and visual impact.

At this level, it might be appropriate for the local authority to become a party to the scheme, since it could potentially offer buildings or land on which an energy centre could be constructed, leverage low cost borrowing and offer anchor heat loads to support the scheme. This might typically be done by the local authority forming an Arms Length Organisation or by forming a joint venture partnership with a private sector ESCO.

Figure 23: Car parks may provide space to locate an energy centre (Poland Street)

(Source: Sturgis Carbon Profiling)

Tenants of the buildings connecting to the scheme would enter into supply contracts with the service provider and would need to provide consent and access for works to their property (involving installation of heat exchanger units, pipework and meters). The service provider would need to guarantee hot water for heating and domestic hot water supply at an agreed price under a heat supply agreement. Electricity could potentially also be sold to customer in the scheme. There would typically be greater complexity around the negotiation of heat supply agreements than for the single development scheme, particularly when existing buildings are involved. The service provider would also carry greater development risk in relation to heat offtake.

A variety of funding sources could be available. As a party to such a scheme, the local authority could potentially attract funding through the Local Authority Internal Reserves, Public Works Loan Board, developer contributions (through the Community Infrastructure Levy or Section 106 Agreements) and allowable solutions. A private sector owned scheme could potentially access Enhanced Capital Allowances to write off the whole of the capital cost of an investment against taxable profits in the first year of operation.

Retrofitting CHP plant and equipment into existing buildings could potentially create many technical issues including access for construction and maintenance, limitations on the scope to modify existing buildings due to listed building status, structural issues, noise containment, ventilation and flues, upgrading of utility connections, and access for thermal storage. Construction of heat networks could also be costly due to issues around existing utilities, contamination and archaeology. Despite these complexities, CHP is a potentially very effective solution that could enable the heritage value of the built environment to be preserved, and warrants further detailed consideration.

Figure 24: Refurbishment of large disused buildings may provide opportunities to develop multi-site schemes (Peter Street)

(Source: Sturgis Carbon Profiling)

Historic infrastructure networks can often be reused to great effect as new technologies replace old ones. For example, from 1871 to 1977 the London Hydraulic Power Company used its network of 150 miles of hydraulic mains to supply power to the city. The network was subsequently sold to a communications company and has been used to lay a new network of fibre optic cables.

Figure 25: London Hydraulic Power Company network

Source: Subterranea Britannica

Indicative costings

Indicative costings for the two schemes in question are provided below. These are based on high level assumptions around the schemes' capital and operating expenditure and contributions towards energy production. The single development scheme assumes a 200kW CHP, whilst the multi-site mixed-use scheme assumes a 1MWe CHP. The upper figures quoted represent a 25% uplift on the lower figures in order to provide a range. The costs for any individual scheme would need to be assessed on an individual basis and the network costs quoted are purely for illustration purposes since they are not based on any particular network plan.

Table 1: Indicative costings for CHP systems

	units	Single Development		Multi-site mixed-use	
		lower	upper	lower	upper
Total heat supplied	[MWh]	2,216	2,216	10,189	10,189
CHP size	[kWe]	200	200	1,000	1,000
Capital cost of energy centre	[£]	1,082,000	1,352,500	2,975,000	3,718,750
Capital cost of heat network	[£]	300,000	375,000	1,500,000	1,875,000
Area required for plant	[msq]	280	350	426	533
Opportunity cost (forgone rental value)	[£]	18,083	22,604	27,513	34,423
CHP running hours (per year)	[hr]	5,000	5,000	5,000	5,000
Electricity produced	[MWh]	1,000	1,000	5,000	5,000
CHP heat	[MWh]	1,219	1,219	5,604	5,604
gas boiler heat	[MWh]	997	997	4,585	4,585
Annual fuel consumption (gas)	[MWh]	4,371	4,371	19,329	19,329
Annual cost of gas	[£]	111,669	111,669	493,753	493,753
Annual non fuel cost (maintenance)	[£]	67,490	84,363	111,462	139,328
Annual income (energy sales to residents)	[£]	260,800	260,800	1,259,450	1,259,450
Gas CHP electrical efficiency	[%]	32%	32%	37%	37%
Gas CHP thermal efficiency	[%]	39%	39%	41%	41%
CO_2 emissions (based on SAP2009 emission factors)	[TCO_2]	337	337	1,182	1,182
CO_2 emissions (gas boilers only)	[TCO_2]	548	548	2,493	2,493
CO_2 savings on heat supplied	[TCO_2]	212	212	1,311	1,311
As a percentage saving	[%]	39%	39%	53%	53%
Present Value of operational cash flow, 3.5% discount rate)	[£]	1,047,526	694,923	10,329,335	9,756,167
Net Present Value (3.5% discount rate)	[£]	-352,557	-1,055,181	5,826,823	4,127,994
Present Value of operational cash flow, 6% discount rate)	[£]	812,480	538,995	-812,480	-812,480
Net Present Value (6% discount rate)	[£]	-587,604	-1,211,109	-5,314,992	-6,440,653

Source: Gifford/Sturgis Carbon Profiling

Potential carbon savings from a borough-wide strategy

A borough-wide strategy to deliver carbon dioxide emissions should incorporate a range of retrofitting measures involving both individual buildings and community-wide initiatives. To illustrate the potential for reductions based on the figures presented in this guidance, four scenarios for a borough-wide strategy have been developed and the emissions associated with each estimated. Descriptions of the scenarios and the assumptions that underlie them are presented in Tables 2 and 3. The estimated annual emissions under each of the scenarios are presented in Figure 26.

Table 2: Four scenarios for emissions reductions

	Description	Annual Emissions (tCO_2)
Current	-	59,171
Scenario 1	Individual building retrofitting	34,115
Scenario 2	Individual building retrofitting and shared ground source heat pump (GSHP) schemes	34,002
Scenario 3	Individual building retrofitting, shared ground source heat pump (GSHP) and 'single development CHP'	31,352
Scenario 4	Individual building retrofitting, shared ground source heat pump (GSHP), 'single development CHP' and 'multi-site CHP'	27,419
80% reduction	?	11,834

Source: Sturgis Carbon Profiling

Table 3: Assumptions underlying four scenarios

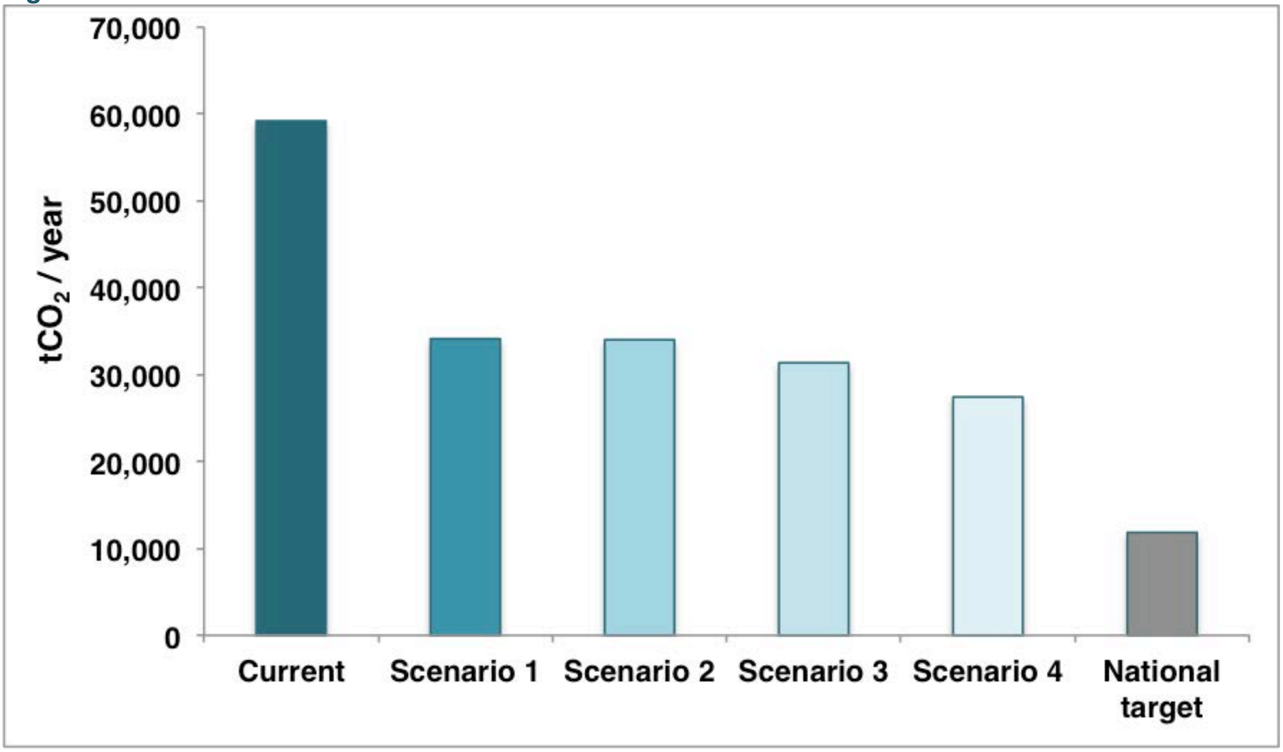
	Assumption	Reduction tCO_2 / year
Retrofitting	Savings from retrofitting 70% of existing buildings with measures as specified in the 'shop with rented office' building	25,056
Shared GSHP	Savings from eight shared heat pump schemes	113
Single development CHP	Savings from 'Single Development' CHP units in 13 medium-sized (7,000msq) buildings	2,650
Multi-site CHP	Savings from three 'Multi-site mixed-use' CHP schemes	3,933

Source: Sturgis Carbon Profiling

Figure 26 suggests that most of the potential for emissions reductions in Soho lies in the retrofitting of individual buildings. Multi-site mixed-use CHP located where space allows and Single Development CHP installed in medium-sized buildings may also offer worthwhile reductions, whereas the benefit of pursuing shared ground source heat pump (GSHP) schemes seems limited relative to the expense and logistics involved. However, even the combination of options represented by scenario 4 does not achieve the government target of an 80% reduction in emissions.

The 80% target applies to all sectors (ie emissions from buildings should be reduced by 80% as well as those from other sources) and the 50-60% contribution we quote here is of building-related emissions rather than 50-60% of overall emissions.

Figure 26: Estimated annual emissions under four scenarios



Source: Sturgis Carbon Profiling

Conclusions and recommendations

Key observations

With average construction rates in the UK remaining below 5% and few sites available for new development, retrofitting the existing building stock is the key to securing a low carbon future for areas such as Soho.

This guidance document illustrates that historic buildings have a significant role to play in securing this low carbon future and that designated historic preservation status has little impact on the capacity of any given building to be retrofitted to high standards.

These models demonstrate that substantial carbon savings can be made of up to 50% and that upgrading services is more cost effective with shorter pay back periods than a number of retrofitting measures to the fabric of the building which only become a real economic proposition when subsidy is available or when the building is undergoing a through going refit.

However, even if there is substantial take up of the various retrofitting elements it will still be difficult for areas like Soho to meet the 2050 target of an 80% reduction in carbon emissions and therefore area based energy solutions such as combined heat and power schemes are likely to be necessary as well.

The following should be considered by all business and residential property owners, as they have clear environmental and cost benefits and little impact on historic fabric:

- installing a real-time energy display, which would deliver a 5% saving on energy usage with a payback period of less than a year;
- installing thermostatic radiator valves, which would deliver a 12.5% reduction in energy use with a payback period of four years;
- improving airtightness, which would deliver a 35% saving on heating requirements with a payback period of seven years;
- installing a high efficiency heating and hot water system, which would deliver a 10% improvement in energy efficiency, with a payback period of 11 years.

The findings of this guidance suggest that the best suite of energy saving solutions depends on many issues including building type and tenure, the building typology section responds to this providing the detail necessary to make decisions, for a summary refer to the recommendations section.

Historic buildings have a great deal to offer in terms of retrofitting potential. Re-introducing original features such as window shutters, and re-using vaults to provide ground source heating can generate significant financial and environmental benefits whilst enhancing the heritage value of the building.

The financial viability of low carbon retrofitting measures can be enhanced if they are carried out as part of a wider refurbishment programme. This may provide an opportunity to restore historic building features that have been lost or obscured by previous alterations (for example, where cornices are hidden by suspended ceilings).

Detailed guidance on the retrofitting measures appropriate to historic buildings can reduce the cost barriers generated by statutory processes and so help increase uptake.

However, action by individual building owners and occupiers is only part of the story. Local and district solutions could also play a very important part in meeting Westminster's emissions reduction targets.

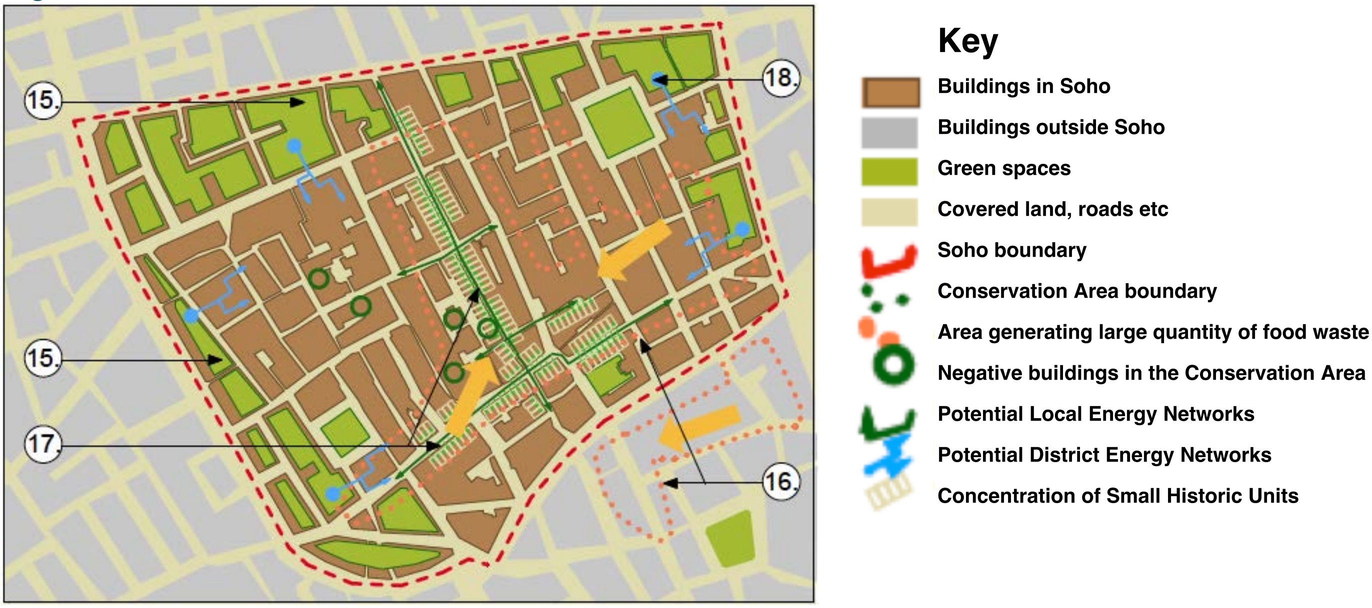
In the longer term, alternatives to fossil fuels will be key to ensuring fuel security and affordability and meeting UK emissions reduction targets. Soho could evolve into an exemplar of sustainable retrofitting, without loss of historic character or cultural value.

A low carbon vision for Soho

Soho has evolved over the past 400 years from an area of small fields and market gardens to the dense urban historical centre it is today. Although its inner streets were declared a conservation area in 1969, several tall buildings have been built which are considered to be of detriment to the Conservation Area (Kemp House, Ingestre Court, William Blake House and Stirling Court). Many of the large office buildings around the edges of the conservation area have been substantially rebuilt, either in whole or behind facades, and combined with neighbouring buildings

Soho has the potential to evolve into an exemplar of sustainable retrofitting, realised without the loss of its historic character or cultural value. Figure 27, (which is intended to only illustrate the potential but which is not representative of exact street layouts) suggests some measures to improve the environmental performance of Soho's buildings through area-based interventions, which could be developed through close consultation with building owners and residents, responding to the community's needs and concerns.

Figure 27: A vision of Soho in 2050



Source: Sturgis Carbon Profiling

Notes: 15. There is potential for many of the large retail and office buildings around the edges of the conservation area to provide green roofs, forming a green belt around the edges of the neighbourhood's busy streets. 16. This area generates large quantities of food waste. This resource has the potential to be used in anaerobic digestors, generating heat and power for local communities and thus minimising waste and landfill costs. 17. In this area the many remaining small historic buildings would benefit from the efficiency savings provided by connection to a district level Combined Heat and Power network. 18. Large future redevelopments around the edges of the Conservation area offer the potential to provide local level Combined Heat and Power to treat buildings in the core.

Recommendations

For owner-occupiers

Based on the thermal modelling conducted for this study, the ten most cost effective ways for owner-occupiers to reduce their energy bills are:

- draught proofing;
- fitting secondary glazing;
- ensuring the roof void is adequately insulated;
- switching to LED lighting;
- installing insulation in floor voids, where access is available;
- installing low use water fittings;
- installing in-usage energy displays;
- installing thermostatic radiator valves;
- where gas central heating is used, installing high efficiency central heating pumps;
- where suitable roof space is available, installing solar photovoltaic panels (although the proposed lower rates available under the Feed In Tariffs Scheme will increase payback periods).
- Installing domestic CHP units, however paybacks are widely variable dependent on buildings demand profile.

Upgrading to a high efficiency heating system is another option to consider, but the specialist labour required could result in a fairly lengthy payback period given current energy prices.

The introduction of the Green Deal (expected in autumn 2012) should provide an accessible and affordable means of implementing improvement measures, and will enhance the financial viability of many of the measures discussed in this guidance.

Fitting bird boxes or other habitat improvement and expansion measures will provide less quantifiable but no less valuable environmental benefits.

Measures that enhance the heritage value of the building, such as reinstating window shutters, can also help to improve the character of the area, bringing benefits to the local community and increasing property value.

For tenants

For tenants with an existing tenancy agreement who are intending to stay in the same property for some time, asking the landlord to implement some of the above measures is the best place to start. Improving environmental performance benefits occupiers by enhancing comfort levels and reducing energy costs, but in the longer term will also benefit landlords by enhancing the rental value of the property.

Tenants will be in a better position if they understand their rights and responsibilities. Under the Energy Act 2011, tenants will be able to benefit from the financing arrangements of the Green Deal, will have more power to request improvements in energy efficiency from April 2016 and will be able to insist upon minimum efficiency standards from April 2018.

Tenants whose lease is coming up for renewal or who are planning to move should consider including a requirement for the installation of basic low cost energy efficiency measures such as improved insulation of the roof void as a condition during the renegotiation of their tenancy agreement[1].

For landlords and developers

The potential to achieve a premium on rents as well as reduced void periods may exist in some locations and should be factored into the business case for retrofitting where this is found to be the case.

For landlords and developers who own or are acquiring several adjacent properties, larger scale solutions such as CHP, CCHP or ground source heat pumps may be worth considering. Larger installations can be more cost effective than numerous micro-scale

[1] This is in line with the concept of 'Green Leases' developed by the Centre for Research in the Built Environment at Cardiff University (http://www.greenleases-uk.co.uk/).

installations. Pursuing these options would require landlords and developers to engage with tenants to work through the potential issues with shared energy supply but could well prove worthwhile for all involved.

Taking a long-term view and being aware of the risk associated with future changes in energy prices and climatic variation may help identify the potential value of measures that seem to be of marginal benefit at present.

The retrofitting activities outlined in this guidance could be implemented at a lower cost than reported here if scheduled as part of a wider refurbishment programme. Renovation and restoration of larger buildings also provides an ideal opportunity to install small-scale CHP or ground source heat pumps, which would result in major disruption to tenants if installed while the building was occupied.

For central government

For some building owners, the process of applying for planning permission can represent a barrier and a disincentive to implementing retrofitting measures. Central government should consider ways to counter this without compromising the conservation and enhancement of the significance of heritage assets. This should increase the number of owners willing to engage with the process.

Central government also needs to do more to promote and support area based heating schemes if the historic and often mixed use core areas of major towns and cities are to be able to achieve the 2050 carbon emission reduction target without destroying the historic fabric and cultural capital that these areas represent. The sooner that this becomes available the greater the chance of integrating such interventions into normal redevelopment and rebuilding cycles.

For local government

Local authorities should continue to provide clear guidance on acceptable ways of implementing retrofitting measures (such as Westminster City Council's forthcoming guidance).

Local authority planning departments are in an ideal position to encourage the development of district heating networks, by identifying suitable sites within their borough, by encouraging major development and redevelopment projects to provide localised heating, and by helping to implement large-scale schemes by use of statutory powers.

Local authorities also have a very important wider role of promoting the various subsidies and incentives available to different sectors within the community. Raising awareness of the provisions of the Energy Act 2011 amongst hard-to-reach groups of landlords and tenants will be particularly important.

For building designers

Retrofitting presents building designers with an interesting challenge and an opportunity to produce imaginative and sensitive responses to a local and global challenge.

This is a challenge that will demand increasing attention, given the likely path of future legislation on embodied carbon and eco-labelling of buildings. Embracing this challenge will require the mastery of new skills and technologies, and for designers to work in a more integrated manner across all design disciplines.

Further investigation and research

There is an urgent need to find effective ways to resolve the current misalignment of incentives whereby it is the property owner, develop or landlord who will need to lead and promote retrofitting but the benefits of doing so largely accrue to the occupier or tenant.

Much more research is needed into all aspects of the provision of area based heating schemes to enable these to become an effective tool in delivering the required reduction in carbon emissions from high intensity built areas.

References

Baker, Dr P (2008); *In situ U-value measurements in traditional buildings - preliminary results,* Historic Scotland.

Carbon Trust. (2012). *Buildings Policy*. Retrieved February 21, 2012 from Carbon Trust: http://www.carbontrust.co.uk/policy-legislation/Business-Public-Sector/Pages/building-regulations.aspx

Centre for Sustainable Energy. (2010). *Westminster Heat Mapping Methodology Report.* Bristol: London Heat Map.

City of Westminster. (2003). *Supplementary Planning Guidance on Sustainable Buildings.* City of Westminster.

City of Westminster. (2005). *Soho and Chinatown Conservation Area Audit.* London: Westminster City Council.

City of Westminster. (2011). *Core Strategy.* London: Westminster City Council.

City of Westminster. (2011b). *City Management Plan: Consultation Draft.* London: Westminster City Council.

City of Westminster (2011c). *Retrofitting Historic Buildings (Consultation Draft).* London: Westminster City Council.

Department of Communities & Local Government. (2012). *National Planning Policy Framework.* Norwich: The Stationery Office.

Department of Energy & Climate Change. (2012). *CRC Energy Efficiency Scheme*. Retrieved February 21, 2012 from DECC: http://www.decc.gov.uk/en/content/cms/emissions/crc_efficiency/crc_efficiency.aspx

Department of Energy & Climate Change. (2012a). *Energy Act 2011.* Retrieved March 14, 2012 from DECC: http://www.decc.gov.uk/en/content/cms/legislation/energy_act2011/energy_act2011.aspx

English Heritage. (2008). *Conservation Principles: Policies and Guidance for the Sustainable Management of the Historic Environment.* English Heritage.

English Heritage. (2011). *Energy Efficiency and Historic Buildings: Application of Part L to historic and traditionally constructed buildings.* English Heritage.

Low Carbon Construction Innovation and Growth Team. (2010). *Final Report.* HM Government.

Max Lock Centre. (2008). *Retrofitting Soho: Improving the Sustainability of Historic Core Areas.* London: MLC Press, University of Westminster.

Mayor of London. (2011). *Delivering London's Energy Future: The Mayor's Climate Change Mitigation and Energy Strategy.* London: Greater London Authority.

Mayor of London. (2011a). *Decentralised Energy for London: Towards a District Energy Manual for London: seeking your opinion.* London: Greater London Authority.

McIntosh, A. & Roberts, G. (2012). *Whole Life Carbon Footprint Measurement and Offices.* British Council for Offices. London: British Council for Offices.

Rye, Dr C; (2010); "The SPAB Research Report 1: U-Value Report." SPAB

Rye, Dr C; Hubbard, D; (2011) "The SPAB Research Report 2.The SPAB Building Performance Survey 2011 -Interim Report" SPAB

Wallsgrove, J: (2008) "The justice estates energy use" in Context 103; March 2008; IHBC

Wood, C; Bordass, B & Baker, P (2009). *Research into the thermal performance of traditional windows: timber sash windows*. English Heritage.

Appendices

Appendix 1: Funding sources

Option: Warmfront

Summary: This scheme provides funding of up to £3,500 for measures such as improved loft insulation, draught proofing, cavity wall insulation and high efficiency heating and hot water. Funding is only available for owner-occupiers and private tenants in England living on income-related benefits in badly insulated homes or those without working central heating systems (equivalent to an Energy Performance Certificate rating of Band D or lower). Warm Front Assessors visit qualifying applicants to survey the property and recommend the most suitable measures on an individual basis.
Website:
http://www.direct.gov.uk/en/Environmentandgreenerliving/Energyandwatersaving/Energygrants/DG_10018661

Option: Energy Efficiency Financing for Business

Summary: Flexible finance options including leases and loans, with fixed repayments offset by anticipated energy savings, offered by a partnership between the Carbon Trust and Siemens Financial Services. Minimum financing of £1,000
Website: http://www.energyefficiencyfinancing.co.uk/Pages/home.aspx

Option: Enhanced Capital Allowances

Summary: This scheme allows businesses to write off the entire capital cost of their investment in certain technologies against their taxable profits in the period during which they make the investment, reducing the payback period considerably. Qualifying technologies include boiler equipment, combined heat and power, heat pumps, high efficiency lighting and solar thermal systems. ECAs are claimed through tax returns in the same way as other capital allowances.
Website: http://etl.decc.gov.uk/

Option: Landlord's Energy Saving Allowance

Summary: This scheme allows landlords to claim up to £1,500 against tax per year per housing unit against the cost of buying and installing insulation and draught proofing products (flats in the same building are treated as separate units). Some refurbishments, such as replacing single glazed with double glazed windows, may also be considered allowable expenditure on repairs.
Website:
http://www.direct.gov.uk/en/HomeAndCommunity/Privaterenting/RentingOutYourProperty/DG_175186

Option: Financing through the Green Deal

Summary: The Energy Act 2011 provides the framework for this scheme, which is expected to be launched in autumn 2012. It will enable private sector companies to offer energy efficiency improvements at no upfront cost, and to recoup the cost through energy bills. Consumer protections will be provided, including a guarantee that the cost to the consumer will not be higher than the savings.
Website: http://www.decc.gov.uk/en/content/cms/tackling/green_deal/green_deal.aspx

Option: Feed in tariffs (FIT)

Summary: Feed in tariffs are payments for electricity generated by small-scale low-carbon technologies. The Energy Act 2008 forms the basis for the scheme, which emerged in 2010 and complements the Renewables Obligation (a mechanism designed to encourage large-scale renewable electricity generation in the UK). Of the qualifying technologies, solar photovoltaic panels and micro-CHP units are most likely to be suitable for buildings in Soho. The payments are intended to decrease the payback period of the technologies, encouraging their uptake.
Website:
http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/feedin_tariff/feedin_tariff.aspx

The Energy Saving Trust[2] provides the following example of expected income generated through a typical domestic PV installation

Income type	Expected income
Income from Generation Tariff	£466 per year
Income from Export Tariff	£33 per year
Savings on energy bills through reliance on own generation capacity	£74 per year
Total	£573 per year

Option: Renewable Heat Incentive (RHI)

Summary: The intention of this scheme is to increase the use of renewable heating sources in place of fossil fuels through tariff payments designed to bridge the financial gap between conventional and renewable systems. The RHI is being rolled out in two phases: the first began in July 2011 and only applies to the non-domestic sector. The second phase, aimed at the domestic sector, is scheduled to begin in autumn 2012 to coincide with the launch of the Green Deal.

Heat generated from the following technologies is eligible for payments under phase 1: biomass boilers, energy from waste combustion (the biomass proportion of municipal waste), heat pumps (ground, water source), deep geothermal, solar thermal, heating from biogas combustion, biomethane injection into the grid, renewable district or community heating, renewable combined heat and power (CHP). Additional technologies will be considered for inclusion in the second phase.
Website:
http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/incentive/incentive.aspx

Option: Renewable Heat Premium Payments

Summary: These one-off vouchers are intended to subsidise the initial investment in renewable heating sources, complementing the tariff payments available under the Renewable Heat Incentive above. To qualify for the scheme, the householder must have already installed basic energy efficiency measures such as loft insulation. Vouchers for heat pumps and biomass boilers are only available for households without mains gas central heating. The current (April 2012) value of the vouchers is £300 (solar thermal), £850 (air source heat pump), £1,250 (ground source heat pump) and £950 (biomass boiler).
Website:
http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/premium_pay/premium_pay.aspx

---

[2] http://www.energysavingtrust.org.uk/Generate-your-own-energy/Sell-your-own-energy/Feed-in-Tariff-scheme

Appendix 2: Specialist advice, policy and guidance

Advice on planning permission and Listed Building Consent

Organisation: Westminster City Council (Planning Department)
Telephone: 020 7641 2513
Email: planninginformation@westminster.gov.uk
Website: www.westminster.gov.uk/services/environment/planning/

Organisation: English Heritage
Telephone: 0870 333 1181
Email: customers@english-heritage.org.uk
Website: http://www.english-heritage.org.uk/your-property/

Organisation: The Planning Portal
Website: www.planningportal.gov.uk

Other specialist advice on energy efficiency and carbon management

Organisation: Carbon Trust
Telephone: 0800 085 2005
Email: Info@customercentre.carbontrust.co.uk
Website: www.carbontrust.co.uk

Organisation: Energy Saving Trust
Telephone: 0800 512 012
Website: www.energysavingtrust.org.uk

Organisation: Building Research Establishment
Telephone: 01923 664000
Email: enquiries@bre.co.uk
Website: www.bre.co.uk

Planning policy

Mayor of London (2011). The London Plan (Spatial Development Strategy for Greater London)

Summary: This document provides the high level policy context against which applications for planning permission are evaluated. Relevant policies include 5.2 (Minimising Carbon Dioxide Emissions), 5.4 (Retrofitting), 5.5 (Decentralised Energy Networks), 5.6 (Decentralised Energy in Development Proposals), 5.7 (Renewable Energy), 7.8 (Heritage Assets and Archaeology), 7.9 (Heritage-Led Regeneration). The general approach to energy use in buildings is based on a hierarchy, in which reducing demand through energy efficiency measures is prioritized, followed by supplying energy more efficiently through decentralized networks and finally supplying energy from renewable sources. The supporting text to 7.8 emphasizes "When considering re-use or refurbishment of heritage assets, opportunities should be explored to identify potential modifications to reduce carbon emissions and secure sustainable development. In doing this a balanced approach should be taken, weighing the extent of the mitigation of climate change involved against potential harm to the heritage asset or its setting."
Website: http://www.london.gov.uk/sites/default/files/The%20London%20Plan%202011.pdf

City of Westminster (2011). Local Development Framework - Core Strategy

Summary: This document sets out the City of Westminster's planning policies and, together with the London Plan, forms the legal basis of decisions on applications for planning permission within the borough. Relevant policies include CS24 and CS27 (quoted in Section 1.1 of this guidance). Soho is part of the designated Core Central Activities Zone, to which the specific policy CS6 applies. The Strategy is supported by a City Management Plan and by Supplementary Planning Documents providing more detailed guidance on specific topics and areas.
Website:
http://transact.westminster.gov.uk/docstores/publications_store/Core_Strategy_Adopted_26_Jan_2011.pdf

City of Westminster (2011). Local Development Framework – City Management Plan (consultation draft)

Summary: This document explains how the council's planning policies will be applied in assessing applications for planning permission. It contains detailed policies, of which CMP2.17 (Retrofitting Heritage Assets) is of particular relevance and is quoted in this guidance. It also includes policies to encourage district heating networks (CMP2.3) and use of renewable energy technologies (CMP2.4), to require a high standard of thermal performance in alterations and extensions (CMP2.6), to conserve listed buildings (CMP2.13) and to control development in conservation areas (CMP2.14). The supporting text to CMP2.17 stresses that small scale and non-contentious energy efficiency measures should be implemented before more significant interventions are considered. Other policies will also be relevant to new developments and major redevelopment.
Website:
http://transact.westminster.gov.uk/docstores/publications_store/CMP_Final_Draft_Nov11_revised%20.pdf

City of Westminster (2005). Soho & Chinatown Conservation Area Audit Supplementary Planning Guidance (SPG)

Summary: This document discusses the special historical character of Soho and establishes the detailed principles against which applications for planning permission in this area will be assessed. It also identifies listed buildings and buildings of special architectural merit, and provides guidance on the type of alterations to building fabric that may be considered acceptable.
Website:
http://www3.westminster.gov.uk/docstores/publications_store/Soho%20and%20Chinatown%20CAA%20SPG.pdf

City of Westminster (2003). Supplementary Planning Guidance on Sustainable Buildings

Summary: This guidance provides advice on a range of measures that can contribute to improving the environmental performance of buildings. It covers aspects relating to design, energy, air, water and drainage, all of which will be of relevance to the low carbon retrofitting of Soho.
Website: http://www.westminster.gov.uk/services/environment/planning/ldf/documents/

Department for Communities and Local Government (2010). Building Regulations (Part L)

In England and Wales the required standards for the design and construction of most new buildings, and the alteration of existing buildings, are defined in the Building Regulations. Building regulations require the owner to obtain permission from the local authority for certain retrofitting activities. The powers to create these regulations were granted to the Secretary of State through The Building Act 1984. The Regulations have undergone multiple revisions since their inception, with the most recent revision having come into effect on 1 October 2010.

The Building Regulations consist of 14 technical parts (Parts A - P). Part L came into effect on 6 April 2006 and is the most relevant to this issue. It was introduced to comply with the requirement for minimum energy performance standards for new buildings and for existing buildings undergoing renovation, as set out in the Energy Performance of Buildings Directive.
Website: http://www.planningportal.gov.uk/buildingregulations/approveddocuments/partl

Other initiatives

Energy Performance Certificates (EPC)

Energy Performance Certificates became mandatory as a result of the Energy Performance of Buildings Directive. Their required content and the rules governing their issue are laid out in the Building Regulations. They provide information on the energy consumption and operational carbon emissions of individual buildings, based on a sliding scale from 'A' to 'G' where 'A' is most efficient and 'G' the least efficient. They also suggest measures that could improve the operational efficiency of the building. Under the Energy Act (2011), it will be illegal to rent out properties with an 'F' or 'G' rating from 2018.

EPCs must be produced by accredited energy assessors. The process of producing them is different for domestic and non-domestic buildings, and EPC assessors may be certified in the production of one or both types. An assessor with the appropriate certification in England and Wales can be found using the online registers provided by Landmark Information Group.

Anyone building, selling or renting out a building is obliged to obtain an EPC for provision to prospective buyers and tenants. The certificates are valid for ten years and must be updated after building works have been carried out (it is the responsibility of the contractor undertaking the work to provide the building owner with an updated EPC).

Useful websites: (information about EPCs) http://www.diag.org.uk/
http://www.direct.gov.uk/en/HomeAndCommunity/BuyingAndSellingYourHome/Energyperformancecertificates/DG_177026
(register of non-domestic assessors) https://www.ndepcregister.com/home.html
(register of non-domestic assessors) https://www.epcregister.com/searchAssessor.html

Display Energy Certificates (DEC)

DECs are intended to raise public awareness of the energy efficiency of the buildings in which they are displayed. They use the same rating scale as EPCs (A-G) but differ in several important respects. EPCs are required for both domestic and non-domestic private buildings, but DECs are required only for buildings that use energy to condition the indoor environment, that exceed 1000msq in floor area, and that are frequently visited by the public. DECs are based on the actual metered energy used in the building over a period of one month, whereas EPCs are based on observations of and assumptions about the building's fabric and services. There are also differences in the information provided by DECs and EPCs, the nature of which reflects the differences in the data used to produce them.
Website:
http://www.communities.gov.uk/publications/planningandbuilding/displayenergycertificates

BREEAM

BREEAM is a voluntary environmental assessment method, developed by the Building Research Establishment (BRE). It is used to rank the overall environmental performance of buildings on a scale ranging from Acceptable to Outstanding, by comparing a wide range of performance indicators against a set of established benchmarks.
Website: www.breeam.org

Code for Sustainable Homes

The Code is the national standard for the sustainable design and construction of new homes in the UK. It was launched in December 2006, replacing the BRE's earlier EcoHomes scheme. It covers nine areas: energy and carbon dioxide; water; materials; surface water runoff (flooding and flood prevention); waste; pollution; health and well-being; management; and ecology.

The overall performance of the home across these nine areas is summarised through a rating system of one to six stars. Minimum standards in various categories must be met in order to achieve successive star ratings: this ensures that high ratings cannot be achieved without addressing key sustainability issues.
Websites:
http://www.planningportal.gov.uk/buildingregulations/greenerbuildings/sustainablehomes/
http://www.communities.gov.uk/planningandbuilding/sustainability/codesustainablehomes/

CRC Energy Efficiency Scheme (CRC)

The CRC (formerly known as the Carbon Reduction Commitment) is a mandatory scheme for all organizations that have at least one half hourly electricity meter settled on the half hourly market, have an electricity consumption of more than 6000MWh/year and are not covered by the EU Emissions Trading Scheme or a Climate Change Agreement. It has been designed to encourage participating organizations to reduce their energy consumption, through a set of financial and reputational incentives and penalties.

The operation of retail and office space often accounts for much of the energy used by organizations of this type, and therefore improving the environmental performance of these spaces should form a key part of their carbon reduction strategies.
Website: http://www.decc.gov.uk/en/content/cms/emissions/crc_efficiency/crc_efficiency.aspx

Further guidance on retrofitting historic buildings

Energy Efficiency and Historic Buildings: Application of Part L of the Building Regulations to historic and traditionally constructed buildings (2011)

Provider: English Heritage
Summary: This document provides extensive technical guidance on meeting the requirements of Part L with respect to historic buildings. The 'Saving Energy' page on the English Heritage website also provides a wealth of information on retrofitting historic and listed buildings, accessible by expanding the topics on the left hand side of the webpage.
Websites: http://www.english-heritage.org.uk/content/publications/docs/eehb-partl.pdf
http://www.climatechangeandyourhome.org.uk/live/saving_energy.aspx

Climate Change and Your Home

Provider: English Heritage
Summary: This website provides access to the Whole Home Energy Toolkit and a wide range of guidance on retrofitting topics.
Website: http://www.climatechangeandyourhome.org.uk/live/

Historic Environment: Local Management

Provider: English Heritage
Summary: This website hosts a guidance library which includes technical guidance on all aspects of renewable energy generation and climate change as they relate to the historic environment.
Website: http://www.helm.org.uk/

Retrofitting Historic Buildings (forthcoming, 2012)

Provider: City of Westminster
Summary: This guidance is being produced to clarify the Council's position on the installation of energy efficiency measures and low and zero carbon technologies in listed buildings and those located in conservation areas, highlighting the different permissions and consents needed.
Website: http://www.westminster.gov.uk/services/environment/greencity/retrofitting-historic-buildings/

Title: Warmer Bath: A guide to improving the energy efficiency of traditional homes in the city of Bath (2011)

Provider: Bath Preservation Trust and the Centre for Sustainable Energy
Summary: This document provides guidance for owners of historic properties on the most effective retrofitting measures, based on the energy hierarchy. It includes the results of a survey of local residents on the acceptability of various measures to retrofit listed buildings.
Website: http://www.cse.org.uk/downloads/file/warmer_bath_june2011.pdf

Title: Sustainable refurbishment
Provider: Energy Saving Trust
Summary: Guidance on refurbishing eight common housing types to improve their energy efficiency, including 'period' (pre-1945) mid-terrace and end-terrace houses.
Website: http://www.energysavingtrust.org.uk/business/Business/Housing-professionals/Existing-housing/House-types

Appendix 3: Energy model specification and assumptions in guidance

Model geometry

The model geometry was based on 82 Mortimer Street, London W1. The building consists of a basement level and four floors above ground level. The total floor area is 350msq. The floor to ceiling height varies between 2.5m and 3m.

Environmental conditions

Weather file: London
Internal conditions were set to standard NCM templates. In order to reflect the diverse usage of buildings in Soho, mixed occupancy of retail, commercial and residential was assumed.

Characteristics of building fabric

Walls	300mm brick with internal plaster
Ground/Exposed Floor	Solid floor with no insulation
Windows	Sash window - Poorly fitting
Ceiling/Internal Floors	Plasterboard ceiling and timber floor with joists
Internal Partition	Single brick wall with plaster finish
Roof	Tiled pitched roof and roof void with no insulation

Characteristics of building services

Heating Systems	Electric heating and hot water Efficiency 100% Heating Hot water 90%
Ventilation	Natural Ventilation with extract in Kitchen and WC
Equipment	Standard efficiency fans and pumps

Appendix 4: Estimation of potential energy savings and carbon emission reductions for Soho

The internal area of Soho's commercial building stock was estimated using Valuation Office Agency (VOA) data. The data provide details on the Net Internal Area (NIA) and use category of commercial units, and were retrieved through the interactive query function on the VOA website (using postcodes that either fall within or intersect the boundaries of Soho: W1F 9, W1F 8, W1F 0, W1D 7, W1D 6, W1D 5, W1D 4, W1D 3, W1D 2, W1B 5 and W1 F).

The numerous use categories in the raw data were mapped to 5 general categories: 'Office', 'Residential', 'Restaurant', 'Retail' and 'Other'. The latter was excluded from further analysis because it consisted predominantly of kiosks, cash machines, telephone booths and parking spaces. In some cases the internal area of a unit was not provided and the average internal area of units of the same use type was assumed.

Westminster City Council GIS department supplied the number of residential units, which was 1223 in total. Given the absence of data on internal area an average of 90msq, equivalent to the average size of the few residential units included in the VOA data, was assumed.

Westminster City Council GIS department also supplied the number of listed buildings in Soho and the area of each building's footprint. To arrive at an NIA figure it was assumed that each building had five floors and that the NIA was 70% of the actual footprint, leading to the following calculation: (Total Area of category footprint*5)*(0.7). The results are contained in the table below.

Table 4: Footprint of listed buildings in Soho

Listing status	Total area of footprint (msq)	Estimated total area (msq)
I	759	2,657
II*	5,466	19,129
II	39,965	139,876
Total	46,189	161,663

Source: Westminster City Council/Sturgis Carbon Profiling

The final estimates for listed and unlisted internal building area were calculated by subtracting the area of listed buildings from the total area of the five general use categories. The number of 350msq '82 Mortimer Street' buildings (see appendix 3) required to represent these two categories was then calculated by dividing the estimated area of listed and unlisted buildings in Soho by 350msq. The results are contained in the table below.

Table 5: Building area and number of building types

	Estimated area of type in Soho (msq)	Number of Mortimer Street (350msq) equivalents
Listed	161,663	462
Unlisted	731,479	2,090
TOTAL	893,142	2,552

Source: Sturgis Carbon Profiling

The estimated energy and carbon savings for generic listed and unlisted buildings were calculated using the figures calculated for the various building elements as follows.

Table 6: Estimated cost savings for listed buildings

Mortimer Street model, listed building	Retrofitting action taken	Area of element or area serviced by component (msq)	Saving (per msq)	Saving from treating entire element
Walls	Install where possible behind existing panelling mineral wool batten 50mm thick in say 35% of wall areas. Modest amounts of dismantling of existing panelling and reinstatement required.	197	£1.20	£235.16
Ground Floor	60mm floating timber floor over with insulation, no mechanical fixing, through to existing floor beneath, build up rigid polyurethane board with x2 cross laid sheets of 12mm ply above.	78	£1.29	£100.36
Roof	Improved insulation 200mm mineral wool insulation in roof void covering ceiling rafters and beams	43	£1.55	£65.98
Window	Internal secondary glazed unit with independent frame to existing window	49	£3.52	£172.46
Door	Wooden door with heavy curtain	2	£1.55	£3.10
Heating and Hot Water	Exchange electric heating and hot water for high efficiency gas heating and hot water	350	£6.25	£2,188.75
Heating and Hot Water	Thermostatic radiator valves	350	£0.25	£87.50
Ventilation	-	350		£0.00
Cooling	-	350		£0.00
Equipment	Modified design resulting in lower energy equipment	87.87	£0.25	£21.97
Metering	Install real time display	350	£0.26	£91.00
Total			£16.11	£2,966.28

Source: Gifford/Sturgis Carbon Profiling

Table 7: Estimated CO_2 savings for listed buildings

Mortimer Street model, listed building	Retrofitting action taken	Area of element or area serviced by component (msq)	Saving $kgCO_2$ (per msq)	Saving $kgCO_2$ from treating entire element	t co_2
Walls	Install where possible behind existing panelling mineral wool batten 50mm thick in say 35% of wall areas. Modest amounts of dismantling of existing panelling and reinstatement required.	197	5.23	1,029	1.03
Ground Floor	60mm floating timber floor over with insulation, no mechanical fixing, through to existing floor beneath, build up rigid polyurethane board with x2 cross laid sheets of 12mm ply above.	78	5.64	439	0.44
Roof	Improved insulation 200mm mineral wool insulation in roof void covering ceiling rafters and beams	43	6.77	289	0.29
Window	Internal secondary glazed unit with independent frame to existing window	49	15.39	755	0.76
Door	Wooden door with heavy curtain	2	6.77	14	0.01

Heating and Hot Water	Exchange electric heating and hot water for high efficiency gas heating and hot water	350	49.40	17,289	17.29
Heating and Hot Water	Thermostatic radiator valves	350	1.10	385	0.39
Ventilation	-	-	-	-	-
Cooling	-	-	-	-	-
Equipment	Modified design resulting in lower energy equipment	87.87	1.50	132	0.13
Metering	Install real time display	350	1.05	368	0.37
Total			92.85	20,699	20.70

Source: Gifford/Sturgis Carbon Profiling

Table 8: Estimated cost savings for unlisted buildings

Mortimer Street model, unlisted building	Retrofitting action taken	Area of element or area serviced by component (msq)	Saving (per msq)	Saving from treating entire element
Walls	External insulation and rendering of secondary non-original facades e.g. rear and side elevations e.g. 70mm rigid polyurethane boards and external render.	197	£1.46	£287.26
Ground Floor	Remove existing screed where non-original fabric and install a new 100mm polyurethane insulation layer lapped up walls behind new skirtings with 50mm screed above.	78	£1.50	£116.70
Roof	New insulation laid to falls external with new roof deck above.	43	£1.58	£67.40
Window	Replacement double glazed window where existing windows not original and not on front facades	49	£4.69	£230.09
Door	Wooden door with heavy curtain	2	£1.55	£3.10
Heating and Hot Water	Exchange electric heating and hot water for high efficiency gas heating and hot water	350	£6.25	£2,188.75
Heating and Hot Water	Thermostatic radiator valves	350	£0.27	£94.50
Ventilation	Ventilation system with mechanical heat recovery	350	£0.29	£101.50
Cooling	-	-	-	-
Equipment	Modified design resulting in lower energy equipment	87.87	£0.25	£21.97
Metering	Install real time display	350	£0.26	£91.00
Total			£18.10	£3,202.27

Source: Gifford/Sturgis Carbon Profiling

Table 9: Estimated CO_2 savings for unlisted buildings

Mortimer Street model, unlisted building	Retrofitting action taken	Area of element or area serviced by component (msq)	Saving $kgCO_2$ (per msq)	saving $kgCO_2$ from treating all of element	t co_2
Walls	External insulation and rendering of secondary non-original facades e.g. rear and side elevations e.g. 70mm rigid polyurethane boards and external render.	197	6.41	1,261	1.26
Ground Floor	Remove existing screed where non-original fabric and install a new 100mm	78	6.57	511	0.51

	polyurethane insulation layer lapped up walls behind new skirtings with 50mm screed above.				
Roof	New insulation laid to falls external with new roof deck above.	43	6.77	289	0.29
Window	Replacement double glazed window where existing windows not original and not on front facades	49	20.52	1,007	1.01
Door	Wooden door with heavy curtain	2	6.77	14	0.01
Heating and Hot Water	Exchange electric heating and hot water for High efficiency gas heating and hot water	350	49.40	17,290	17.29
Heating and Hot Water	Thermostatic radiator valves	350	1.10	385	0.39
Ventilation	Ventilation system with mechanical heat recovery	350	1.20	420	0.42
Cooling	-	350		0	0.00
Equipment	Modified design resulting in lower energy equipment	87.87	1.50	132	0.13
Metering	Install real time display	350	1.05	368	0.37
Total			101.29	21,676	21.68

Source: Gifford/Sturgis Carbon Profiling

The savings calculated for the two categories were then multiplied by the estimated internal area of each category within Soho and summed to provide a single estimate for Soho as a whole. The final figures are shown in the table below.

Table 10: Estimated total savings

	Estimated area of building type in Soho (msq)	Number of Mortimer street (350msq) equivalents	Estimated total potential savings on energy bills in Soho (£/year)	Estimated total potential savings (tCO_2/year)
Listed	161,663	462	£1,370,109.08	9,561
Unlisted	731,479	2,090	£6,692,544.10	45,301
TOTAL	893,142	2,552	£8,062,653.18	54,862

Source: Sturgis Carbon Profiling

Energy usage and CO_2 emission averages for office buildings were obtained from the Carbon Trust's *Energy Consumption Guide 19* (2003), often referred to as ECG019.

Table 11: Typical energy usage for office buildings

	Naturally ventilated cellular office building (kWh/msq)	Air-conditioned standard office building (kWh/msq)
Heating and hot water – gas or oil	151	178
Cooling	0	31
Fans, pumps, controls	6	60
Humidification (where fitted)	0	18
Lighting	23	54
Office equipment	18	31
Catering, gas	0	0
Catering, electricity	3	6
Other electricity	4	8

Computer room (where appropriate)	0	18
Total gas or oil	151	178
Total electricity	54	226
Total energy	205	404

Source: Carbon Trust

Table 12: Typical CO_2 emissions for office buildings

	Naturally ventilated cellular office building ($kgCO_2$/msq)	Air-conditioned standard office building ($kgCO_2$/msq)
Heating and hot water – gas or oil	28.7	33.8
Cooling	0	16.1
Fans, pumps, controls	3.1	31.2
Humidification (where fitted)	0	9.4
Lighting	12	28.1
Office equipment	9.4	16.1
Catering, gas	0	0
Catering, electricity	1.6	3.1
Other electricity	2.1	4.2
Computer room (where appropriate)	0	9.4
Total gas or oil	28.7	33.8
Total electricity	28.1	117.5
Total CO2	56.8	151.3

Source: Carbon Trust

The following assumptions were made about energy consumption and CO_2 emissions:

- Assumption 1: for 90% of the buildings in Soho, energy consumption and CO_2 emissions are close to those in the 'naturally ventilated cellular office building' category in ECG019;
- Assumption 2: for the remaining 10%, energy consumption and CO_2 emissions are close to those in the 'air-conditioned standard office building' category.

The resulting estimates of the internal area of the two categories in Soho were as follows.

Table 13: Estimated area of naturally ventilated and air-conditioned office buildings

	Area in Soho (msq)
Naturally ventilated cellular office building (90%)	803,828
Air-conditioned standard office building (10%)	89,314

Source: Sturgis Carbon Profiling

The annual energy usage and emissions for the two categories were then multiplied by the area figures to obtain the following estimate of the energy usage and emissions for Soho as a whole.

Table 14: Estimated total energy usage and CO_2 emissions

Estimated annual energy consumption of buildings in Soho	200,867,636 kWh
Estimated annual CO_2 emissions of buildings in Soho	59,171 $kgCO_2$

Source: Sturgis Carbon Profiling