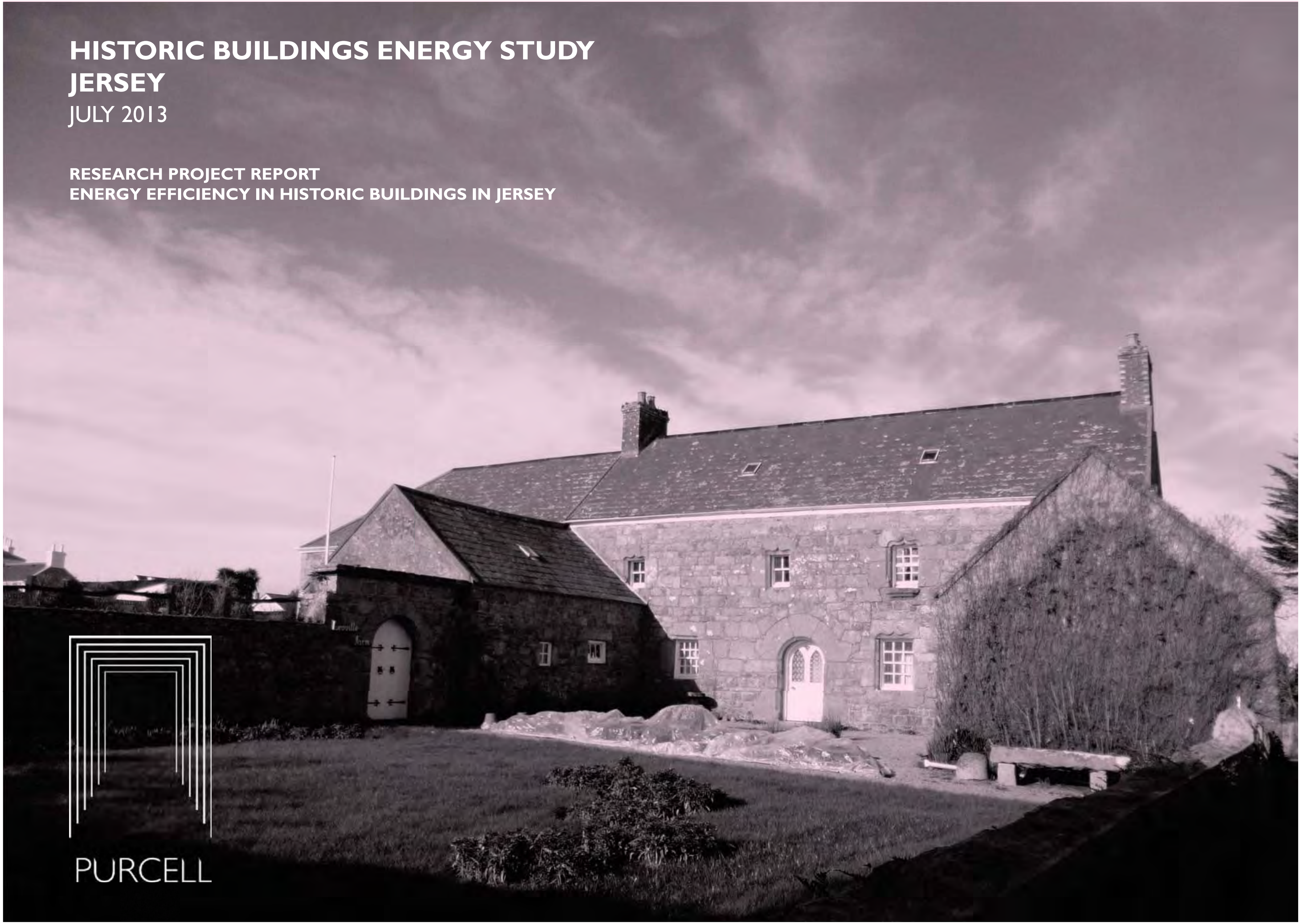
HISTORIC BUILDINGS ENERGY STUDY
JERSEY
JULY 2013

RESEARCH PROJECT REPORT
ENERGY EFFICIENCY IN HISTORIC BUILDINGS IN JERSEY



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1.0 INTRODUCTION

This report has been commissioned by the Minister of Planning and Environment of Jersey and completed by Purcell, in partnership with Wallace Whittle. It follows the recognition by the Minister that, in order to formulate a coordinated approach towards improving energy efficiency of domestic residences on the Island, consideration must be given towards the practicalities and implications of this on the historic building stock.

The report evaluates the potential for improving the energy performance of listed buildings (pre-1924) within a conservation framework. It is based upon a study of available research and advisory documentation produced by multiple sources including British, French and Jersey statutory bodies. This has been combined with analysis by professionals with experience in both the implementation of energy efficient measures and the conservation of historic fabric.

EXECUTIVE SUMMARY

Such analysis has ultimately been broken down into a summary of possible measures and the constraints placed on these. There are many possible measures for improving the energy efficiency of buildings available today, both well established and through innovative new technologies and materials. It is therefore context that focuses the options into suitable and feasible measures. It is clear that, even with a notable number of constraints, there are many measures that can be used to improve the energy efficiency of Jersey's listed buildings. These have been included within this report, along with a comparative method to assist in choosing those measures which are likely to be the most cost effective when all issues have been considered. It should be noted however that all buildings should be assessed on an individual basis and that it is not suitable to issue a 'one size fits all' solution. Additional actions have also been suggested for the Minister to help implement initiatives that will inform and aid the general public to achieve these measures.

Potential Action:

Extend scope of study

Promote energy efficiency in post 1924 buildings

One set of constraints identified are those that relate to legal frameworks in Jersey. These cover a range of categories from permissible works to listed buildings, protection of wildlife and regulations controlling the quality of construction works and the expected energy performance of these. In order to place Jersey within a wider context, a comparison of these regulations with neighbouring countries and standard EU directives has been completed. This shows that, while the current Jersey targets are aiming higher than some, there is room for increasing the energy efficiency ask of all buildings in Jersey.

As part of the report numerous gaps within current research and understanding of the performance of traditional buildings have been identified, leading to suggested areas of further research, some of which is specific to Jersey. Testing of building construction in relation to energy efficiency has to be related to local climate, materials and building techniques. Additionally, costs of fuel, materials and labour will vary in Jersey when compared to other countries, altering expected pay back periods.

One issue that is particularly pertinent to Jersey is the need for public engagement in these issues. As an Island community, Jersey has closer relationships between officials, trades and residents. This can be an asset to be capitalised upon, as interworking and the sharing of knowledge can benefit all involved.

While this report focuses on the listed buildings in Jersey, it is important to note that many of the measures will be applicable to more modern building stock as well.

2.0 CONTEXT

When considering which measures are appropriate to improve the energy efficiency of residential listed buildings in Jersey it is important to look at the context. This will inform those measures that are applicable and those that are inappropriate, whether this be down to the building's historic value, energy efficiency benefits or costs. As part of this report the context of Jersey listed residences has been evaluated against the possible measures to provide suggested priority measures included in section 3.0 Improvements.

2.1 BUILT HERITAGE SIGNIFICANCE

In Jersey there are an estimated 44,698 households. Some of these will be multiple occupancy of one building i.e. flats. The Minister of Planning and Environment has recently undertaken a resurvey of historic buildings, which has found that 3,200 residential buildings are either listed, potentially listed or under review.

A review visit was carried out by Purcell as part of the preparation for this report, taking a wide look at the vernacular architecture of Jersey. Across the Island residential properties range from rural farms, cottages and manor houses, through to urban terraces and multi-storey flats. Rural properties tie into the agricultural history of Jersey while urban development has seen the spread of towns like St Helier into the surrounding countryside. In both situations historic buildings benefit from the generally mild climate of Jersey. During our visit we noted the large number of similarities, in building materials and construction methods used, between Jersey and Scotland. We also identified good quality modern buildings that could become the listed buildings of tomorrow. As these make up a large number of the residences on the Island, compared with a relatively small number of listed buildings, we have included references applicable to these to provide a complete overview.

Example: potentially listed building in Jersey with Solid Granite Wall Construction

Example: Scottish House with Solid Granite Wall Construction

With the array of listed buildings in Jersey dating back to the 12th century there is a visible variety and interest to Jersey's architecture. The value of this heritage can be assessed on many levels. The historic built environment tells the story of an area in physical, social and cultural terms. This makes a strong connection between the built fabric and the individual identity and character of an area.

Most countries run systems to identify and protect such heritage assets. The importance of this protection is widely recognised. Jersey is signed up to the Convention on the Protection of the Archaeological Heritage (revised) in Valetta 1992: requiring a legal system for the protection of archaeological heritage, refer to section 3.4. Often, as in Jersey, the attractive qualities of the vernacular architecture can be of great appeal, encouraging tourism industry as well as creating a pleasant environment to live in.

To aid the preservation of historic fabric and its integral merits the Minister has published Supplementary Planning Guidance, 'Managing Change in Historic Buildings'. This has been issued as advice to owners and occupiers of listed buildings when considering an over-arching philosophy of conservation. Similar guidance has been issued by English Heritage in the form of a set of Conservation Principles.

Principle 1: The historic environment is a shared resource

Principle 2: Everyone should be able to participate in sustaining the historic environment

Principle 3: Understanding the significance of places is vital

Principle 4: Significant places should be managed to sustain their values

Principle 5: Decisions about change must be reasonable, transparent and consistent

Principle 6: Documenting and learning from decisions is essential

Germany apartment block character preserved

German apartment block character lost - alterations to roofline

2.2 BUILDING FABRIC

From a technical point of view the historic buildings of Jersey can be split into the following building element sub-categories based on construction techniques. Each of these exhibits different properties and presents different challenges when considering improvements. For a review of possible improvements to these elements refer to Section 3.0.

ROOF

- Timber frame roof with slate coverings.
- Timber frame roof with tile coverings, either terracotta or later replaced with cement.
- Timber frame flat roofs with felt/lead or zinc.
- All historic thatch was removed by 1715 bye-law. Modern examples have been re-introduced.
- Verges - junction between roof coverings and vertical faces - cement/lime mortar, lead, zinc.

FLOORS

- Suspended timber boards or joists.
- Stone slabs on compacted earth/ash hardcore base.
- Concrete/Screed on compacted earth/ash hardcore base without damp proofing.
- Concrete/Screed on compacted earth/ash hardcore base with damp proofing.

Example: listed building in Jersey

Example: Granite rubble walls with remains of lime render

Potential Action:

Carry out testing of traditional granite with cementitious render/ mortar and 'piere pedu' for potential damage due to trapped water

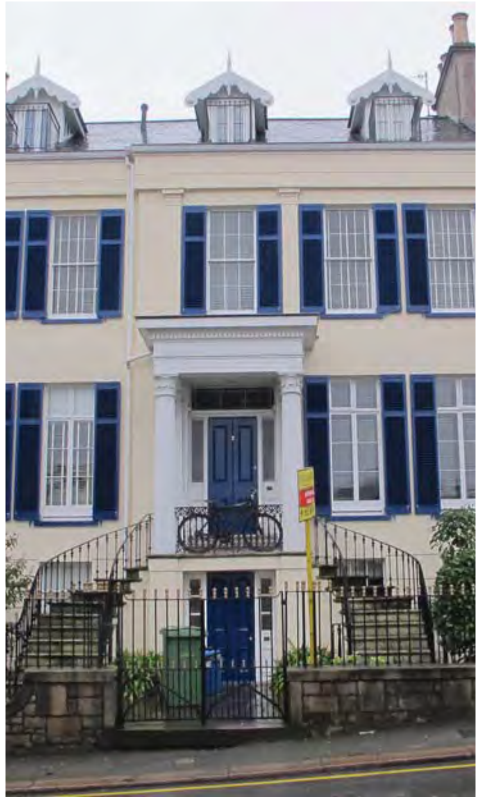
WALLS

- Timber frame buildings (historic examples no longer found in Jersey).
- Granite rubble often with render finish. Generally using locally quarried pink stone, the render and mortar was traditionally lime based but later replaced with cement. A tradition of leaving individual stone faces exposed is evident called 'pierre perdu'. Further discussion on the potential risks of this detail are included on page 40.
- Granite ashlar (mix of local pink and imported blue stone).
- Brickwork often with stucco finish.
- Rubble masonry with cementitious render.
- Concrete block with cementitious render.

DOORS

- Timber planked – the oldest form of door in Jersey, planked doors are formed from several strips of timber held together with cross timbers to the rear face. This form of door later became common in service areas and less evident as main entrances.
- Timber panelled – the range of styles of panels correspond with shifts in fashion from only two to ten panels. Panel sizes were dictated by Palladian proportions. These doors often had glazed fanlights over them and occasionally side lights. They can also have glazed panels. They became increasingly decorative over time, with doorcases and elaborate features, as an opportunity to display the wealth of the occupant.
- Modern timber and UPVC doors – installed to modern developments or as replacements to historic buildings. The use of modern materials, construction and patterns means that these can appear very different to traditional doors. They may be incorrectly proportioned with standardised add on features that do not relate to historic Jersey styles. In addition UPVC can discolour over time. For these reasons they are not acceptable for use in listed buildings.

Example panelled door, St Helier



Example door with doorcase, St Helier

WINDOWS

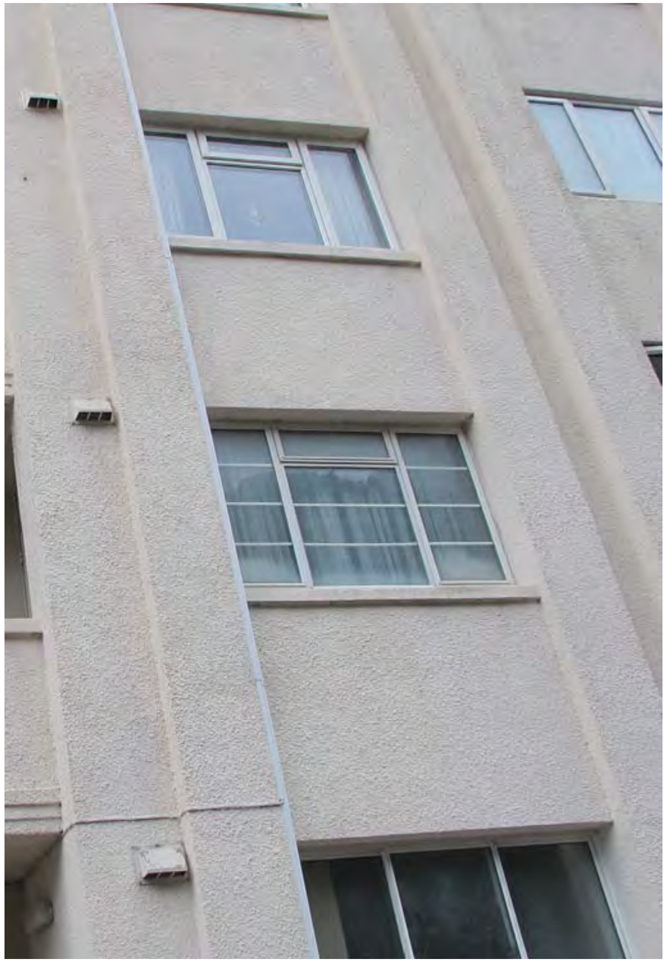
- Timber casement – the most common form of window in Jersey until the mid 18th C. These typically open inwards with varying glazing bar patterns and single glazing. Later examples exist from late 19th C.
- Timber sliding sash – single glazed evident from mid 18th C onwards, vertical sliding sashes allow both top and bottom sash to move. Glazing bar patterns changed over time as glass production techniques developed allowing for greater sized glass panes. Sash windows are often used to date a building as their proportions follow period styles from Georgian 6 over 6 to later single panes and the introduction of horns to improve sash strength. Glazing bars also changed in size with the different fashions; becoming thinner over time. This is the predominant style of window in Jersey with a variety of details and features evident to listed buildings. Jersey also has a tradition of painting two-tone colour schemes to sashes and boxes.
- Metal – evident in the early 20th C metal windows offered robust slim profiles with single and later double glazing. One major producer of metal windows was W F Crittal.
- Any of the above may have leaded lights – inserted into fixed or casement timber frames as single glazing. Leaded lights were used in early Jersey windows as available glass pane sizes were small.
- Modern windows in timber, metal or UPVC with sealed unit double glazing – installed to modern developments or as replacement to traditional windows. Again the materials and use of standardised inappropriate details, including surface mounted glazing bars, makes them unsuitable for use in listed buildings.
- External and internal shutters - made in timber. The use of both is seen widely, although many examples have been removed.

Potential Action:

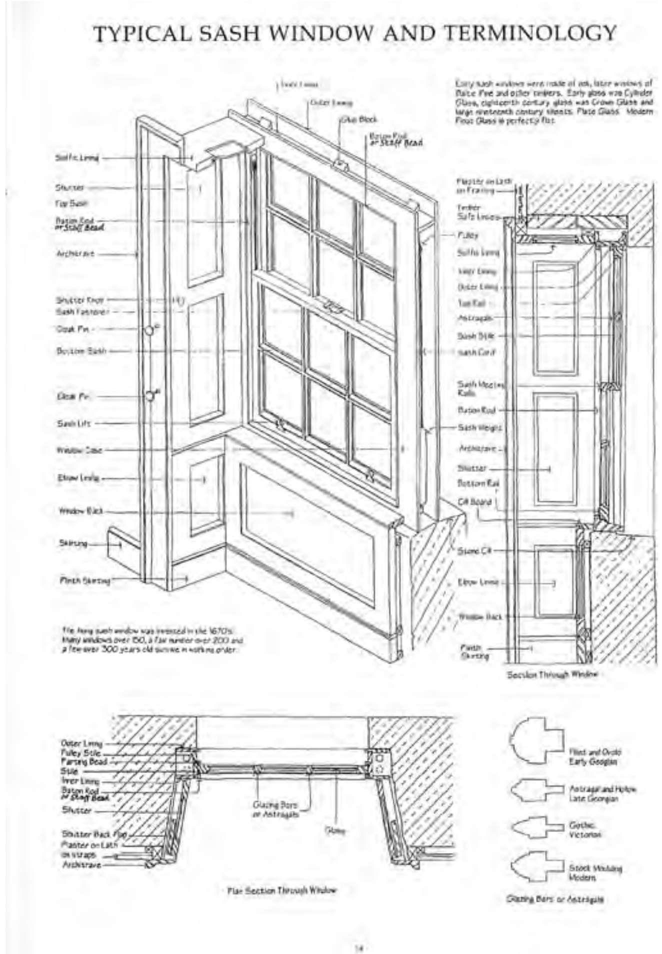
Carry out testing of draught and thermal improvements from use of external shutters

Example timber frame fixed leaded light, casement and vertical sliding sash

Example two-tone sash colour scheme and external shutters



Example original Crittal windows with modern replacements above



Typical Sash Window and terminology

2.3 ENERGY IN JERSEY

While the innate value of Jersey's historic buildings is clear to see, they are often considered to be poor performers in terms of energy efficiency. While this assumption is not always correct, as discussed on page 17 of this report, it is important to find a balance between the need to protect heritage assets while improving energy efficiency.

Global recognition of the need to reduce energy consumption is evident. Many countries, including Jersey, are signed up to commitments like the Kyoto Protocol. This promises an 80% reduction on 1997 greenhouse gas emission figures by 2035. As just over 10% of global emissions are related to residential buildings[1] this has been identified as a prime area for reductions.

Improving the energy efficiency of residential buildings has been favoured as a simple and effective objective. Being efficient with energy means avoiding waste and reducing energy requirements, while making the most of the energy that is available.

Jersey is currently very dependent on energy imports. The cost and future security of these supplies has been questioned in the latest draft Energy Plan, currently under consultation. A chapter of the plan highlights the need to reduce energy demand in Jersey and notes that the domestic sector has a significant role to play in achieving this.[2] A reduction in energy requirements would also improve the prospects of Jersey being able to achieve autonomy from the fluctuating and unpredictable external market of energy suppliers.

This report focuses on constraints and measures applicable to historic buildings in Jersey when faced with the need to repair, renovate, upgrade or retrofit existing fabric and systems to improve energy efficiency.

Example Eco House, Hens Tooth, Kent, **Purcell**

1 World Recourses Institute 2009, July

2 Pathway 2050: An Energy Plan for Jersey

2.4 ENERGY TYPES

Energy is used in Jersey domestic properties in two forms:

OPERATIONAL ENERGY

The most tangible is the energy used to live in the home, achieving a comfortable environment through heating and cooling, maintaining adequate light levels and running appliances. There are many measures that can make more efficient use of this energy in historic buildings. These can result in financial savings for the occupier in the form of reduced energy bills, while improving user comfort. It is clear that occupiers can be encouraged to reduce the use of operational energy when the benefits are both identifiable and measurable.

EMBODIED ENERGY

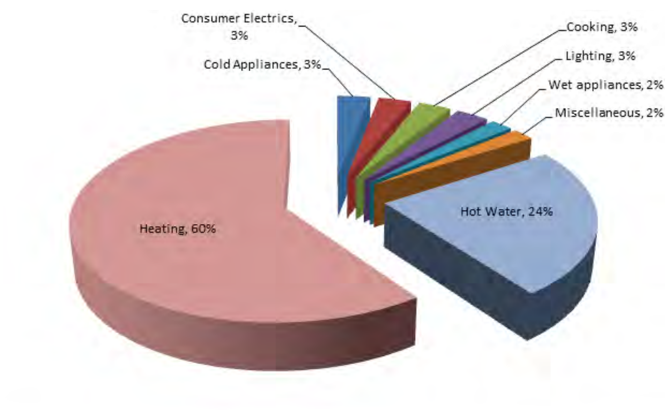
A less obvious energy use is that involved in forming the building and its materials. This is called embodied energy and is often overlooked in energy efficiency considerations. However, this use of energy can be quite significant and should be considered when carrying out any alterations to existing building stock. Historic buildings benefit from traditional building techniques and materials, typically resulting in low levels of embodied energy. It is often more efficient, in energy terms, to repair existing fabric or to reuse traditional materials rather than replace with a modern equivalent. Many traditional buildings also use timber which, during growth, takes carbon out of the air, called carbon sequestration. This can be viewed as a positive step towards reducing CO_2 levels.

Example: the energy required to form a new UPVC window includes excavation of raw materials, like oil, which is then refined through processes using chemicals and heat, and finally transport. This is very high when compared with retention of an existing or reclaimed metal or timber windows.

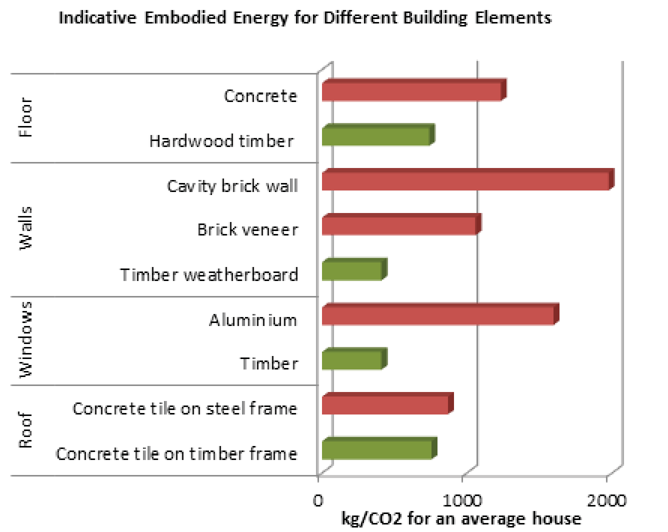
Jersey must import most of its building materials as there are not sufficient natural resources available. This reliance on external resources could be reduced should local initiatives be developed to retain or reuse traditional materials. Similarly, the use of traditional materials and techniques with well established durability will reduce the frequency of renewal, saving energy and expense over the longer term.

Potential Action:

Develop initiatives in Jersey to promote retention, reuse and repair of existing building materials using local trades



Data from Household Energy Consumption report, UK Department of trade industry 2004



Data from **Attiwill P**. **England J**. and **Whittaker K**. (**2001**) The **environmental credentials** of **production**, **manufacture** and **re-use** of **wood fibre** in **Australia**

2.5 COSTS

Cost saving can often be deemed at odds with improving energy efficiency in historic buildings. However with a more in-depth look at capital and running costs over the long term, financial motivation can be a key driver.

The costs associated with improving energy efficiency vary with the measures proposed. Often it can be difficult to evaluate the benefit of any particular measure purely on a financial pay back. However where measures relate directly to reducing billed energy use savings are quantifiable.

Whole life costing (WLC) has been proffered as a way to measure the benefits of implementing more durable construction techniques or retain/repair existing elements instead of replacement. In some cases the expected life of modern building elements is substantially lower than that of traditional construction e.g. well maintained timber windows, whether historic or modern, can endure for 80 years or more while high quality UPVC windows have a maximum expected life of 35years[1]. Life cycle analysis (LCA) is another system, similar to whole life costing with the added consideration of the embodied energy of an element. Again it can be difficult for occupiers to see the benefits of this approach, especially when they themselves intend to own a building for a shorter period than the expected life of its elements.

Example: historic timber windows have a great capacity for repair. In terms of WLC and LCA it is often preferable to retain these items, this is in addition to their historic value. The thermal efficiency of these elements can be upgraded in a sympathetic manner to enable the retention of not only frames but historic glazing as well, refer to page 49 for examples. This has been contested in the past with the argument that replacement of old timber windows with new is cheaper than repairing the existing. While UPVC windows offer the lowest initial cost, studies have proven that over whole life costing or LCA timber windows are the most cost effective option[2], in part because of their relative ease of repair and consequent extended service life.

Potential Action:

Increase quantity and extent of official advice from EES to Jersey residents

Potential Action:

Train local Trades and professionals in understanding whole life costing concepts

GRANTS AND FUNDING

The Home Energy Scheme (HES), run by the Energy Efficiency Service (EES) in Jersey currently provides grants to enable the installation of energy saving measures for those who meet the income and age related criteria. The organisation also provides advice to those who do not match the criteria. It is understood that as part of the proposed Energy Plan the EES will be utilised as a key delivery mechanism for improving energy efficiency in the domestic sector, increasing its offer to those who do not qualify for grants. This report has been developed to inform this agenda.

1 D. Langdon, Comparison of Environmental Impact (CO_2e) of Timber and PVC-U Windows 2010, the Wood Window Alliance

2 Dr G. Menzies, Life Cycle Assessment of Timber, modified timber and aluminium-clad timber windows, March 2013. Heriot Watt University

PAY BACK

When considering cost it is advisable to consider potential pay back for different measures which will compensate for the initial outlay. When energy efficiency measures are installed pay back can often be expressed in terms of years, i.e. that it will take x number of years for a resident to recoup their costs through reduced energy bills. This is a very complicated area to assess as each case will be individual and it is unlikely that any measure will be carried out in isolation. Also energy costs can be unpredictable, a sharp rise will speed up pay back periods but may have the opposite interpretation from the occupier who still sees increased bills.

The Jersey Energy Efficiency Service have carried out reviews of the financial impact of energy efficiency measures. These are verified by the Energy Saving Trust who are an independent body. The Energy Saving Trust also publishes figures on costs and pay back periods for the UK and to a lesser extent Jersey. It is expected that similar works in Jersey will experience a mark-up in costs when compared to UK prices as materials and trades may need to be imported. A table of comparable information has been included on this page.

Purcell have carried out several similar appraisals in relation to specific projects. An example of this is included in Appendix 4.

Potential Action:

Carry out Jersey specific testing of relative costs for energy efficiency measures and pay back period

Measure	Costs based on available UK data from the EST. Note: grey zones figures inserted by Purcell	Saving per year based on available UK data from the EST. Note: grey zones figures inserted by Purcell	Savings per year based on available Jersey data from EST.	Payback based on available UK data from the EST. Note: grey zones figures inserted by Purcell
Full draught proofing	Up to £200	Up to £115		2 years
Draught proofing to windows and doors	Up to £50	£30	£30	2 years
Insulation at ceiling level up to 100mm	£300	£150		Up to 2 years
Insulation at ceiling level 100mm - 270mm	£300	£25	£30	Up to 12 years
Replace single glazed windows with double glazing	Standard £600	Up to £170	£160	3 and a half years
Install secondary glazing	Standard £400	£105	£85	4 years
Install insulation between floor joists	£530	£60	£85	9 years
Install cavity wall insulation	Up to £500	Up to £140	£210	4 years
Install internal solid wall insulation	Up to 8,500	£460	£675	18 and a half years
Install external solid wall insulation	Up to £13,000	£490	£710	26 and a half years
Replace G rated boiler with A rated new gas boiler	£2,300	£310	£395	7 and a half years
Install room thermostats	£50	£70	£100	1 year
Turn down background temperature of heating	-	£65		-
Replace bulb with energy efficient	£4	£4		1 year
Install PVs	£7,000 + maintenance £1,000	£645 including UK feed in tariff		12 and a half years
Install Wind Turbine (rural Kent)	£2,000 + maintenance £2,000	£484 including UK feed in tariff		4 years
Install Air Source Heat Pump to existing gas fuelled system	From £6,000	£110		55 years
Install Ground Source Heat Pump to existing gas fuelled system	From £9,000	£290		81 years
Install Solar Thermal Panels	£4,800 + maintenance £400	£60		86 years

The Energy Saving Trust UK information available from website May 2013 -
The Energy Saving Trust Jersey Information updated June 2012

2.6 OCCUPANT ENGAGEMENT

In order to reach energy saving targets set in Jersey in line with the Kyoto Protocal, a widespread programme of performance improvements is required to its domestic building stock. Such a programme relies on public and user engagement. This report focuses on those residing within listed buildings but many of the principles are applicable across the general building stock. Users will vary in wealth, age, how they use the building and inclination. Even where user engagement is high there may be disagreement with official advice. Building owners and occupiers can be resistant to following supplied guidelines if they are not fully explained and supported, particularly where these require a financial outlay.

One example of systematic miscommunication between the authorities and the residents of Jersey is over the upgrade and upkeep of existing windows and doors. The Minister of Jersey has over the last 12 years put in place policies, guidance and technical information packs detailing the benefits and methods to maintain and refurbish existing important features, including timber sash windows. Unfortunately these efforts came too late to save many windows which have been replaced with UPVC double glazed units or other inappropriate window types. Policy now protects the surviving historic fabric and aims to restore some lost character; requiring the reinstatement of historic window types, even if a UPVC window has been previously installed.

The public desire to replace these features often stems from the aim of improving user comfort and finances. However both of these can be improved while retaining historic features through careful alteration and upgrade and good general maintenance, refer to page 51 for examples.

The wider impact of the loss of individual pieces of historic fabric can be difficult to evaluate on a case by case basis. The loss of one window here or there could be thought to be harmless. In real terms though many areas rely on a uniform and coherent aesthetic to retain their unique character. It can be understood that residents may be unable to identify the significance of particular features. Any resident should be encouraged to seek guidance before considering alterations to listed buildings.

Potential Action:

Encourage greater public consultation and relations

Potential Action:

Prepare guidance documentation identifying significant features of Listed Buildings for issue to residents

Example historic window replaced with inappropriate UPVC units

Example historic glass detail retained

Example Internal Surface Temperature Sensor and External Air Temperature Sensor, reference, Historic Scotland Technical Paper 2 2008
Crown copyright (Historic Scotland)

Potential Action:

Carry out testing to determine performance of typical building types in Jersey and encourage testing after implementation of measures

2.7 RESEARCH AND DOCUMENTATION

There is a variety of on-going research into the methods by which energy efficiency can be improved in both new and existing buildings. As part of this study a list of relevant research documentation has been compiled for review, see Appendix 3.

A similar review has been carried out by the Sustainable Traditional Buildings Alliance (STBA) the results of which were published in 2012. This report was concerned with the recent UK government initiative 'The Green Deal', which encourages upgrading and retrofit of traditional buildings, and the potential damage that could be caused through misinformed implementation of these measures. The report concluded the following:

- While there is an abundance of documentation available only a small percentage can be deemed reliable and well informed.
- Traditional buildings perform differently to modern buildings.
- There is a lack of understanding of the performance of traditional buildings both before and after energy efficiency measures are implemented.
- Traditional buildings before implementation of energy efficiency measures often perform better in reality than in theory; this means software modelling can be misleading.
- Traditional buildings require careful consideration of moisture movement.[1]

Most notably research and testing carried out by organisations like Historic Scotland, English Heritage and SPAB has shown that historic building fabric is widely misunderstood and its thermal performance often undervalued. Further testing is being carried out, however this is restricted by available funding and identifying appropriate properties with amenable occupiers.

1 N. May and C. Rye. Responsible Retrofit of Traditional Buildings. Sustainable Traditional Buildings Alliance, 2012, December

2.8 MEASURING PERFORMANCE

Following on from the Kyoto Protocol many countries including Jersey have set internal interim goals and dictates to ensure that the 2035 emissions target is met. Jersey has a special relationship with the EU; it is not a member state but does share regulation on limited matters. As such it is outside EU Directives like 2002/91/EC on the Energy Performance of Buildings. However, as many of Jersey's neighbours are EU members, references to EU Directives have been included in this report for comparison and context. The report describes the approaches and targets of a number of Northern European countries and then assesses them, both to a nominal unmodified existing listed Jersey house construction and to the State of Jersey's aims for energy efficiency improvements. Therefore, the report illustrates both the States of Jersey's efficiency improvement aims in relation to other countries and the level of improvement which might be targeted for listed buildings.

Other countries approaches are reviewed on page 23 set out in Appendix (2) and there is an evident correlation between the climate and the amount of energy conservation aimed for; Sweden and Denmark set appreciably higher standards than the UK and Republic of Ireland. However, the targets that the States of Jersey have are less stringent than most other Northern European countries analysed. Only two countries have the same or lower targets; France's average out to the same level as the States of Jersey while those of Belgium are appreciably lower.

In the UK initiatives like the Green Deal and Building Energy Performance Certificates require an evaluation of the existing building stock. BREEAM and Passivhaus are European assessment systems, along with the American system LEED. These accreditations are widely recognised performance indicators of energy efficiency.

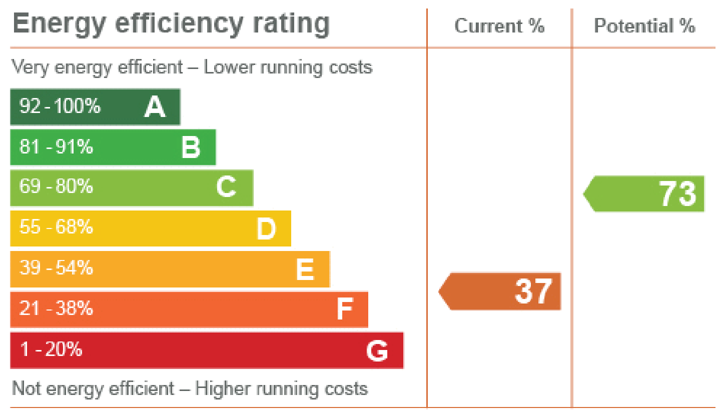
Generally these assessments are carried out through the use of standard forms which have not been developed to deal with historic fabric. Additionally assessors are not required to have any prior experience in the construction industry, let alone with traditional building methods and materials. It is clear that these assessments can produce inaccurate representations of the existing performance of a building. More worryingly, by altering individual elements, they could potentially have a detrimental impact on both the character and overall performance of the building.

Potential Action:

Ensure assessors in Jersey have an understanding of historic building fabric and it's performance

Example: the thermal performance of built elements such as walls is noted in 'U' value, with a lower 'U' value indicating better thermal performance. The method used to calculate the rating for systems like the Building Energy Performance Certificate have been developed using a standard brick cavity construction and defaults to high 'U' values for other types of historic wall construction. This clearly is not an accurate method of evaluating the performance of traditional buildings and assumes the worst case scenario encouraging greater intervention.

Another example is where an assessment system disregards a potential area of inefficiency. SAP calculations, as required under UK Building Regulations, are a computer based assessment used to predict the Energy Performance of a building before it is constructed. A widely recognised failure of SAP is that it makes no reference to ventilation losses and therefore cannot predict energy use reductions through the removal of draughts.



2.9 ECOLOGY

Encouraging increased biodiversity is a common goal of 'green design' and should be encouraged, even where legislation does not require its inclusion. Many internationally recognised assessments, including BREEAM, have sections devoted to encouraging animal and plant life adjacent to buildings. While not directly related to improving energy efficiency, improving biodiversity is good environmental practice and there are many easily implemented measures available to achieve this.[1]

Historic buildings often develop a close integration with the local ecology. Structures that have existed for many years regularly play host to plants and animals, some of which are recognised protected species. Jersey has policies which relate to the protection of these species and their habitats, including those made within human built structures. The protection of these species is often overlooked, but damage caused to an animal or its habitat can incur severe penalties. It is the responsibility of the building owner to ensure protected species are not harmed during any works to avoid legal action.

Protected species in Jersey are covered by the Conservation of Wildlife (Jersey) Law 2000 (as amended) and the States of Jersey Island Plan 2011 - Natural Environment.

Example of a Living Wall Athenaeum Hotel: London: **Purcell**

1 Biodiversity for Low and Zero Carbon Building; A Technical Guide for New Build, Dr Carol Williams.

Policy NE1
Conservation and enhancement of Biological Diversity
There will be a presumption in favour of the conservation and enhancement of biological diversity in accord with Policy SP4 'Protecting the natural and historic environment'.
Permission will not be granted for:
the total or partial loss of a protected site;
development which would seriously adversely affect biological diversity.
In exceptional circumstances, where the need for a proposed development clearly outweighs the biodiversity value of a site and development which would have an adverse effect on biodiversity is allowed, the Minister for Planning and Environment will use planning conditions and planning obligations to provide appropriate mitigation and compensatory measures to secure a demonstrable net gain in biodiversity.
The Minister for Planning and Environment will encourage and promote opportunities to conserve wildlife and to create and manage new natural or semi-natural habitats in the context of development schemes through appropriate building design and site layouts, landscaping and choice of plant species.
Applications for proposals affecting protected sites which do not provide sufficient information to enable the likely impact of proposals to be considered, understood and evaluated will be refused.

Policy NE2
Species protection
Planning permission will only be granted for development that would not cause significant harm to animal or plant species protected by law, or their habitats.
Where a proposal may have an adverse effect on protected species or habitats, applications will be expected to undertake an appropriate assessment demonstrating proposed mitigation measures.

Relevant articles from 'Wildlife Law' include:

- Under Article 5(1) of the Wildlife Law it is an offence for any person to knowingly kill, injure or take any species of reptile, amphibian, bat, shrew, red squirrel or bird (apart from feral and wood pigeon, magpie and crow) or the egg of such bird;
- Under Article 6(1) of the Wildlife Law it is an offence for any person to knowingly damage or destroy the den or nest of any of the above protected species, obstruct access to a den or nest in use or to disturb any protected species occupying a den or nest;
- In accordance with Article 5(6) of the Wildlife Law, before anything is done in relation to a bat, the Department of the Environment must be notified and their advice sought as to whether the operations should be carried out and if so the method to be used.

Ecological surveys may be required as part of a Planning Application, to determine the presence of protected species prior to consent for works being granted.

The presence of a protected species in a building does not necessarily mean that works will not be permitted, but it does mean that these need to be carefully considered and planned. Some species are dependent on the availability of these human habitats to survive. For a full list of protected species refer to the relevant policies.[1] Early ecological assessment can be used to inform environmental value and available options.

1 Conservation of Wildlife (Jersey) Law 2000 (as amended)
States of Jersey Island Plan 2011 - Natural Environment
Policy NE1 - conservation and enhancement of Biological diversity
Policy NE2 - species protection

There are many protected species in Jersey. The following have been identified as having a close relationship with historic buildings and therefore are at risk during upgrades and other works.

BATS

Eleven species of bat have been recorded in Jersey, several of which are considered rare or extremely rare within the UK. They use many different parts of buildings not only roof spaces and lofts but also wall crevices, spaces between timber joists, behind tiles, flashings, fascias or any feature that provides shelter. They roost both singularly and communally using different parts of a building for different purposes throughout the year. Bats may use one roost site or several but often return generation after generation to the same sites. Being long lived and slow to breed the loss of a roost can have a dramatic impact on the wider population. Bats also roost in trees and may depend on the shelter of trees and adjoining hedgerows to commute and navigate within a location.

BIRDS

Again there are many different types of bird that use buildings to form their nests such as House Martins and Swallows. Timing of works may be affected to avoid nesting periods. There are a variety of boxes available that can be built into walls in which birds can form their nests. Additionally roofs can be detailed to encourage birds like House Martins to nest.

VEGETATION

Living roofs or walls are a very effective way of improving the ecology of a building. In addition to providing a diversity of plant life which will be inhabited by insects, Green roofs and walls insulate the building while absorbing rainwater, reducing the amount of surface run off water. Surface run off can be an issue in some areas where rainfall overcomes drainage provision causing flooding.

Bat

Bat access tile

House Martin

2.10 STATUTORY APPROVALS

In order to control the quality and suitability of proposed alterations to listed buildings, legislation has been developed to ensure that these cannot be carried out without the relevant approvals in place. Failure to attain these can result in severe penalties as any work to a listed building without consent is against Jersey law and therefore illegal.

The relevant law is: Planning and Building (Jersey) Law 2002 Revised Edition 22.550 Showing the law as at 1 January 2013, under Part 6 Additional Controls, Chapter 1 – Site of Special Interest the most important articles are:

Article 51 - the Minister will maintain Lists of Sites of Special Interest, Articles 52 and 53 clarify the procedures;

Article 54 - sets out the controls on development; and

Article 55 - sets out the restrictions on activities allowed, the ability to get permission for alterations and censure on those who fail to adhere to the requirements of the legislation.

ALTERATIONS TO LISTED BUILDINGS

Following the recent resurvey the listed building framework is undergoing a restructure. As part of this all listed buildings will be given a grade and eventually conservation areas will be identified. The grades run as follows:

Grade 1 - Buildings and sites of public and heritage importance of exceptional interest, being outstanding examples of a particular period, style or type, and those of more than island-wide importance.

Grade 2 - Buildings and sites of public and heritage importance with special interest to Jersey, being important, high quality examples of a particular period, style or type that are either substantially unaltered or whose alterations contribute to the special interest.

Grade 3 - Buildings and sites of public and heritage importance and special interest to Jersey, being important, good examples of a particular period, style or type but with alterations that reduce the special interest; and/or have special elements worthy of listing.

Grade 4 - Buildings defined particularly for their contribution to townscape, landscape or group value and thus exterior characteristics.

Applications to carry out building works to listed buildings are made under a standard Planning Application as the Jersey Planning Department does not operate a separate procedure for listed buildings. Therefore it may be necessary to apply for Planning Consent for works which may appear minor to a resident but impact on the heritage value of the building. Works to listed buildings are evaluated alongside other Planning Policies. Specific items of work may require use of particular forms, for instance there is a specific form for works concerning windows and doors, refer to the States of Jersey website to download the relevant forms and guidance www.gov.je/PlanningBuilding. The level of permitted alterations will depend upon the grade of listing and the extent to which the proposed works will impact on the historically significant features of the building.

Consent to alter a listed building gives permission to carry out the work applied for, but this is only one half of the approval process, the works must also satisfy the Building Bye-laws (Jersey) 2007 Revised Edition 22.550.05 (showing the law as at 1 January 2011), provided they are not exempt under Schedule 1 of the Bye-laws.

There is, within the bye-laws no specific exemption or relaxation available for listed buildings from satisfying the requirements of the bye-laws as is normally the case elsewhere in Northern Europe. However supplementary technical guidance documentation does note that in some cases full compliance may not be achievable. Where this is the case circumstances will be viewed individually to reach a 'reasonable' outcome in terms of meeting bye-law requirements and protecting historic fabric.

JERSEY'S EXISTING FABRIC AND BUILDING BYELAWS IN CONTEXT - SUMMARY TABLE

As stated on page 18, in order to accurately assess the States of Jersey's aims, it is helpful to compare the States' requirements with those of other countries. We have therefore investigated the energy conservation statutory regime for the following countries or jurisdictions.

- Jersey
- England and Wales
- Scotland
- France
- The Republic of Ireland
- Germany
- Belgium
- Denmark
- Sweden

There are a number of reasons for assessing these countries' building control regimes against the States of Jersey's:

1. They are all Northern European countries which will respond to similar climatic conditions. Noting that, in contrast, Jersey has a mild maritime climate with reduced chances of frost.
2. All have significant historic building stock needing protection from insensitive change but whose thermal performance also needs improvement.
3. All of them bar the States of Jersey are members of the European Union and therefore should be responding more than adequately to relevant EU Directives.

We have made an assessment of the 'U' values for walls, roofs, floors, windows and doors of an unimproved typical historic Jersey construction. This provides a baseline against which to compare all other interventions. We have then, where possible, compared the various performance levels required by countries' current regulations to one another. This means we can compare:

1. The current level of improvement Jersey regulations aim for over the historic baseline constructions.

2. Where Jersey's target improvement sits within the range of other Northern European countries.

3. To what extent other countries have tried to aim higher than an average level of improvement and how Jersey compares to the average.

A comparison table expressing the different responses as percentages of a nominal existing situation is given below.

In this instance the lower the percentage given the better the energy efficiency target. It can be seen that Jersey aims are nominally in line with the UK while mainland European countries have mixed results.

It is important to note that the figures expressed in the historic base line constructions are, if they are not available from measurement, arrived at using industry standard calculation software. Research carried out by several UK based establishments (Glasgow Caledonian University, SPAB, Historic Scotland et al) suggests that the calculated figures tend to be pessimistic. Only actual measurement will give certainty to these figures.

We give links to each regime's legislation, summarise each system and compare them more fully in Appendix 2.

Construction	Historic Jersey	EU Directive	Jersey Current Regulations	England & Wales	Scotland	France	Ireland	Germany	Belgium	Denmark	Sweden
Floor	100%	20%	13%	11%	10%	14%	11%	18%	47%	6%	8%
Wall	100%	20%	15%	11%	10%	14%	8%	11%	14%	8%	7%
Roof (Pitched)	100%	20%	9%	8%	8%	9%	7%	8%	11%	6%	6%
Window	100%	20%	42%	33%	38%	42%	33%	27%	46%	33%	27%
Door	100%	20%	46%	38%	38%	42%	33%	38%	46%	33%	27%
Average (Mean)	100%	20%	25%	21%	21%	25%	19%	20%	33%	17%	15%

3.0 IMPROVEMENT

This section of the report will focus on the possible measures available to improve energy efficiency of Jersey's listed buildings. It will also highlight those areas that require careful consideration when dealing with historic fabric.

There are many measures available to home owners and occupiers in Jersey to improve energy efficiency and it can be difficult to identify those that will provide the greatest benefit. As a general rule of thumb it is always advised to REDUCE energy use as a primary objective. This can be achieved using 'passive' measures. The logic is similar to that of the popular slogan 'reduce, reuse, recycle' applied to waste. However just as it is common for attention to be drawn to recycling (third on the list) it can also be all too easy to focus on 'active' energy producing measures, noted below. It is understandable that these measures would garner more attention. They are 'active' as opposed to 'passive', they can be seen to be working and make consumers feel that they are getting more value for money. In a very small number of cases, due to particular constraints, they can be the only option available; however they should be seen as the last resort once all passive options have been exhausted.

PASSIVE (ENERGY SAVING)

Passive measures are things that perform in the background to save energy. Generally these are items that should be included within good design to reduce the amount of energy required to run a building. In listed buildings these will include fabric upgrades like insulation, draught proofing, use of thermal mass, maximising use of daylight and natural ventilation methods.

ACTIVE (ENERGY PRODUCING)

Active measures are things that perform to create energy, whether it be in the form of heat or electricity. These are the items that get a lot of attention and tend to be used to signify a 'green building'. They include wind turbines, photovoltaic and solar thermal panels, biomass boilers/generators etc. It is widely accepted that these measures are really only viable as part of a holistic design and only after energy use has been reduced to the point where these items can cover the majority or all of the energy required.

Potential Action:

Carry out regular review of developing research and technologies

When implementing improvements to a historic building there are several areas that need special consideration in terms of not only aesthetics and principles but in technical performance as well.

3.1 RETENTION/REPLACEMENT OF EXISTING FABRIC

As previously stated the retention of existing historic fabric is considered of importance in terms of heritage significance, embodied energy and cost. An example of this can be made in the case of windows and doors with similar principles applied to all areas of historic fabric from masonry to railings or plaster.

Following consideration of upgrades to improve energy efficiency that can be made to existing windows and doors, included on page 50, the alternative is full scale replacement. This is not a decision to be taken lightly as the windows and doors of any historic property play a vital role in maintaining its character. The loss of original fabric can have a detrimental effect on the individual property and also the group value of the local built environment.

Generally historic elements should be repaired, timber and metal replacement pieces can be spliced into existing, however, there will always be a point at which existing fabric is beyond saving and needs to be replaced.

If existing windows and doors are well maintained, there is no reasonable need to replace them since thermal upgrades and draught proofing options are readily available. It may be possible to retrofit double glazing panes within existing windows but a review of the visual impact of this needs to be made and is not generally accepted in Jersey to listed buildings. A similar assessment is required where historic windows have been neglected and fallen into disrepair.

In replacement cases a strict like for like policy should be adopted to ensure the character of the building is maintained. New timber and metal windows can be made to approximately match existing proportions and design features but these should be carefully considered as their appearance can be detrimental to the historic building.

Other considerations of replacement include cost of installation, maintenance and embodied energy. These elements can be combined to carry out a Life Cycle Assessment (LCA)[1]. Recent studies have shown that in all cases timber windows are preferable to UPVC due to their reduced environmental impact and cost over the lifetime of these elements.

1 Dr G. Menzies, Life Cycle Assessment of Timber, modified timber and aluminium-clad timber windows, March 2013. Heriot Watt University

3.2 VENTILATION AND MOISTURE IN HISTORIC FABRIC

When reviewing improvements to existing buildings like damp/draught proofing or insulation, it is important to consider ventilation and moisture movement as historic buildings must be dealt with differently to new construction. Historic buildings tend to be very draughty and while undesirable for human comfort, this is often necessary for: the health of the building - to evacuate airborne moisture, and human health, to evacuate unwanted gases and bring in fresh air. Ventilation is also important when there is a fire or other naked flame in the room as this burns oxygen and releases harmful gases. It should be noted that historic openings may also be used by protected species for access, i.e. bats, and thorough investigation should be carried out prior to sealing, refer to page 19.

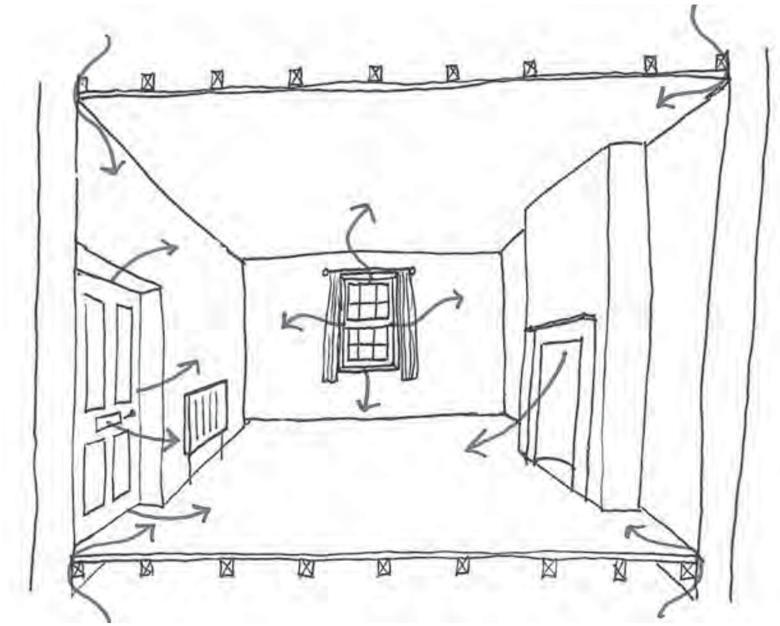
3.3 HYGROSCOPIC AND VAPOUR PERMEABLE MATERIALS

Historic buildings are generally formed from 'natural' materials, synthetic materials being a modern development. Jersey historic buildings exhibit these natural local materials, refer to pages 7-11. Most natural materials are hygroscopic, which means that they can take water into themselves and release it later. They are also vapour permeable (breathable), meaning water can pass through them. As such natural materials allow a building to 'breathe' with routes for moisture to escape through the building fabric. Synthetic materials do not absorb moisture in this way, and in some cases they are not vapour permeable. Where these are inserted into historic environments they can cause deterioration of the adjacent materials by blocking existing moisture paths.[1] It is important that natural materials are not exposed to permanently damp conditions as they can rot. This is particularly of concern to structure members like timber floor joists.

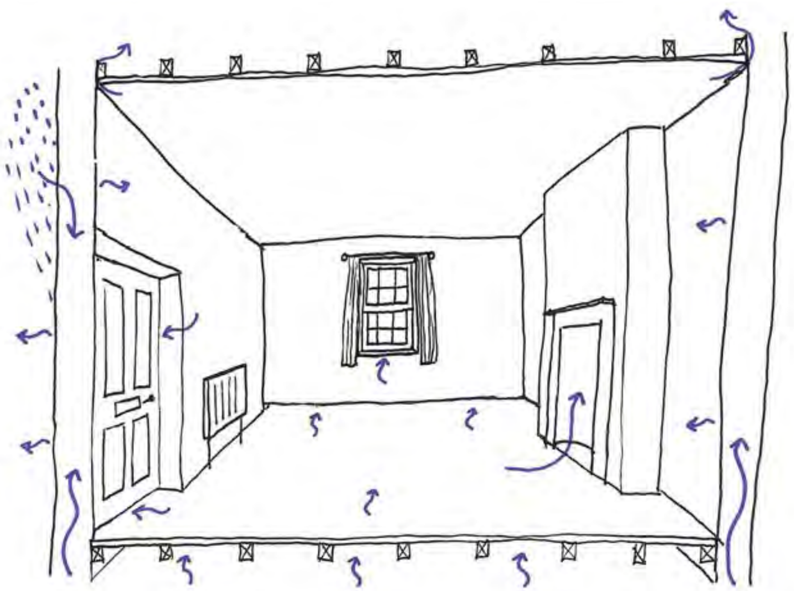
Natural materials may be viewed as supportive to building and occupant health, as they can be used help to regulate humidity levels within buildings.

Example: the National Maritime Museum, Greenwich, completed by Purcell.
The archive at the NMM has a highly controlled environment to ensure that the artefacts housed therein are maintained in the best possible conditions. As part of the strategy a very low number of air changes was specified along with tight air leakage standards. The walls of the archive are lined in clay and reed boards with a clay plaster finish. If humidity levels rise the walls absorb the moisture protecting the objects from harm.

1 Historic Scotland Fabric Improvements for Energy Efficiency in Traditional Buildings



Draught routes



Moisture routes

3.4 TYPES OF IMPROVEMENT

There are many improvements that can be made to the energy efficiency of listed buildings and these can be easily broken down into different types. A brief description of the overriding issues in relation to these are included below with further information referenced within Appendix 1.

OCCUPANT

As identified by the summary table included on page 30, the simplest improvements can often be made directly by occupants of listed buildings with little potential for negative impact on historic fabric. These improvements can be through regular and thorough general maintenance (see page 39) and upgrades to user controls, monitoring and small changes in behaviour in energy use (see page 42).

Recently the Minister of Planning and Environment commissioned the creation of a heat loss map through the use of thermal imaging cameras taking shots from aircraft. This map is available online at 'http://www.gov.je/Environment/GenerateEnergy/Energyefficiency/Pages/JerseyHeatLossMap.aspx'. Although interpretation of the results can vary, this is a useful tool to indicate the energy efficiency of Jersey buildings in general, see page 27 for example image.

FABRIC

Improvements to the fabric of a building refer to the upgrade, overhaul or retrofit of materials to the existing building to form better thermal separation between inside and out (or sometimes different rooms internally). These can be split into draught proofing (see page 43), damp proofing (see page 46) and insulation (see page 47), although they are often installed together as part of improvement works. As with any addition to existing historic fabric, care should be taken to maintain features and details that inform the character of the building both internally and externally.

Example of decay to Timber Sash Window through poor maintenance

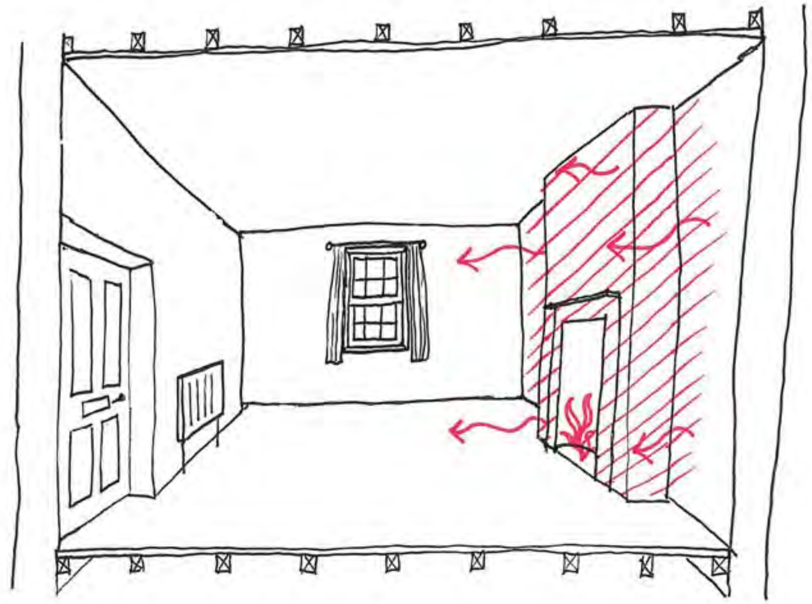
Heat Loss Map - A survey was taken of all Jersey using thermal images taken from aircraft to form a heat map
The information has been distilled into categories of heat emission indicating energy efficiency

CLIMATE

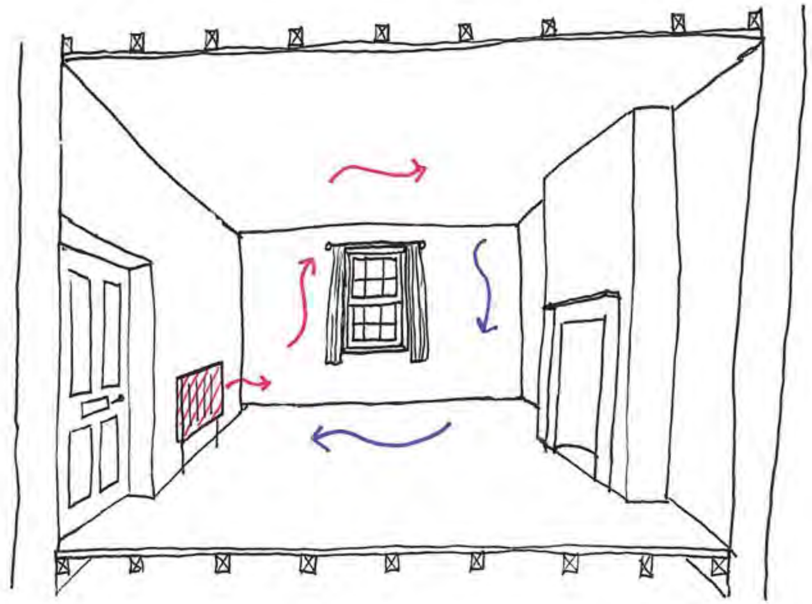
In contrast to fabric improvements, which improve energy efficiency by creating a greater thermal barrier between internal and external conditions, climate improvements consider the use of energy in controlling the internal climate through heating (see page 55) and cooling/ventilation (see page 57). This is an area where understanding of historic fabric and the way it has been expected to behave in both the past and present are key. Traditionally houses were heated with a form of fire, typically a chimney and hearth arrangement, spreading radiant heat through the building via the thermal mass of the chimney and fireplace, as well as radiantly through the air. Modern insertions are common in almost all residences using boilers with radiators which heat a building differently to its original design using radiant heat only.

When considering heating provision in a listed building the impact is not only on the visual appearance of heating, like radiators, but also on the building fabric itself. As noted above heating traditional buildings has changed over their life. Historically a building being at a lower temperature was accepted with small areas of comfortable occupied space near to fires etc. Today buildings are expected to maintain higher general temperatures throughout. Studies have been carried out into the damage to historic fabric from overheating and drying out and the benefits of a return to lower general temperatures with local increases in occupied spaces only.[1] Systems like underfloor heating can be employed to keep a low background temperature coupled with localised radiant heat sources like radiators, stoves or open fires.

It is unlikely that suitable warmth will be generated for modern living standard by open fires alone, but these can be successfully used as part of an integrated system. Locating a sustainable supply of fuel is an important issue and should be as locally based as possible to avoid transport energy.



Fire heat pattern



Radiator heat pattern

1 Historic Scotland Technical Paper 14

CONSUMPTION

The consumption of electricity (page 59) and water (page 58) are also areas in which improvements in energy efficiency can be made. In relation to listed buildings there is ample scope to make improvements in consumption without having an impact on the historic fabric.

PRODUCTION

As previously stated, once all improvements noted above have been reviewed and implemented the local production of energy may be considered. Jersey's listed buildings may have limited scope to introduce these improvements as they do tend to impact on historic fabric and settings. However, areas of lower significance can be identified i.e. in rural areas properties can make use of garden space to avoid negative effects to a listed building.

Energy production can be broken down into the creation of electricity (page 60) and heat (page 61).

3.5 SUMMARY TABLE

As part of this report a review of possible improvements has been analysed against the Jersey context, (included in the previous section) and a traffic light system utilised to highlight those measures that, on balance, present 'easy wins', graded GREEN. Those measures that, although still considered beneficial, are perhaps more complex to implement are graded AMBER and RED. For the purposes of clarity these can be split into different areas of improvement, while more detailed information has been included within Appendix 1 and referenced in the table on the following page. As noted previously the implementation of these improvements is entirely dependant on their impact on the historic fabric and most will require planning consent.

	Measure	Upgrade/ Overhaul/ Retrofit	Traditional/new tech/emerging	Constraints					Total
				Energy efficiency benefit	Impact on historic fabric	Likelihood of receiving Planning Consent	Cost	Payback	Total
				0 - no benefit 5 - potential large benefit	0 - no impact -5 - greatly detrimental 5 - greatly beneficial	0 - not likely 5 - highly likely	0 - low cost -5 - high cost	0 - low payback 5 - high payback	up to 0 - grey 1-4 - red 5-8 - amber 9 upwards - green
ENERGY SAVING									
General maintenance (p.39)	Annual building inspection		Traditional	0	5	5	0	0	10
	Repointing of mortar	Upgrade	Traditional	1	5	5	-1	0	10
	Repairs to cementitious render	Upgrade	Traditional	1	3	3	-1	0	6
	Repairs to lime render	Upgrade	Traditional	1	5	5	-1	0	10
	Repainting doors and windows	Upgrade	Traditional	1	5	5	0	0	11
	Unblock gutters	Upgrade	Traditional	1	0	5	0	0	6
	Check unwanted plant growth	Upgrade	Traditional	1	5	5	0	0	11
	Repair loose roof slates/tiles	Upgrade	Traditional	1	5	5	-1	0	10
Damp Proofing (p.46)	Install dpc to walls	Retrofit	Both	2	-1	2	-2	1	2
	Install dpc to floor	Retrofit	Both	2	-3	2	-3	1	-1
	Install french drain externally		Both	1	0	4	-1	1	5
Draught proofing (p.43)	Install draught strips to doors & windows	Overhaul	New technology	2	0	5	-1	1	7
	Localised sealing of air gaps, letterbox, cat flap etc.	Retrofit	Traditional	2	0	5	-1	1	7
	Fit register plate to chimney	Retrofit	Traditional	2	1	5	-1	1	8
	Install uninterupted vapour control layer to walls, floors and ceilings	Retrofit	New technology	3	-2	2	-3	1	1
Insulation - roofs (p.51)	at rafter level	Retrofit	New technology	5	0	5	-3	4	11
	over rafter level	Retrofit	New technology	5	-3	1	-5	4	2
	at ceiling level	Retrofit	New technology	5	0	5	-3	4	11
Insulation - windows (p.49)	New timber double glazed with thermal break frames (incl. Insulated glass)	Retrofit	New technology	5	-1	3	-2	3	8
	New metal double glazed with thermal break frames (inclu. Insulated glass)	Retrofit	New technology	5	-1	3	-2	3	8
	New UPVC double glazed with thermal break frames (incl. Insulated glass)	Retrofit	New technology	2	-5	0	-1	3	-1
	New slim fit double glazed units to existing frames	Retrofit	New technology	4	-1	4	-2	3	8
	Secondary glazing	Retrofit	New technology	4	0	4	-2	3	9
	Internal shutters	Retrofit	Traditional	3	2	4	-1	3	11
	External shutters	Retrofit	Traditional	?	3	4	-2	?	5
	Heavy curtain/blind	Retrofit	Traditional	2	0	5	0	1	8

	Measure	Upgrade/ Overhaul/ Retrofit	Traditional/new tech/emerging	Constraints					
				Energy efficiency benefit	Impact on historic fabric	Likelyhood of receiving Planning Consent	Cost	Payback	Total
				0 - no benefit 5 - potential large benefit	0 - no impact -5 - greatly detrimental 5 - greatly beneficial	0 - not likely 5 - highly likely	0 - low cost -5 - high cost	0 - low payback 5 - high payback	up to 0 - grey 1-4 - red 5-8 - amber 9 upwards - green
Insulation - doors (p.49)	New timber with thermal break frames	Retrofit	New technology	5	-1	3	-2	3	8
	New metal with thermal break frames	Retrofit	New technology	5	-1	3	-2	3	8
	New UPVC with thermal break frames	Retrofit	New technology	2	-5	0	-1	3	-1
	Insulated lining to existing door leaf/infill panels	Retrofit	New technology	3	-1	3	-1	1	5
	Heavy curtain/blind	Retrofit	Traditional	2	0	5	0	1	8
Insulation - floor (p.52)	New floating floor over existing	Retrofit	New technology	4	-2	3	-3	4	6
	New insulated solid floor	Retrofit	New technology	4	-4	2	-4	4	2
	Between joists	Retrofit	New technology	4	0	5	-2	4	11
Insulation - walls (p.53)	Internal	Retrofit	New technology	4	-3	3	-2	4	6
	Cavity	Retrofit	New technology	4	-1	3	-2	4	8
	External	Retrofit	New technology	4	-4	2	-3	4	3
Heat/ Cooling (p.55-57)	Replace existing inefficient boiler	Retrofit	New technology	5	0	5	-3	3	10
	Improve user controls	Retrofit	New technology	?	0	5	-1	?	4
	Maximise solar gain		Traditional	3	0	5	0	1	9
	Reduce general temperatures and locally heat occupied spaces		Traditional	3	2	5	0	1	11
	Install underfloor heating	Retrofit	New technology	4	-2	3	-3	1	3
	Install alternative heat generator i.e. CHP, boifuel burners etc	Retrofit	New technology	4	0	5	-4	3	8
	Use shading to control solar gains		Traditional	2	0	5	0	1	8
	Use natural ventilation in favour of mechanical		Traditional	5	0	5	0	0	10
	Install heat recovery in mechanical ventilation	Retrofit	New technology	3	-3	3	-3	1	1

	Measure	Upgrade/ Overhaul/ Retrofit	Traditional/new tech/emerging	Constraints					
				Energy efficiency benefit	Impact on historic fabric	Likelyhood of receiving Planning Consent	Cost	Payback	Total
				0 - no benefit 5 - potential large benefit	0 - no impact -5 - greatly detrimental 5 - greatly beneficial	0 - not likely 5 - highly likely	0 - low cost -5 - high cost	0 - low payback 5 - high payback	up to 0 - grey 1-4 - red 5-8 - amber 9 upwards - green
Electricity (p.59)	Energy saving bulbs	Upgrade	New technology	1	0	5	0	1	7
	LED light fitiings	Overhaul	New technology	2	0	5	-1	1	7
	Maximise use of daylight	Retrofit	New technology	2	0	5	0	1	8
	Install 'light pipes'	Retrofit	New technology	2	-1	4	-1	1	5
	Install better controls/ PIR/ timed switches	Retrofit	New technology	2	0	5	0	1	8
	Turn off unneeded lights and appliances		Traditional	2	0	5	0	1	8
	Upgrade to A rated appliances	Upgrade	New technology	3	0	5	-1	1	8
Water conservation (p.58)	Install spray/aerators taps/ showerheads	Retrofit	New technolgy	1	0	5	-1	1	6
	Install controls i.e. sensor ot timer operated taps	Retrofit	New technology	1	0	5	-1	1	6
	Use garden water butt	Retrofit	Traditional	1	0	5	0	1	7
	Install low flush/dual flush WCs	Retrofit	New technology	1	0	5	-1	1	6
	Install WC cistern hippos	Upgrade	New technology	1	0	5	0	1	7
	Install leak detectors	Retrofit	New technology	1	0	5	-1	1	6
	Install low water use washing machines, dishwashers	Retrofit	New technology	1	0	5	-1	1	6
	Use greywater recycling plant	Retrofit	Emerging	2	0	3	-3	1	3
	Use rainwater harvesting for water in the home	Retrofit	New technology	2	0	5	-2	1	6
	Install composting WCs	Retrofit	New technology	1	0	5	-3	1	4
	Take showers not baths or power showers		Traditional	1	0	5	0	1	7
ENERGY PRODUCTION									
Heat (p.61)	Solar thermal panels installed on roof	Retrofit	New technology	2	-4	3	-3	2	0
	Solar thermal panels installed in garden	Retrofit	New technology	2	-1	3	-2	2	4
	Ground source heat pump	Retrofit	New technology	3	0	4	-3	3	7
	Air source heat pump	Retrofit	New technology	1	-5	2	-2	1	-3
Electricity (p.60)	Wind Turbines installed to roof	Retrofit	New technology	1	-5	0	-3	1	-6
	Wind Turbines installed to garden	Retrofit	New technology	1	-3	0	-3	1	-4
	Photovoltaics installed on roof	Retrofit	New technology	3	-4	3	-4	3	1
	Photovoltaics installed in garden	Retrofit	New technology	3	-1	3	-3	3	5

4.0 FURTHER RESEARCH

As previously discussed there are many gaps in current research into the physical performance of existing buildings and the impact and effectiveness of measures to improve energy efficiency. Much of the existing research is based on case studies and example buildings. This can limit the relevance of results for developing generalised standards or advice. A wider range of testing, under controlled conditions, is required to form a database of information from which conclusions can be drawn.

Some testing has been identified as being of particular relevance to Jersey. It would be beneficial for this testing to be carried out in context to ensure that it specifically relates to the Jersey climate and building construction techniques. A number of suggested testing areas has been identified within this report, a summary of these is included below.

- **Carry out testing to determine performance of typical building types in Jersey**

  This testing would be of a similar set up to that carried out to-date by Historic Scotland with temperature and humidity sensors installed internally and externally to determine the U-value of an existing wall. The focus would be on traditional Jersey granite solid wall construction in rubble and ashlar construction. Testing should take place over a sufficiently long period of time to obtain reliable results and should be carried out at different seasons to explore the annual cycle of a building in terms of heat and moisture.

- **Encourage testing after implementation of measures**

  There is very little data available to prove the improvements made by implementing energy efficiency measures to traditional buildings. Proof of this can be in a variety of forms, including simply taking energy use readings and comparing these to before the improvements were made. More in depth studies could be carried out, installing sensors into buildings to measure specific outcomes like U-value and moisture levels. However, it should be noted that occupants often change use patterns following the installation of energy efficiency measures, and care must be taken to ensure that results are not misleading.

- **Testing of traditional granite walls with cementitious render/mortar and 'pierre perdu' for signs of damage**

  As identified previously the use of cementitious render and mortar on traditional granite walls could be trapping moisture within the wall. This could potentially be causing damage through premature weathering and reducing the thermal performance of the wall. Testing should be carried out to determine the nature of Jersey granite and how this relates to the local cementitious mortar and render mixes. The results will indicate whether moisture will be inclined to move through the stone or mortar/render or neither. It is worth noting that a standard mix may not be present on the Island. The results could inform whether cementitious render/mortar can be implemented in the future safely, as an alternative to lime renders and mortars, through the use of a recommended mix.

  On site testing should also be carried out to check the application of the theory and to investigate the ability of 'piere pedu' to allow moisture to escape and, if it is the only outlet, the area required to effectively vent the wall.

- **Testing of draught and thermal improvements from use of external shutters**

  The traditional louvred external shutters evident in Jersey were designed to shield windows in the summer months, reducing the amount of solar gain into rooms and keeping the occupants cool. In many instances these have been removed and, even in cases where they are retained, it is unlikely that they are used as intended. These features form an important part of Jersey built environment and should be retained and reinstated where possible.

  The ability of these shutters to perform additional roles should be explored. For instance, shutters could have insulated panels, draught proofing or removable perspex panels applied in winter only etc. Testing would be carried out via mock ups in a laboratory, comparable with Historic Scotland's research for sash windows, or on site.

- **Testing of roof insulation**

  As it is current Jersey policy to insulate roofs when other works are carried out, it may be possible to evaluate the effectiveness of different insulation positions and techniques. Performance could be monitored with sensors in a similar way to the testing of U-values for walls previously described.

  Another helpful indicator would be to repeat the Jersey heat loss map at regular intervals, establishing how the performance of individual building develops over time. This option is obviously open to speculation is a drop in measured heat from a property an indication of improved thermal effectiveness or are the occupants simply not home etc? Despite this if a sufficient number of improvements are seen, it might indicate that policy is working and help to target particularly inefficient buildings, helping to lower the Islands energy consumption.

Example external shutters closed

- **Testing of typical residence types annual heating fuel use and impact of installing user controls/improved boiler**

  Any measures implemented to improve energy efficiency should be measurable through a reduction in annual energy use. A significant reduction should be evident in heating fuel consumption, whether it be gas, oil or biofuel. Testing could simply be a collation of meter readings from a wide sample of different building types and demographic of occupants. Such a wide scale collaborative effort would also help to raise public engagement and understanding of the issue.

  The first round could be used to set a base line to which future assessments will be related.

  Further to this similar testing could be carried out, requesting that occupants indicate if any energy efficiency improvements have been made or general use patterns altered.

  This type of testing could be applied to a small number of buildings to measure validity and success before encouraging on a larger scale.

- **Testing of typical residence types annual electricity use and impact of installing user controls**

  This would be very similar to testing heating fuel use although electricity use can vary widely depending on the appliances etc. installed.

The test conditions and methods applied to any of the above should be carefully considered to ensure useful results are received. A consultation process would be advisable drawing on the knowledge of academics and professionals who have already carried out similar studies and will apply appropriate controls to ensure variables are limited.

- **Carry out Jersey specific testing of relative costs for energy efficiency measures and pay back periods**

  Appoint a specialist to carry out analysis of costs and benefits for the different energy efficiency improving measures available. The study will include analysis of fuel costs and anticipated savings from the implementation of these measures. This will be informed by the practical testing suggested in the previous points. These figures should be regularly revised, perhaps on a five yearly basis, to keep them relevant.

5.0 ACTIONS

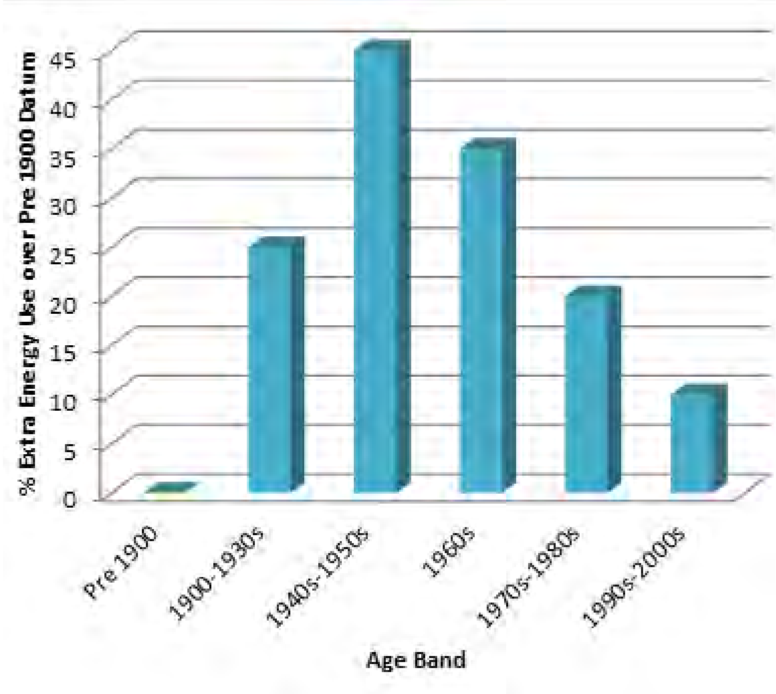
In addition to the previously suggested areas of further research this report has also identified several actions, some of which can be implemented prior to the completion of the further research. These have been set out below.

- **Extend scope of study/promote energy efficiency in post 1924 buildings**

  The number of listed buildings in Jersey is relatively small when compared with the overall figure of properties. While this report deals specifically with the challenges faced when attempting to improve the energy efficiency of listed buildings we noticed many buildings not currently listed which are at risk from alteration works. It has been noted that buildings of post war construction are typically energy inefficient, in addition modern multiple occupancy buildings, particularly housing many people, presents opportunities to implement shared efficiencies not available to small individual residences. The cap of pre 1924 buildings omits nearly a century of construction. As such a further study would be beneficial in the aim to improve energy efficiency, this time extending the scope of buildings considered and possibly covering policies relating to new developments.

- **Carry out regular review of developing research and technologies**

  The development of research and technologies is constant. A regular review of these should be held every 5 years with all relevant progressions fed back into any systems and documentation as necessary.



Data from UK Ministry of Justice report, The justice estate's energy use March 2008, energy consumption of public buildings

- **Develop Initiatives in Jersey to promote retention reuse and repair of existing building materials using local trades**

  Jersey has a fairly unique opportunity where local trades can be utilised to work in conjunction with the government to ensure there is understanding and provision of techniques and skills to help residents to make the right decisions when it comes to working with historic buildings. Trades often offer advice and guidance to their employers, Jersey has the chance to collaborate with locals improving the treatment of heritage assets and increasing business for resident workers. This could be implemented through an approved list of trades offered to residents who want to carry out works to listed buildings.

- **Train local trades and professionals in understanding of whole life costing**

  In a similar vein to the point above, Jersey has an opportunity to ensure local personnel are educated in whole life costing and therefore able to advise residents on the benefits of retaining existing features or the most appropriate replacements and their financial implications over the long term.

- **Ensure assesors in Jersey have an understanding of historic building fabric and it's performance**

  Following on from the local trades and professionals engagement, these individuals could be utilised to carry out energy efficiency assessments while having an understanding of the specific issues relating to listed buildings. This should help to avoid unnecessary works and works that could damage the traditional fabric. This could be implemented through detailing an adequate test for potential assessors combined with short courses prepared by professionals with adequate knowledge and experience.

- **Increased quality/content of official advice from EES to Jersey residents**

  It is understood that the aim of this report is to inform the development of a larger scale scheme to action improvement in energy efficiency in listed buildings. It is anticipated that this scheme already intends to improve the quality and quantity of available information for residents, helping to relay measures and approaches that can be implemented on the ground. The need for this service has also been identified within this report as important in improving user engagement in tackling the global environmental need to reduce energy consumption. The areas for improvement have been identified within the points for Further Research and Actions.

- **Encourage greater public consultation and relations**

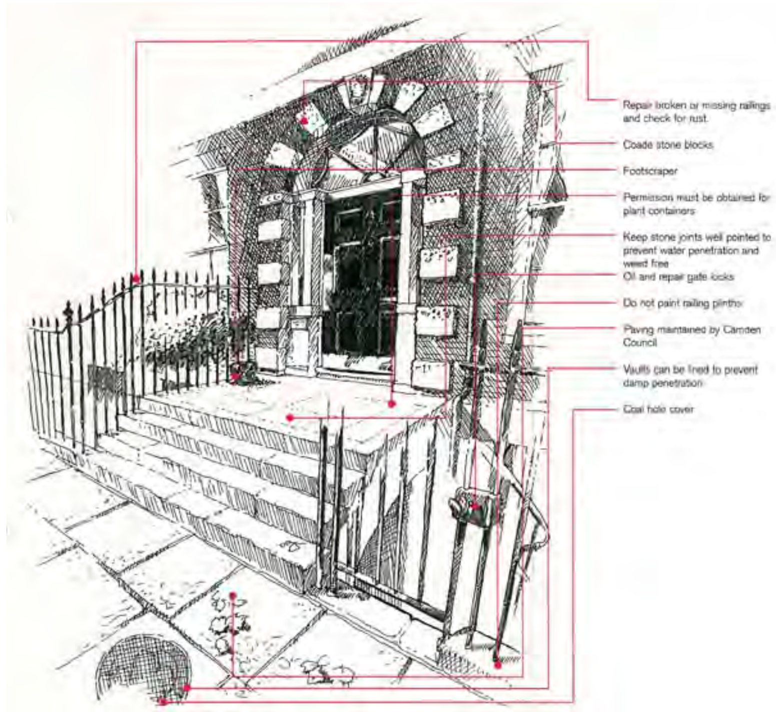
  To achieve significant improvements in energy efficiency user engagement is needed at a high level, therefore increased public consultation and feedback interface would serve to achieve this. Public consultation can take multiple forms and it is often advisable to carry out a variety of methods to ensure a wide demographic of the population is reached and that engagement occurs on a variety of levels. Questionnaires can often be useful to gauge public views and mood. Public meetings, workshops and open days can also help give the residents a chance to understand the reasons behind government initiatives. Exhibitions are another public interface which gives the opportunity for more in-depth questioning.

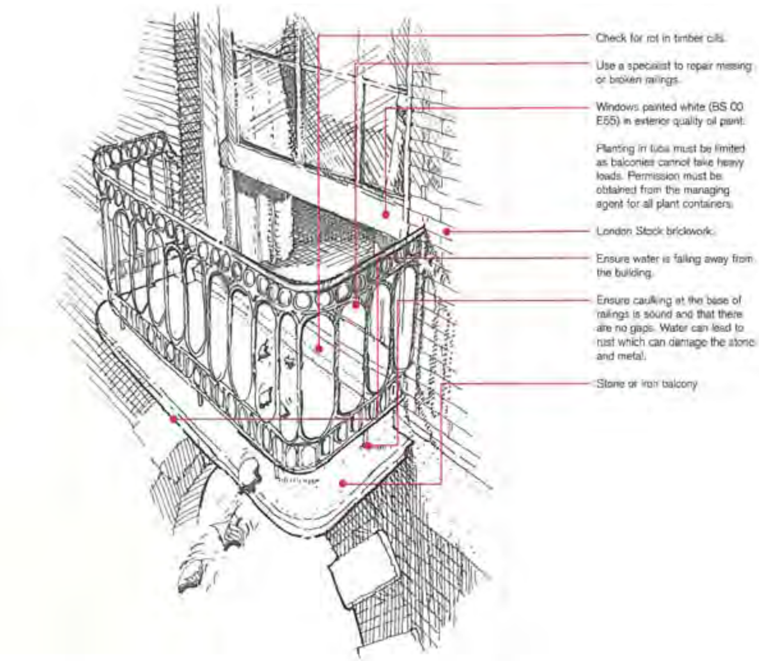
  Any such consultation should be collated and issued under an accessible report to ensure that the public feel their views have been heard and considered.

- **Prepare guidance documentation identifying significant features of listed buildings for issue to residents**

  Another way to aid understanding of the aims for protection of listed buildings between Jersey government and building occupants would be to issue general guidance to all occupiers and subsequently to all new owners when a property changes hands. The pack could include documents already prepared by the Department of Environment i.e the Annual Traditional Building Inspection Sheet and Advice on Traditional Windows and Doors information. Such a pack would help to instil an appreciation by occupiers that a listed building needs to be protected and cared for and that residents have a responsibility to maintain these assets for future generations.

  This is a system employed by the UK Crown Estate in relation to their London tenants. A pack is issued whenever a lease changes hands containing advice and setting out principles of acceptable and unacceptable alterations. These restrictions are quite detailed, a Jersey pack would likely be less so.





Example: Crown Estate advice **Purcell**
Crown Copyright (Crown Estate)

APPENDIX 1

APPENDIX 1.1: GENERAL MAINTENANCE

GRADED GREEN TO AMBER WITHIN THE SUMMARY TABLE, REFER TO P29 ONWARDS

One very simple and easily overlooked element to improving energy efficiency is general maintenance. Many building defects can be treated with very minor repairs if caught early. Whereas if left untreated, the problem will grow to a point where major overhaul or replacement is required. Some examples of these are set out over the next pages.

To avoid unnecessary cost and loss of valuable historic fabric and character a regular appraisal of the building should be carried out to catch any potential issues before they arise. The Jersey Heritage Trust has published advice for building maintenance including an inspection checklist to be used by a property owner or occupier as part of an annual review.[1]

- **Painting timber or metal windows and doors**

  As external items windows and doors are exposed to the elements. To protect the materials that form these sacrificial layers are added. This is often in the form of paint which prevents timber from becoming saturated with water and rotting[2] or metal rusting through exposure to oxygen[3]. Regular repainting, maintenance and repair is required to keep the main fabric of the window or door protected and in good working order. If these are allowed to deteriorate a greater amount of repair will be required, eventually leading to wholesale replacement at greater expense.

  During repainting, areas of rot or damage may be uncovered. These should be dealt with and not simply painted over. Smaller repairs can be carried out by drilling out all areas of rot and using resin fillers. Larger repairs will require splicing in of new timber or replacement of whole timber lengths.

  Decayed or damaged windows and doors are likely to be more draughty, wasting energy through excessive ventilation losses. Where deterioration is sufficient to require complete replacement of an element, there is also a cost in terms of embodied energy.

  Example: the window shown opposite can be repaired by installing a new timber cill and bottom rail, subject to investigation.

- **Loose roof slates/tiles**

  Any damaged areas of the roof will be at risk of letting in water. This can damage internal finishes and cause rot to timber structural roof elements. It can also wet wall structures causing similar problems to those discussed on page 40. Replacement or repair of these can be very costly and disruptive. Therefore regular inspection and minor repairs are preferable.

Example of decay to Timber Sash Window through poor maintenance

1 This Old House: How to look after your historic property.

2 Paint, Wood and Weather – Building Conservation article by Colin Mitchell-Rose

3 Metal Windows – Building Conservation article by Peter Clement

Example of 'Pierre Perdu'

- **Pointing render to stone/brickwork**

  Walls become damp through a number of ways such as rain, rising damp from the ground, leaks from pipes etc. Damp walls are to be avoided as they are less thermally efficient than dry ones[1]. If mortar or render is damaged this allows routes for water to enter the wall construction. Therefore they should be kept in good condition to obtain the best thermal performance for the wall.

  When brick or stone becomes damp the moisture moves to the face of the material to evaporate, often bringing salts from the material that have dissolved in the moisture. This can cause failures on the face due to frost expanding the moisture in the material causing cracking. In traditional building construction lime mortar is used between bricks and stone. Lime mortar is softer and more porous than brick or stone, encouraging any moisture to move into the mortar to evaporate, protecting the structural elements of the wall. In this way the mortar is sacrificial and therefore requires regular repair to keep moisture levels under control in the wall itself. Repointing in cementitious mortar, which is harder and less porous than brick or stone, can cause the opposite effect with irreversible consequences for historic fabric. [2]

PIERRE PERDU

The traditional stone used in Jersey is a pink granite. Granite is a naturally hard stone which does not absorb moisture readily. A tradition of 'pierre perdu' is also evident in Jersey where a render (typically cementitious) is applied to the face of a wall leaving some stone faces exposed. In these cases it is not clear whether water will travel preferentially through granite or cementitious render. It is possible that moisture will be trapped between the stone face and back of the render. With 'pierre perdu' some may be able to escape in the positions of exposed faces. This could cause issues during periods of frost, although these are limited in Jersey's mild climate. Replacement in lime based render should be carried out where possible.

Historic cracks can be used by protected species for access or roosting i.e. bats. Investigation should be carried out prior to repair.

1 Historic Scotland Fabric Improvements for Energy Efficiency in Traditional Buildings

2 Pointing in Lime – Building Conservation article by Craig Frew image as well

Example of Unchecked Vegetation Growth

- **Plant growth**

  Overgrown plants can cause damage to historic buildings. Tree roots can lift building foundations, rotting roots can cause subsidence. If a plant takes hold on the facade of a building it can move window and door frames and damage pointing.

  As previously noted, the presence of protected species, birds nests etc. can put restrictions on works, limiting these to particular times of the year.

  There is currently debate over the potential damage caused by creeping plants like ivy, that draw moisture from a root system that is attached to the building fabric. The plant itself insulates and screens the building but the damage caused should such a plant work its way into a crack in the building fabric is clear. It is therefore important to control plant growth and carry out regular inspection of building fabric even if covered in vegetation.

- **Blocked gutters**

  Gutters and rainwater pipes direct water into drains or soakaways. If these are blocked by overgrown plants or other detritus, the water will overflow. This can cause regular wetting of building elements that are not designed to withstand the effects. As already mentioned on p.40 the wetting of building fabric lowers thermal performance. In addition these areas can then deteriorate and, if the problem goes unrecognised, can be the cause of greater failures requiring building works.

APPENDIX 1.2: MONITORING USER CONTROLS AND BEHAVIOURS

GRADED AMBER TO RED WITHIN THE SUMMARY TABLE, REFER TO P29 ONWARDS

One of the most effective ways to improve energy efficiency is to facilitate a greater level of understanding and control over energy use by the user. From switching off electrical lights and appliances when not in use, to turning down or switching off heating in unused rooms, small steps can be the precursor to a greater understanding of how to live more efficiently within a building.

It is possible to provide users with controls and monitoring equipment that allows them to evaluate their use and behaviour patterns, identifying where they can make savings on an individual basis. The results can also help to inform what types of measures would be best suited to the specific property.

In the case of listed buildings the way in which occupants live and expect a building to perform will have altered vastly across the decades. Many older buildings were designed to function using fires for heat, warming the building's mass by burning for many hours in the day, with natural sources of light and ventilation. If an occupier was cold they were expected to put on more clothing. Furniture was designed to protect occupants from draughts, i.e. wing chairs, occupants rose and retired with the sun. This is not in line with modern expectations.

With modern interventions, like central heating, the way in which the building functions has changed. Fires would heat a chimney stack, which is generally formed of brickwork or stone that has a high 'thermal mass'. Thermal mass is good at absorbing and storing heat and then radiating it at a later time when the heat source has been removed. Often terraced houses would share walls with chimney stacks and therefore share the benefit of the heated thermal mass which was also protected from losing heat to the outside. Modern radiators are often mounted on walls not in the location of the original fireplace. Radiators heat the air around them rather than the thermal mass. This means that the air is heated quickly but less heat is stored or shared. Also heated air rises to the ceiling creating a gradient of heat which can be felt to be cold to those occupying lower levels, i.e. seated. This can be particularly evident in historic buildings with high ceilings where energy is used to heat air above the occupied zone.

APPENDIX 1.3: DRAUGHT PROOFING

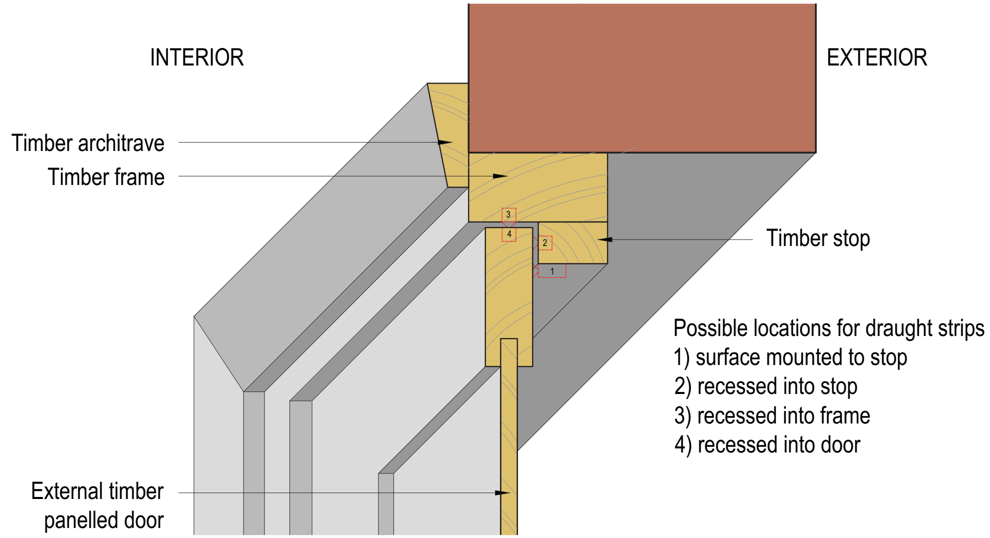
GRADED AMBER TO RED WITHIN THE SUMMARY TABLE, REFER TO P29 ONWARDS

Draught proofing is a practice that has been undertaken in buildings for many years. If a space is heated to a temperature above that experienced in an adjacent space or externally, then any gaps in the building fabric will allow air to pass between these different temperature zones. This is experienced as draughts and cause a great deal of occupier discomfort and energy loss.

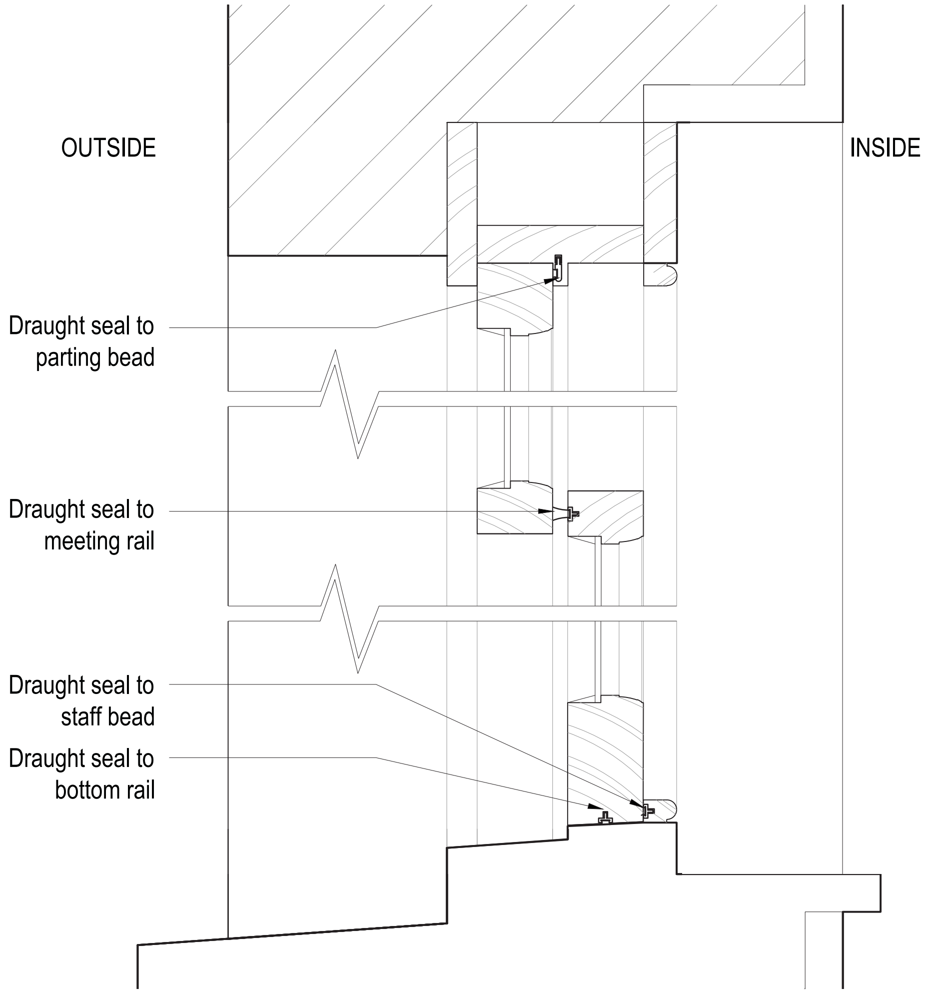
In order to specify draught proofing first the gaps must be identified. These will often be greatest around windows and doors, other potential areas are chimneys, between floor boards and at junctions between walls and ceilings or floors. In Jersey's listed buildings, sash windows are often present. If poorly maintained these can have a poor fit and provide routes for the passage of air. It is worth noting that even within a completely sealed room air currents caused by convection (warm air hitting a cold surface like single glazing) can also be felt as draughts.

Draught proofing is widely believed to be a very effective way of increasing thermal separation between spaces and can be achieved at a much lower cost and disruption when compared with other measures like insulation.

The travel of moisture in buildings is often termed breathability, whether through solid building materials like brick or stone or as vapour in the air. Draughty buildings and vapour permeable materials allow moisture in the air to escape. If the draughts are sealed up then the moisture movement will be reduced and must be controlled in other ways to stop damp issues arising. In modern construction all of these issues are dealt with through building regulations requirements for damp proof courses, vapour barriers, breather membranes, mechanical extraction and trickle ventilation. There are similar solutions to controlling moisture in existing historic fabric but these must be reviewed on an individual basis by a qualified assessor to ensure the right measures are put in place that do not jeopardise the historic fabric either physically or aesthetically.



Door draught strip



Example sash window draughtproofing

- **Windows and Doors**

  There are several draught proofing systems available for both timber and metal windows and doors. These generally introduce a rubber or brush strip to the edge of the frame which seals the gap reducing air flow which in turn improves thermal performance and noise insulation. Tests carried out by Historic Scotland showed a 86% reduction in air leakage to a draught proofed timber sash window. This compared with 97% reduction gained from installing secondary glazing.[1]

  Air leakage can also be reduced to keyholes and letter boxes with suitable covers, draught proofing at door thresholds can be very effective.

  When new double glazed sealed units were first developed UK Building Regulations required that these be fitted with trickle vents which allow air to pass in and out. The size of these was based on the estimated air gap evident on a standard sash window and its intended purpose was to make sure that the room still received adequate ventilation.

1 Historic Scotland Technical Paper 1 – Thermal Performance of Traditional Windows, with corrections 2010 Dr Paul Baker

APPENDIX I

- **Chimneys**

  Jersey's historic buildings often have chimneys, these represent a large opening in the building fabric allowing heat to rise and escape, creating negative pressure, dragging in cool air through windows and doors etc. Chimneys that are no longer in use should be closed at the top and bottom to reduce heat loss. However a vent should be introduced at high and low level to maintain adequate levels of air movement within the chimney to reduce moisture build up in the stone or masonry.

- **Walls**

  Draughts can be evident in walls where services have been run through the building envelope, cracks can occur at junctions with ceilings, other walls and floors. In most cases these can be dealt with under general maintenance. Air Bricks and other means of ventilation should however be maintained. Residents should seek advice before carrying out any works if unsure of the purpose of a ventilation item.

- **Floors**

  Timber board floors allow draughts to pass between the boards, other floor constructions will exhibit draughts around junctions between the floor and walls. Timber floors are often suspended over ventilated voids with air bricks in external walls. To seal draughts a vapour permeable membrane could be installed below the floor boards. If the floor boards are lifted consideration should be given to installing insulation at the same time. Where boards are not to be lifted, a vapour permeable carpet could be installed over the floor boards, without a rubber backing. Sealing to the adjacent walls using skirting boards can also be implemented. In listed buildings the effect to the historic fabric would need to be assessed before carrying out these works.

  Note: draught proofing to floors should only be installed as part of a fully designed ventilation and moisture control method. Inadequate ventilation could lead to damp in timber structural elements and subsequent decay.

Register plate to chimney

APPENDIX 1.4: DAMP PROOFING

GRADED AMBER TO GREY WITHIN THE SUMMARY TABLE, REFER TO P29 ONWARDS

As moisture can travel through solid materials this provides a route for water in the ground to rise into a building via walls bedded down into the soil and solid floors without a cavity between the ground and the floor finishes. As previously noted when materials are damp they allow the loss of heat more than when dry. For this reason modern buildings are constructed with damp proof measures to stop moisture movement which can also cause damp in building elements causing these to rot or fail.

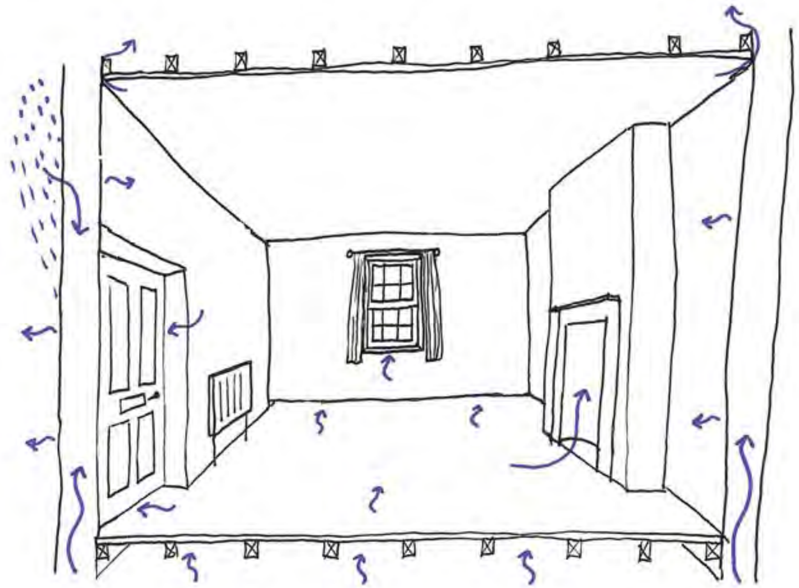
One measure installed to walls is known as a damp proof course (dpc), this should be installed below the internal floor finish of the ground floor. Traditional solid wall construction did not have this measure, later construction saw slate inserted between brick or stone courses while modern buildings make use of plastic membranes. The aim is to create a continuous layer that water cannot penetrate. Retrofit options for installing a dpc to a listed building are limited as these generally require invasive action that is deemed irreversible. Chemical dpcs require regular holes to be drilled into an existing wall and chemicals pumped to form a continuous layer. Besides the questions that arise over the validity of inserting a chemical to traditional building fabric, the correct installation of these dpcs is very difficult to achieve on site often resulting in gaps that allow moisture to rise in concentrated areas. This is particularly an issue in traditional Jersey stone walls where chemicals may not soak into hard granite. A similar situation arises with electro osmotic systems that use an electric current to interrupt water movement; they require damage to the existing fabric in installation and can leave untreated zones which are difficult to identify. Additionally the use of an constant electric current is not conducive with improving energy efficiency.

Good general maintenance can help avoid excessive damp by controlling external ground levels, not allowing these to be increased above internal levels. In addition external walls should be kept clear of linings or other abutments that will prevent any moisture evaporating.

Solid floors can also cause internal damp issues. Removal of the existing floor to install a ventilated cavity or damp proof membrane may be costly and damaging to the historic fabric.
Where floor levels (and conservation officers) permit, a new floor might be constructed over the old solid floor. This would retain the existing fabric and be reversible in the future. The floor can then be lined with a vapour barrier that stops water from passing into the building. Careful consideration of existing features should be carried out along with providing routes for moisture to escape, avoiding the potentially damaging effects of trapped water.

The installation of French drains (also known as Dutch drains) to the perimeter of a building can also reduce damp issues. This is a deep trench filled with gravel which allows water to soak away below the building level.

Depending on the severity of the damp issue it may be possible to plan for adequate ventilation, allowing any moisture in the wall or floor to escape through the use of breathable internal finishes. This would rely on annual cycles drying the building out and is more in line with the way a traditional building was designed to function.



Moisture routes

APPENDIX 1.5: INSULATION

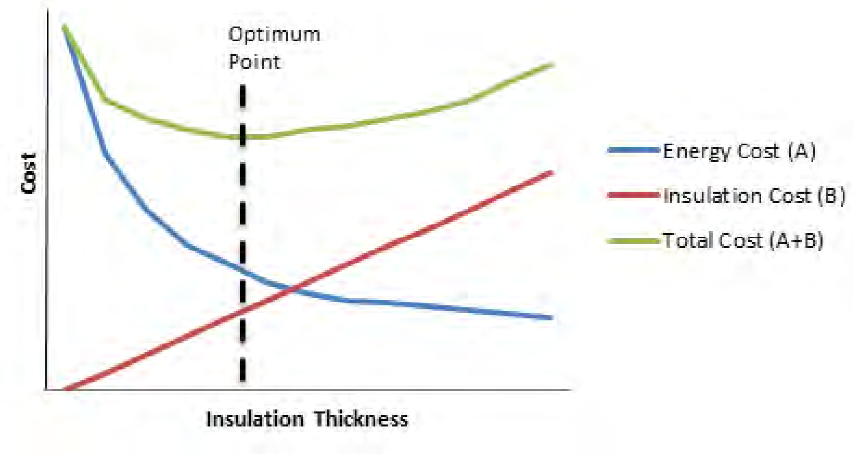
GRADED GREEN TO RED WITHIN THE SUMMARY TABLE, REFER TO P29 ONWARDS

The thermal performance of building elements (walls, roof, floor, window and door) can be given a 'U'-value. The lower the value the better the thermal performance. Current building regulations and Jersey bye-law requirements have been discussed on page 23. Unfortunately there is a large deficit in known U-values for traditional construction methods.

Where a build-up is found to be very poor at forming a thermal barrier, i.e. it has a high U-value, it can be improved by adding a highly insulating material.

There are many materials available on the market today that offer different performance properties. The same thickness of different materials will not offer the same reduction in overall U-value, however other constraints, such as budget or space availability, can encourage the use of one insulation over another. A sample of different insulation types typically available in Jersey has been included in the opposite table. Standard insulants include mineral fibres (rock and glass wools) and foamed or expanded plastics. These materials are non-hygroscopic and are often resistant to moisture movement, i.e. not breathable. The application of these materials in historic buildings needs to be carefully considered, refer to page 26. It is also worth noting that the percentage of thermal improvement per additional unit depth of insulation goes down as the overall depth of the insulation increases. For example if 50mm of insulation improves thermal performance by 10%, 100mm will not double that improvement. The optimum thickness of insulation from a cost perspective can be calculated but it is worth considering rising fuel costs in the future.

Insulation can be split into two categories based on their material content. These are classed as natural and synthetic.



Data O. Kaynakli. A review of the economical and optimum thermal insulation thickness for building applications, January 2012

Insulation type	Thickness	Thermal conductivity (k value)	Thermal resistance (r value)	Thermal transmittance (u-value)
Kingspan K7 Pitched Roof Board (Other polyurethane insulants are available)	100mm	0.02W/mK	5m²K/W	0.2W/m²K
Warmcel 100 (other cellulose fibre insulants are available)	100mm	0.035W/mK	2.86 m²K/W	0.35W/m²K
Rockwool Roll (other mineral wool insulants are available)	100mm	0.044W/mK	2.27m²K/W	0.44W/m²K

Hemp insulation with render finish - external application

NATURAL INSULATION

Natural insulation materials generally have a greatly reduced embodied energy when compared with synthetic insulation and are typically formed from a renewable resource. Natural materials can be hygroscopic, taking in moisture, they can also be breathable, allowing vapour to pass through. Their use must be carefully considered to ensure that they are not exposed to excessive moisture, which can lead to rotting of the material. Protection from insect infestation should also be considered.

SYNTHETIC INSULATION

Synthetic insulants are typically made in high energy processes, often using fossil resources (oil) to fabricate the base material. Synthetic insulants are often impervious to water and are particularly useful in damp conditions. Additionally synthetic insulants tend to offer greater thermal performance per unit and as they are widely used they are typically cheaper than natural materials. Some manufacturers have introduced recycled materials into their products in an attempt to appear 'greener'.

When dealing with historic fabric it is often necessary to avoid installing synthetic materials. They may alter the pattern of vapour movement and condensation control within a building, allowing problems to develop that did not exist previously. In some cases the waterproof nature of synthetic materials can be advantageous. Such considerations should be carefully assessed by a professional.

When looking to insulate building elements it is worth considering which offer greatest gains for the smallest financial outlay or disruption. This should be assessed on an individual basis, particularly in connection to listed buildings, however a general guide to the order in which thermal improvements can be made is given on the following pages.

APPENDIX 1

- **Windows**

Following on from the various draught proofing measures discussed previously, windows are prime areas for thermal improvement as they are a potential weakness in the building envelope. Made from materials with a high 'U'-value, they lose approximately 20-30% of a building's energy, depending on size, type and orientation. Poor thermal performance of windows can create draughts in a room by warm air hitting cold glass and dropping as it cools. This also causes condensation to form on the glass.

Understanding a window's energy performance is complicated by the fact that it is an openable item made from several different elements that perform in different ways. To help understanding, the British Fenestration Rating Council set up Window Energy Ratings (WER) in 2004 based on the following criteria applied to a standard window size.

- Solar heat transmittance of the glass (g value).
- U-value of the window (the window frame and glass combined).
- Air infiltration through the window seals.

Historic Scotland has carried out extensive research into different methods of insulating single glazed timber windows. A list of these measures is included on the following page along with percentage reduction in heat loss and improvements in U-value. These measures can be installed to most windows but consideration must be given to their impact on historic fabric.[1]

One architectural element frequently seen in Jersey is external window shutters. As a feature that adds a great deal of character to the street scene, these were traditionally used to shade the interior of the home from solar gain during summer months. Research could be carried out to assess the suitability of shutters to provide thermal or draught proofing benefits during winter months.

1 Historic Scotland Technical Paper 1 – Thermal Performance of Traditional Windows, with corrections 2010 Dr Paul Baker

- **Doors**

Similar to windows, any glazed elements to doors can be reviewed against the table on the following page. Panelled doors can be treated in a similar way to shutters, while full length draught curtains have similar benefits to window curtains. Draught proofing, particularly at the threshold, and to letter plate openings, can be very effective.

APPENDIX 1

Consider the following options to improve the performance of existing windows and doors:

- Heavy curtains improve a window's overall thermal performance by creating a second barrier to external conditions. The air between the curtains and glass acts as a buffer between climates and reduces uncomfortable draughts. Curtains can also be used to upgrade the performance of doors.
- Roller blinds again create a buffer zone with improved performance with tighter fitting and more insulating materials.
- Closing shutters act in a similar way to curtains but are more successful due to being denser with a lower U-value and can be upgraded with high performance insulating materials. These can also be draught sealed to further improve performance.
- Secondary glazing performs in a similar way to shutters with the added advantage of being able to keep them closed during the day and still admit light. Similarly to shutters, these can be draught sealed to improve condensation and reduce condensation.
- There are several slim profile double glazed units on the market today that can be installed within existing windows. These often require alterations to glazing beads and, depending on existing dimensions, can require the replacement of sashes or casements while retaining sash boxes and frames. Care must be taken to achieve the correct sight lines in glazing and to use the right materials. Note that linseed oil lime putty can deteriorate the seals to modern double glazed units.

Improvement method	Reduction in heat loss	U-value W/m^2K
Unimproved single glazing		5.4
Fitting and shutting heavy curtains	14%	3.2
Closing shutters	51%	2.2
Modified shutters, with insulation inserted into panels	60%	1.6
Modern roller blind	22%	3.0
Modern roller blind with low emissivity plastic film fixed to the window facing side of the blind	45%	2.2
Victorian blind	28%	3.2
A "thermal" duette honeycomb blind	36%	2.4
Victorian blind and shutters	58%	1.8
Victorian blind, shutters and curtains	62%	1.6
Secondary glazing system	63%	1.7
Secondary glazing and curtains	66%	1.3
Secondary glazing and insulated shutters	77%	1.0
Secondary glazing and shutters	75%	1.1
Double glazed pane fitted in existing sash	79%	1.3

Historic Scotland Table indicating thermal improvements from different measures
Crown Copyright (Historic Scotland)

- **Roof**

As noted by the Energy Saving Trust, up to 25% of a building's heat is lost through its roof. Insulation can be introduced either between the ceiling joists, forming a 'cold-roof' with unheated roof space, or at a higher level between the rafters, it may be possible to install insulation over rafters called a 'warm roof'. This detail will alter the existing roofline and eaves detail and is unlikely to receive Planning consent. The level at which the insulation is installed will be informed by accessibility and whether any additional works are being carried out. Consideration should always be given to providing ventilation to the roof where necessary to prevent build-up of moisture. The Minister of Planning and Environment currently has a policy that requires the introduction of insulation to roofs wherever roof coverings (slate, tile etc.) are renewed. Many users have implemented the installation of a multi layer foil as opposed to more traditional materials like mineral wool or modern rigid foams. Again, air movement and moisture control should be considered when introducing such materials.

Thatch roofs in Jersey are rare due to the removal of historic thatch under byelaw in 1715. The sustainable qualities of thatch have recently seen a resurgence of use in both new and traditional applications. Thatch is a natural material from renewable sources that provides an insulating and breathable roof covering. Local resources for thatch should be identified to reduce transport energy. Thatch can easily be renewed and repaired with often only the top layers of material having decayed. Thatch roofs can provide a high level of insulation on their own with u-values, down to 0.23W/m^{2}K with only minimal amounts of additional insulation required to achieve Jersey byelaw required 0.2W/m^{2}K. Any insulation to thatch roofs should be carefully designed to avoid trapping moisture and causing decay to the natural materials.[1]

Fire risks with thatch need to be managed and reduced through good maintenance of chimneys and installation of smoke detectors.

Note: thatch replacement of existing roofs to listed buildings in Jersey will only be relevant where it can be demonstrated it is historically applicable, i.e. an urban terrace within St Helier is not suitable to receive a thatch roof but a rural farmstead may be.

> Potential Action:
>
> Carry out testing of improvements of multi-layer insulation in Jersey

Multi Layer Foil Insulation under rafters

1 English Heritage Energy Efficiency and Historic Buildings - Insulating Thatched Roofs 2012

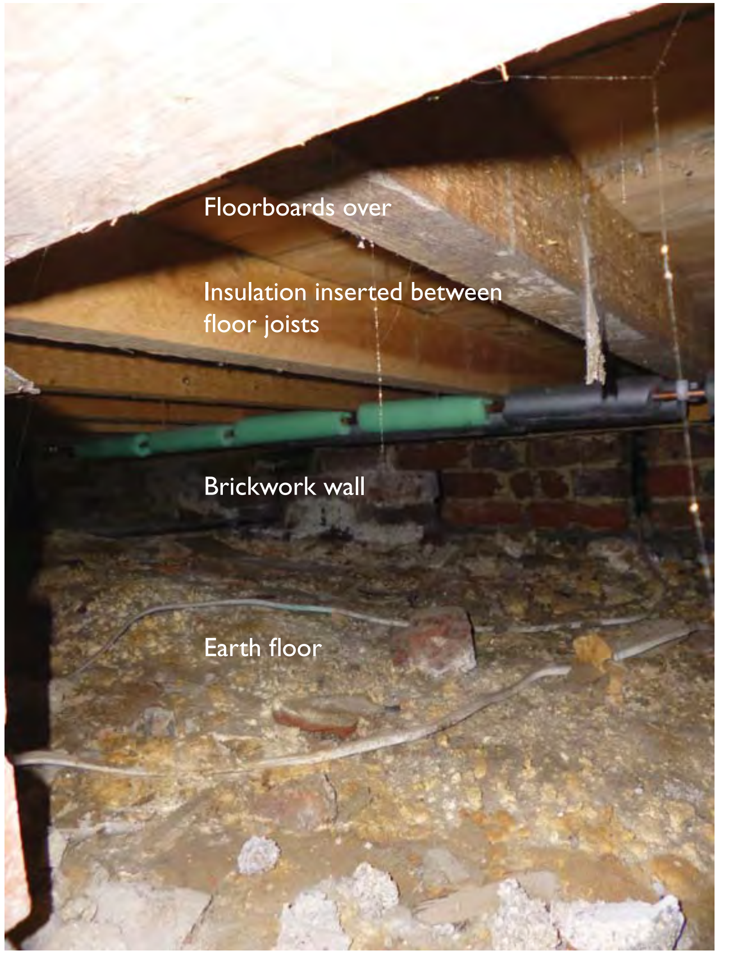
- **Floor**

Up to 10% of heat loss occurs through the ground floor of a building. In houses cold floors can be particularly uncomfortable for occupants, especially those with young children or the elderly who may be more vulnerable to the cold.

As discussed previously suspended timber floors can allow draughts into a heated space. If insulation is installed between the supporting joists under the floor boards it will not only reduce these draughts but also reduce heat losses and create a more comfortable environment for occupants. This insulation must be vapour permeable to allow moisture to move without trapping it next to timber elements.

Solid floor constructions can have ridged insulation installed over the existing, increasing the floor level. Alternatively if the floor is to be removed insulation can be introduced into the new floor build-up.

In both cases careful consideration of the impact on historic fabric is required.



Under timber floor cavity

Gothic style, St Helier

- **Walls**

Advice from the Energy Savings Trust states that up to 45% of heat loss can be through walls. A limited number of listed residential properties in Jersey are built from double skin masonry, however this is used as the benchmark in many assessments and likely the model to which the 45% can be applied. Many Jersey buildings are of stone construction with no cavity. As shown in research carried out by Historic Scotland and SPAB traditional stone wall construction performs better in tests than anticipated.

Insulation can be applied to walls either internally, externally or in the wall itself if there is a suitable cavity. On many historic properties the introduction of a lining either internally or externally could cause damage to the character of the building.

- **External**

Rigid synthetic insulation is installed to the external skin and rendered over. This can be more acceptably installed to those properties that already have render finishes, although detailing around door and window openings and at eaves can be challenging. External insulation means that the thermal mass of the wall can be used for heat storage, although this will result in the overall internal air temperature taking longer to rise once a heating system is activated. Consideration should be given to the passage of moisture in this arrangement and the possible requirement to maintain or introduce ventilation or vapour control in the wall build-up

- **Internal**

Internal insulation is generally installed behind wall finishes like plasterboard. This approach results in the air temperature rising quickly, but loses the advantage of using the wall's thermal mass. However, this could be present in the form of a chimney stack, a party wall or a solid floor. The main disadvantages of internal insulation is the reduction in internal space and the potential loss of historic features.

- **Cavity**

Modern construction often includes insulation within this gap between structural elements, generally found from early 20th Century onwards. Cavity insulation can be added to buildings by blowing or injecting through small holes in the outer or inner skin. When installing it is important that the insulation does not find an escape path, so the tops, bottoms and junctions with floor voids etc. should be sealed. It can be difficult to ensure that the insulation is distributed through all of the cavity, particularly under window openings, creating cold spots. Problems can arise in cavity insulation where it interferes with the movement of moisture. In some cases the cavity needs to be ventilated to draw out moisture, if infilled the moisture becomes trapped. Equally the infill may move the condensation point within the wall build-up, causing vapour to turn to water in the building fabric. Also the infill of the cavity can form a bridge for moisture to travel from the outer skin to the inner. All of these issues can lead to failures internally and externally including rot, damp, mould growth and cracking to render and brickwork. For these reasons cavity insulation should only be installed where a complete assessment has been carried out by a qualified and approved installer.[1]

It is also worth noting that protected species, i.e. bats, can use wall cavities as roosts. A thorough investigation should be carried out prior to works. refer to Section 3.5.

Example Listed Building St Helier

1 Journal of Building Survey, Appraisal and Valuation Volume 1 No. 4 Cavity Wallss – retro-injected insulation – kill or cure? Tim Davies 1 October 2012.

APPENDIX 1.6: HEATING

GRADED GREEN TO RED WITHIN THE SUMMARY TABLE, REFER TO P29 ONWARDS

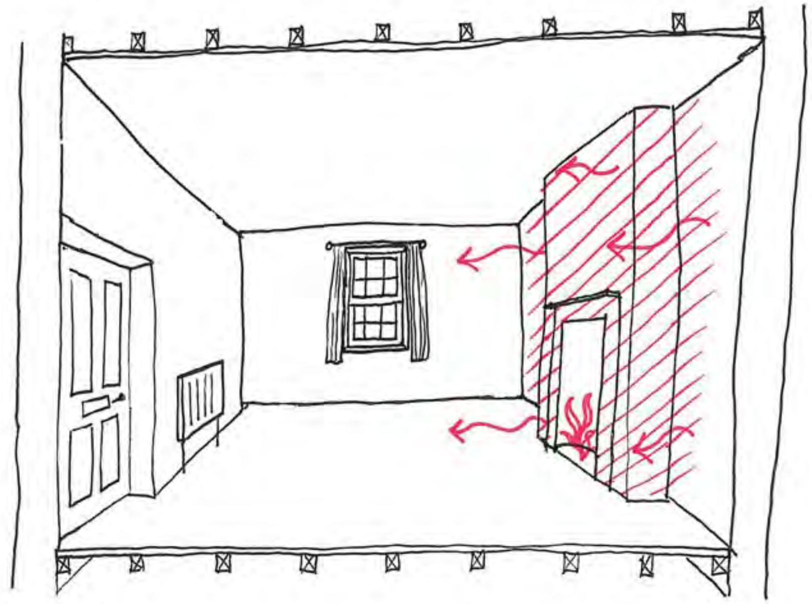
In Jersey the primary concern in controlling internal climate is heating, although consideration should also be given to potential overheating in summer months, discussed below. Although some residences retain their fireplaces the main source of heating and hot water is now typically the central heating boiler.

Steps to improving energy efficiency in heating include the following measures:

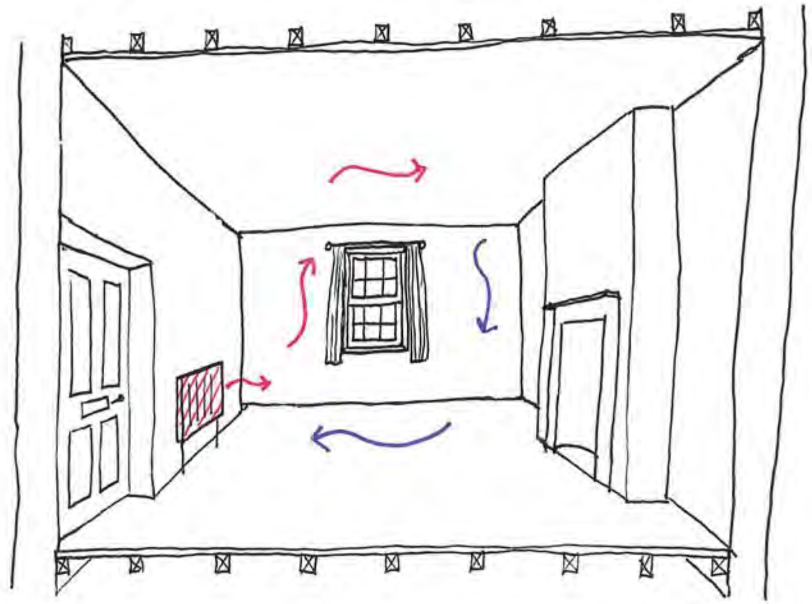
- Replace old inefficient boilers with new, more efficient units. Approximately 55% of household annual energy bills are spent on running a boiler.[1] Oil is commonly used throughout Jersey although some residences use gas and electricity as fuel sources.
- Reduce use of electrically run heaters as these are less efficient (when electricity generation is taken into account) than a central heating system.
- Improve heating controls through the use of zoning, thermostatic valves and room thermostats.
- Size radiators correctly for the space they are heating.
- Make use of solar gain as a renewable source of heat energy.
- Insulate hot water pipes.

Potential Action:

Carry out testing of typical residence types annual heating fuel use and impact of installing user controls/improved boiler



Fire heat pattern



Radiator heat pattern

1 Energy Saving Trust

ALTERNATIVE APPROACHES

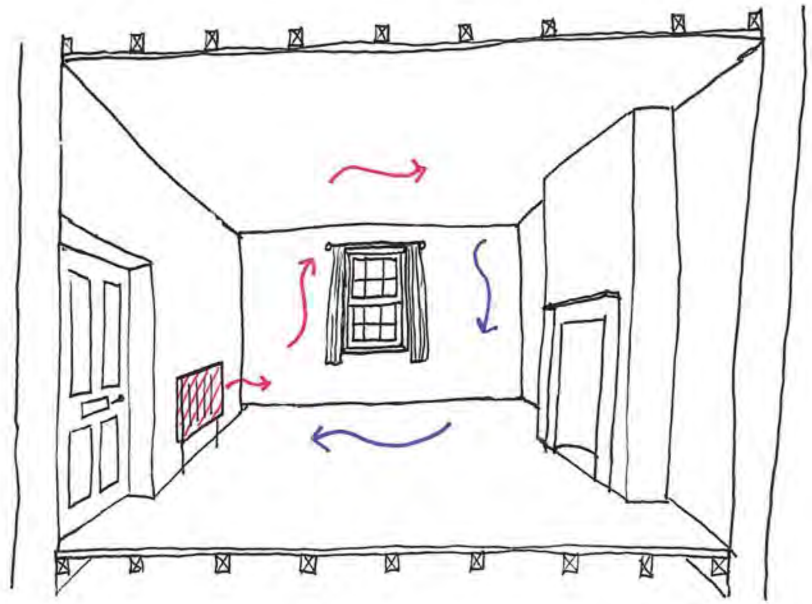
An alternative to using traditional radiators is to install underfloor heating. This can be either 'wet' in the form hot water pipes, or electrical. A wet system is generally considered most efficient.

It is commonly recognised that underfloor heating systems are more comfortable for occupants than radiators, especially if seated. Heated air will rise near the radiator causing a circulation of air in the space, sometimes felt as draughts. Underfloor heating radiates heat from the floor evenly, and circulation currents are greatly reduced.

Underfloor heating works well with alternative heat sources like ground source heat pumps, refer to page 61.

However underfloor heating also has downsides:

- It takes a longer time to heat the space than radiators and has a larger installation cost. Underfloor heating systems may not be suitable for a residence that is unoccupied during the day, or is occupied intermittently.
- Underfloor heating works best through a dense material like stone or concrete and does not work as well through wood. It is not always suitable for use under existing floorboards.
- If a suitable system of radiators is already installed it may be preferable to reuse these to avoid unnecessary scrapage. However if fabric upgrades have been implemented these radiators may now be oversized. It is worth noting that in some cases existing radiators may be of historic value in listed buildings.



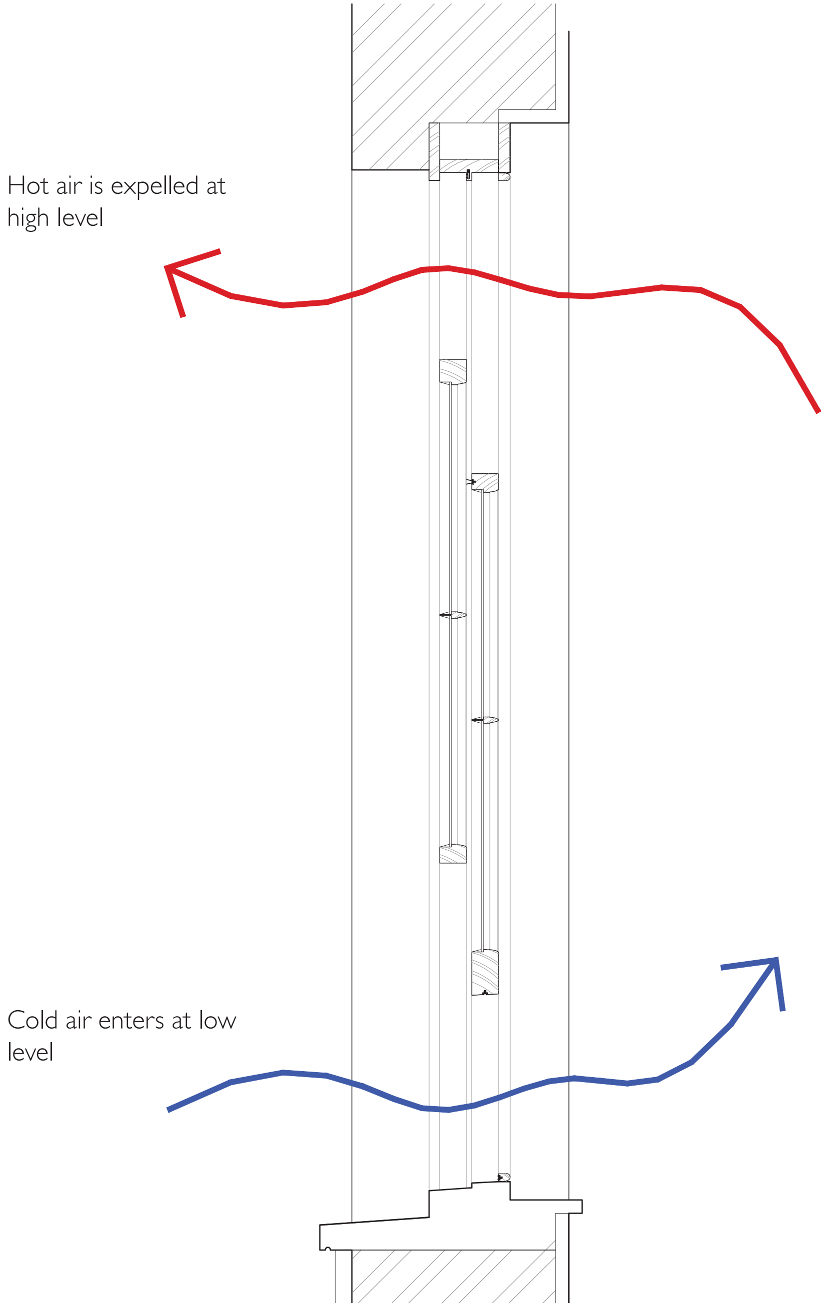
Radiator heat pattern

APPENDIX 1.7: COOLING AND VENTILATION

Considerations of passive means to maintain a cool environment in summer include reducing unwanted solar gain through the use of blinds or the vernacular louvered external shutters. Opening windows and using natural ventilation can let air move without the need for fans. Hot air rises and so the use of opening high and low level windows will encourage air movement through a building, known as the 'stack effect'. A traditional vertical sliding sash works on this basis.

It is very important that damp air is effectively removed from the building through adequate ventilation. Passive ventilation systems can also make use of the stack effect to draw damp air up through the building and out through small vents in the roof.

In some instances 'whole house ventilation systems' may be considered feasible. These require minimal ventilation loss through the fabric (difficult to achieve and possibly undesirable in a historic building) and are driven by a low power fan.



Sash window ventilation

APPENDIX 1.8: WATER CONSUMPTION

GRADED AMBER TO RED WITHIN THE SUMMARY TABLE, REFER TO P29 ONWARDS

Water use is an area where savings can be made very easily. The need to reduce water use can be difficult to understand in many European countries where water is in abundance. In terms of energy efficiency reducing hot water use can be directly linked back to the energy used by the boiler in the first instance. Additionally water is a resource that should not be squandered. In some cases water use is metered and so savings will have a financial value. Energy is required to treat waste water.

WATER SAVING

Water saving measures available include:

- Water saving taps and showers - these work in a number of ways either aerating the water emitted so that the flow feels adequate for washing but uses less water, or using sensors or timers to limit the flow of water when not required.
- More efficient washing machines and other water using appliances with high EPC grades will use less water than older models.
- Toilets can have their flush volume reduced by either installing new cisterns with dual flush functions or putting an insert in the cistern to displace water volume. In the past this has been suggested as a brick, but there are several products available to fulfil the role in a similar way that are less likely to damage the cistern.
- Rainwater can be collected in water butts for use in watering the garden to avoid using treated drinking water.
- Rainwater Harvesting – collecting larger volumes of rainwater for use in the home for flushing WCs, swimming pools etc. but not for use as drinking water.

RAINWATER RUN OFF

Rainwater run off is an increasing concern in urban areas as more and more surfaces are hard paved reducing the provision of soak away through exposed soil. This puts increased pressure on drainage systems and can cause localised flooding. This can be reduced by the use of 'green' surfaces either in gardens, on green roofs or living walls. Local rainwater collection (for reuse), as noted above, can also help with this issue.

WATER TREATMENT

Waste water is treated in large plants to make it suitable for recirculation as drinking water (potable), or for return to a water course. This process requires energy to complete and also uses a number of chemicals that require energy to produce. Smaller domestic systems are also available but it is always more energy efficient to reduce water use than attempt localised treatment or recycling. In Jersey large scale applications include swimming pools.

Grey Water recycling – this takes waste water from sinks, baths and basins, WCs or kitchen sinks, filters and treats it, usually with chemicals although some new systems use UV and organic processes. This is again used in the home for non-drinking water applications.

APPENDIX I.9: ELECTRICITY CONSUMPTION

GRADED AMBER WITHIN THE SUMMARY TABLE, REFER TO P29 ONWARDS

Energy saving through items that use electricity to operate is a straight forward concept and one that can be readily applied in Jersey residences. Switching off appliances or lights not in use is a first, along with reducing periods of use. User control and understanding of electricity used by different items can benefit from the introduction of a display panel connected to the electricity supply.

LIGHTING

Reducing energy use in lighting can be through the following measures:

- Increase the use of natural daylight. Often lights are switched on out of habit when natural light is adequate. The available daylight can be increased by pushing back heavy window coverings or cutting back encroaching vegetation, and keeping windows clean can help.
- Install timer or sensor switches to ensure lights are not left on when not needed.
- Use energy saving light bulbs in existing fittings.
- When new fittings are needed choose those with lower energy use. LEDs have the lowest energy use, although more expensive generally than fluorescent, which also use less energy than traditional tungsten filament bulbs. Halogen fittings are also available but have relatively high energy use.

Potential Action:

Carry out testing of typical residence types annual electricity use and impact of installing usage display panels

APPLIANCES

As previously noted all new domestic appliances come with an Energy Performance Certificate. New appliances will generally perform more efficiently and use less energy than old ones. Do not leave appliances on standby. Switch off and if possible unplug when not in use.

APPENDIX 1.10: ELECTRICITY PRODUCTION

GRADED AMBER TO RED WITHIN THE SUMMARY TABLE, REFER TO P29 ONWARDS

There are several ways to produce electricity locally as opposed to supply from the main grid. In all cases any residence that employs these measures should also be connected to the main grid as a back-up for when insufficient amounts of electricity have been produced or to cover equipment failures. Again the application of any installation to a listed building would need to be carefully assessed for impact.

When producing electricity it is often the case that it is not required at the time or in the quantities at which it is produced. Excess electricity can be stored in batteries but these are expensive and will deteriorate over time. Several EU countries including the UK and Germany have set up a feed-in tarriff where electrcity produced in domestic properties can be run into the main grid for a fee paid by the energy supplier. In fact the UK system pays for the production of electricity even if it is used domestically and not fed into the grid. Such incentives including grants towards initial installation have led to a recent increase in the amount of small scale electrical production.

A summary of available electricity producing technologies is included:

- Photovoltaics (PVs) - these consist of flat panels that use sunlight to produce electricity. They are most effective when installed at a 45° angle and facing South. They work best when exposed to direct sunlight; their output will be greatly reduced if overshadowed. They also have a very high level of embodied energy. Application should be carefully considered and only installed if high efficiency can be guaranteed, and impact on the historic context controlled.
- Wind Turbines - these are supplied in a variety of configurations using wind to generate electricity. As a general rule the larger the blade length the greater the effectiveness in energy production, therefore large turbines installed at sea or on high ground are most efficient. Recent studies have shown that small scale domestic turbines in urban environments are not viable[1]. In addition noise produced while turning can be very disturbing to neighbours.
- Hydro Turbines - using flowing water to generate electricity is not a viable option in most domestic situations.

1 S. Dance et al. Wind Turbines, London Southbank University

APPENDIX 1.11: HEAT TRANSFER

GRADED AMBER TO RED WITHIN THE SUMMARY TABLE, REFER TO P29 ONWARDS

Heat energy can be transferred from an external source into the building and, typically, used for space heating and domestic hot water applications. A summary of available technologies is as follows:

- Solar Thermal - this is the installation of water and antifreeze filled pipes (often in panels that look similar to PVs) that use energy of the sun to heat the water. The heat is then transported in the water to a heat exchanger which is connected to the buildings heating system and hot water supply.
- Ground source Heat Pump - pipes filled with water and antifreeze are used to transfer heat from the ground through a heat exchanger into a heat pump. Pipes are laid either in horizontal loops below the ground's surface or down vertical shafts called bore holes. Temperature in the ground remains at a more constant level than air temperature. It can be used to heat in winter and by reversing the cycle, cool in summer. This technology does not produce high flow temperatures, but can be used to heat radiators, underfloor or warm air heating systems and to provide hot water.
- Air Source Heat Pump - this is similar to ground source heat recovery but transfers heat energy from the outside air into the building. These need to be located externally, or in a very well ventilated enclosed space. They have a similar appearance to an externally located air conditioning unit, and this may be detrimental to the appearance of a historic building.

When contemplating any of the above options in connection with a listed building the impact on the building and its surroundings should be considered. It would be inappropriate to insert an item like solar thermal panels on the principal facade or roof slopes of a property, but it may be possible to install items in less obtrusive locations where they will not be seen, or in the garden. Each application should be carefully assessed to understand its repercussions on a historic building or community.

APPENDIX 2

Comparison of assumed existing historic building's performance against EU Directive's aims and selected Current European Community Building Regulations

The values stipulated below have been derived from U values found in a number of sources:

- The relevant local building laws and regulations, these are dealt with in greater detail in the later stages of the Appendix
- International comparison of energy standards in building regulations: Denmark, Finland, Norway, Scotland, and Sweden (page 16) http://www.scotland.gov.uk/Resource/Doc/217736/0091414.pdf
- "Implementing the EPBD - Featuring Country Reports 2010" http://www.epbd-ca.org/Medias/Downloads/CA_Book_Implementing_the_EPBD_Featuring_Country_Reports_2010.pdf
- The Building Regulations England and Wales 2010 Part L1B http://www.planningportal.gov.uk/uploads/br/BR_PDF_AD_L1B_2011.pdf
- Building Regs 10 for glazing in Europe
- http://www.glassforeurope.com/images/cont/91_96281_file.pdf
- Irish Building Regulations http://www.environ.ie/en/Publications/DevelopmentandHousing/BuildingStandards/FileDownLoad,27316,en.pdf

Assumed indicative U-values or Energy performance for existing historic Jersey Constructions

Floor - U = 1.92w/m2k
Assumed floor build up is: 25mm timber boards on timber joists over compacted solum, ventilated underfloor (base figure 1)

Wall - U = 2.58w/m2k
Assumed wall build up is: 450mm granite rubble walling with lime:sand mortar, 25mm lime:sand plaster internally on the hard

Roof (pitched) - U = 2.37w/m2k
Assumed roof build up is: Slate/tile on battens on felt, lath & plaster ceiling on rafter or ceiling collar underside

Window - U = 4.8w/m2k
Assumed window is: Single glazed timber or casement, un draught sealed

Door - U = 4.8w/m2k
Doors, timber 44mm overall, 12mm panelled for 50% of surface area

Note: The historic figures quoted for the Jersey wall constructions are derived from industry standard Hevacomp software. Historic Scotland's data suggests lower heat loss results when on site measuring of the actual constructions; however, measurements have not been made on significant numbers of granite built buildings in Scotland and these constructions are not necessarily absolutely equivalent to those in Jersey.

Construction	Historic Jersey	EU Directive	Jersey Current Regulations	England & Wales	Scotland	France	Ireland	Germany	Belgium	Denmark	Sweden
Floor	100%	20%	13%	11%	10%	14%	11%	18%	47%	6%	8%
Wall	100%	20%	15%	11%	10%	14%	8%	11%	14%	8%	7%
Roof (Pitched)	100%	20%	9%	8%	8%	9%	7%	8%	11%	6%	6%
Window	100%	20%	42%	33%	38%	42%	33%	27%	46%	33%	27%
Door	100%	20%	46%	38%	38%	42%	33%	38%	46%	33%	27%
Average (Mean)	100%	20%	25%	21%	21%	25%	19%	20%	33%	17%	15%

APPENDIX 2

Energy Performance of Buildings Directive 2002/91/EC & Energy Performance of Buildings (recast) Directive 2010/31/EU

Article 6

Member States shall take the necessary measures to ensure that when buildings with a total useful floor area over 1000 m2 undergo major renovation, their energy performance is upgraded in order to meet minimum requirements in so far as this is technically, functionally and economically feasible. Member States shall derive these minimum energy performance requirements on the basis of the energy performance requirements set for buildings in accordance with Article 4. The requirements may be set either for the renovated building as a whole or for the renovated systems or components when these are part of a renovation to be carried out within a limited time period, with the above mentioned objective of improving the overall energy performance of the building.

The European Council of March 2007 emphasised the need to increase energy efficiency in the Union so as to achieve the objective of reducing by 20% the Union's energy consumption by 2020 and called for a thorough and rapid implementation of the priorities established in the Commission Communication entitled 'Action plan for energy efficiency: realising the potential'.

http://ec.europa.eu/energy/action_plan_energy_efficiency/doc/com_2006_0545_en.pdf

That action plan identified the significant potential for cost-effective energy savings in the buildings sector. The European Parliament, in its resolution of 31 January 2008, called for the strengthening of the provisions of Directive 2002/91/EC, and has called at various times, on the latest occasion in its resolution of 3 February 2009 on the Second Strategic Energy Review, for the 20 % energy efficiency target in 2020 to be made binding.

Comparison to Existing Jersey Situation (Nominal % improvement)

See table on first page of Appendix, copied in main text of report, we have assumed that the reduction to 20% of existing should apply to all constructions and whatever their proportion of the total "normal" building envelope, this is inexact but provides an overall base level comparison.

Potential Historic Building Impacts

The Directives do not actively refer to historic places, therefore it is conceivable that a legislature could apply them without reference to the potential loss of historic fabric, however, other EU bodies and international agreements and bodies, like the International Council on Monuments and Sites (ICOMOS) would make this highly unlikely.

APPENDIX 2

Existing Jersey Building Regulations

States of Jersey: The Building Bye Laws (Jersey 2007) Technical Guidance Documents

- Bye-law 7 Materials & Workmanship
- Part 3 Combustion appliances and fuel storage systems
- Part 4 Site preparation and resistance to moisture
- Part 5 Means of Ventilation Condensation in Roofs (2011 Edition)
- Part 11, 11.1B, Conservation of Fuel & Power in Existing Dwellings (2011 Edition)

Comparison to Historic Jersey Situation (Nominal % improvement)

See table on first page of Appendix, copied in main text of report.

Bye-law 7 Materials & Workmanship

The requirements of Bye-Law 7 will be met where materials are:

a. of a suitable nature and quality in relation to the purposes and conditions of their use, and
b. adequately mixed or prepared, and
c. applied, used or fixed so as to perform adequately the functions for which they are intended.

Materials: include products, components, fittings, naturally occurring materials e.g. stone, timber and thatch, items of equipment, and backfilling for excavations in connection with building work.

There are no provisions under the Building Bye-Laws for continuing control over the use of materials following the completion of building work.

Part 3 Combustion appliances and fuel storage systems

Air supply for combustion appliances

Combustion appliances require ventilation to supply them with air for combustion.

Ventilation is also required to ensure the proper operation of flues or, in the case of flueless appliances, to ensure the products of combustion are safely dispersed to the outside air. In some cases, combustion appliances may also require air for cooling control systems and/or to ensure that casings remain safe to touch. General guidance on where it may be necessary to install air vents for these purposes is given below.

Air vent sizes are dependent upon the type of fuel burned. The air supply provisions will usually need to be increased where a room contains more than one appliance (such as a kitchen containing an open-flued boiler and an open-flued cooker).

Permanently open ventilation of rooms

A room containing an open-flued appliance may need permanently open air vents.

An open-flued appliance must receive a certain amount of air from outside dependent upon its type and rating. Infiltration through the building fabric may be sufficient but above certain appliance ratings permanent openings are necessary.

APPENDIX 2

Part 4 Site preparation and resistance to moisture

In the view of the Committee the requirements 10, 11 and 12 of part 4 will be met by taking precautions to reduce risks to the health and safety of persons in buildings by safeguarding them and the buildings against the adverse effects of:

a. vegetable matter, and
b. contaminants on or in the ground to be covered by the building, and
c. ground water.
In the view of the Committee requirement 13 of part 4 will be met by:
a. a floor next to the ground preventing undue moisture from reaching the upper surface of the floor
b. a wall preventing undue moisture from the ground reaching the inside of the building, and, if it is
an outside wall, adequately resisting the penetration of rain and snow to the inside of the building
c. a roof resisting the penetration of moisture from rain or snow to the inside of the building
d. ensuring that floors next to the ground, walls and roof are not damaged by moisture from the ground, rain or snow and do not carry that moisture to any part of the building which it would damage.

Damage can be avoided either by preventing moisture from getting to materials which would be damaged or by using materials which will not be damaged.

Part 5 Means of ventilation / Condensation in roofs

In general terms, the requirement may be achieved by providing a ventilation system which:

a extracts, before it is generally widespread, water vapour from areas where it is produced in significant quantities (e.g. kitchens, utility rooms and bathrooms);
b extracts, before they are generally widespread, pollutants which are a hazard to health from areas where they are produced in significant quantities (e.g. rooms containing processes or activities which generate harmful contaminants);
c rapidly dilutes, when necessary, pollutants and water vapour produced in habitable rooms, occupiable rooms and sanitary accommodation;
d makes available over long periods a minimum supply of outdoor air for occupants and to disperse, where necessary, residual pollutants and water vapour. Such ventilation should minimise draughts and, where necessary, should be reasonably secure and provide protection against rain penetration;
e is designed, installed and commissioned to perform in a way which is not detrimental to the health of the people in the building; and
f is installed to facilitate maintenance where necessary.

Types of ventilation

Buildings are ventilated through a combination of infiltration and purpose-provided ventilation.

- Infiltration is the uncontrollable air exchange between the inside and outside of a building through a wide range of air leakage paths in the building structure.
- Purpose-provided ventilation is the controllable air exchange between the inside and outside of a building by means of a range of natural and/or mechanical devices.

APPENDIX 2

It is important to minimise the uncontrollable infiltration and supply sufficient purpose provided ventilation. Air tightness measures to limit infiltration are covered in Part 11 of the Building Bye-laws and its supporting Technical Guidance Documents. Technical Guidance Document 5 recommends methods of achieving sufficient purpose-provided ventilation, allowing for a reasonably high level of air tightness. For the purposes of Part 5, a reasonably high level of air tightness (air permeability) means a level higher than the target value recommended under Part 11because all new buildings are expected to better the target value to some degree. Research suggests that the most airtight domestic and non-domestic buildings, using normal (but carefully executed) construction methods, can have an air permeability down to around 3-4m3/h per square metre of envelope area at 50 Pascal pressure difference. Therefore, the ventilation provisions recommended in this Technical Guidance Document have been specified to cope with air permeability at these levels or worse in typical building types. Where special measures are to be taken to achieve greater air tightness, additional ventilation provisions may be required.

Historic buildings

The inclusion of any particular ventilation measure in existing buildings should not introduce new or increased technical risk, or otherwise prejudice the use or character of the building. In particular, consideration should be given to the special needs of historic buildings. Such buildings include those registered on the Planning and Environment Ministers register of Buildings and Sites of Architectural, Archaeological and Historic importance.

Historic buildings are those registered on the Planning and Environment Ministers register of Buildings and Sites of Architectural, Archaeological and Historical Importance. Conserving the special characteristics of historic buildings needs to be recognised: see BS 7913. In such work, the aim should be to improve ventilation to the extent that is necessary, taking into account the need not to prejudice the character of the historic building nor to increase the risk of long-term deterioration to the building fabric or fittings. It may be that the fabric of the historic building is more leaky than a modern building, and this can be established by pressure testing. In arriving at a balance between historic building conservation and ventilation, it would be appropriate to take into account the advice of the Departments' historic buildings officer and the building control surveyor.

Particular issues relating to work in historic buildings that warrant sympathetic treatment and where advice from others could therefore be beneficial include:

a restoring the historic character of a building that had been subject to previous inappropriate alteration, e.g. replacement windows, doors and rooflights;
b rebuilding a former historic building (e.g. following a fire or filling in a gap site in a terrace);
c making provisions enabling the fabric to 'breathe' to control moisture and potential long term decay problems: see SPAB Information Sheet No. 4, The need for old buildings to breathe, 1987.

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Part 11 Conservation of fuel and power

Historic buildings

Where undertaking work on historic buildings the aim should be to improve efficiency where and to the extent that it is practically possible. This is provided that the work does not prejudice the character of the host building or increase the risk of long-term deterioration to the building fabric or fittings. Particular issues relating to work in historic buildings that warrant sympathetic treatment and where advice from others could therefore be beneficial include:

a restoring the historic character of a building that has been subject to inappropriate alteration e.g. replacement windows, doors and rooflights.
b rebuilding a former building (e.g. following a fire or filling a gap site in a terrace).
c making provisions enabling the fabric of historic buildings to "breathe" to control moisture and potential long term decay problems.

In arriving at a balance between historic building conservation and energy efficiency improvements, it would be appropriate to take into account the advice of the Departments' historic buildings officer and building control surveyor.

Elemental Analysis

Type of element	(a) Area-weighted average U-value (W/m²K) for all elements of the same type	Type of element (b) Individual element U-value (W/m2K)
Wall	0.35	0.70
Floor	0.25	0.70
Roof	0.25	0.35
Windows, doors, rooflights	2.2	3.3

Comparison to Historic Jersey Situation (Nominal % improvement)

See table on first page of Appendix, copied in main text of report

Potential Historic Building Impacts

The Bye-laws are clear about the need to balance increased energy efficiency against the potential for loss of character or fabric when Listed Buildings are being considered, this does not remove the need for care or mean that damage will not sometimes happen, but it does mean that the mechanisms are in place to deal with problems should they arise. The small size of the island will make management easier.

APPENDIX 2

English & Welsh Building Regulations

The Building Regulations 2000

- Part C Site preparation and resistance to contaminants and moisture (2004 Edition)
- Part F – Ventilation
- Part G – Sanitation, Hot Water Safety and Water Efficiency
- Part L – conservation of fuel and power

Part C Site preparation and resistance to contaminants and moisture (2004 Edition)

In the Secretary of State's view the requirements of C1 will be met by making reasonable provisions to secure the health and safety of persons in and about the building, and by safeguarding them and buildings against adverse effects of:

a. unsuitable material including vegetable matter, topsoil and pre-existing foundations;
b. contaminants on or in the ground covered, or to be covered, by the building and any land associated with the building; and
c. groundwater.

In the First Secretary of State's view the requirements of C2 will be met if the floors, walls and roof are constructed to protect the building and secure the health and safety of persons in and about the building from harmful effects caused by:

a. moisture emanating from the ground or from groundwater;
b. precipitation and wind-driven spray;
c. interstitial and surface condensation; and
d. spillage of water from or associated with sanitary fittings and fixed appliance

Part F – Ventilation

In general terms, the requirement may be achieved by providing a ventilation system which:

a extracts, before it is generally widespread, water vapour from areas where it is produced in significant quantities (e.g. kitchens, utility rooms and bathrooms);
b extracts, before they are generally widespread, pollutants which are a hazard to health from areas where they are produced in significant quantities (e.g. rooms containing processes or activities which generate harmful contaminants);
c rapidly dilutes, when necessary, pollutants and water vapour produced in habitable rooms, occupiable rooms and sanitary accommodation;
d makes available over long periods a minimum supply of outdoor air for occupants and to disperse, where necessary, residual pollutants and water vapour. Such ventilation should minimise draughts and, where necessary, should be reasonably secure and provide protection against rain penetration;
e is designed, installed and commissioned to perform in a way which is not detrimental to the health of the people in the building; and
f is installed to facilitate maintenance where necessary.

Types of ventilation

Buildings are ventilated through a combination of infiltration and purpose-provided ventilation.

- Infiltration is the uncontrollable air exchange between the inside and outside of a building through a wide range of air leakage paths in the building structure.
- Purpose-provided ventilation is the controllable air exchange between the inside and outside of a building by means of a range of natural and/or mechanical devices.

APPENDIX 2

It is important to minimise the uncontrollable infiltration and supply sufficient purpose provided ventilation. Air tightness measures to limit infiltration are covered in Part L of the Building Regulations and its supporting Approved Documents. Approved Document F recommends methods of achieving sufficient purpose-provided ventilation, allowing for a reasonably high level of air tightness.

For the purposes of Part F, a reasonably high level of air tightness (air permeability) means a level higher than the target value recommended under Part L because all new buildings are expected to better the target value to some degree. Through good design and execution domestic and non-domestic buildings can currently achieve an air permeability down to around 2-4m3/h per square metre of envelope area at 50 Pascal pressure difference. Some buildings constructed are tighter than this. It can be anticipated that there will be a continual trend towards more airtight buildings due to drivers for higher energy efficiency and lower carbon emissions.

<u>Historic buildings</u>

Buildings included in the schedule of monuments maintained under section 1 of the Ancient Monuments and Archaeological Areas Act 1979 are exempt from compliance with the requirements of the Building Regulations. There are other classes of buildings where special considerations may apply in deciding what is adequate provision for ventilation:
a listed buildings
b buildings in conservation areas
c buildings which are of architectural and historical interest and which are referred to as a material consideration in a local authorities development plan or local development framework
d buildings which are of architectural and historical interest within national parks, areas of outstanding natural beauty, registered historic parks ad gardens, registered battlefields, the cartilages of scheduled ancient monuments, and world heritage sites
e buildings of traditional construction with permeable fabric that both absorbs and readily allows the evaporation of moisture

When undertaking work on or in connection with a building that falls within one of the classes listed above, the ain should be to provide adequate ventilation as far as is reasonable and practically possible. The work should not prejudice the character of the host building or increase the risk of long term deterioration of the building fabric or fittings.

Part G – Sanitation, Hot Water Safety and Water Efficiency

Part J – Heat producing appliances

Part L – conservation of fuel and power

Comparison to Historic Jersey Situation (Nominal % improvement)

See table on first page of Appendix, copied in main text of report

Potential Historic Building Impacts

The Regulations are clear about the need to balance increased energy efficiency against the potential for loss of character or fabric when Listed Buildings are being considered, this does not remove the need for care or mean that damage will not sometimes happen, but it does mean that the mechanisms are in place to deal with problems should they arise. However, the larger size of the areas being considered means the onus falls heavily on local government to maintain vigilance and experience has shown this has varying levels of application. However, there is a well-developed conservation movement in the UK as a second line of defence in many cases.

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Scottish Building Regulations

See:

http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards

Building (Scotland) Act 2003 and the Building

(Procedure) (Scotland) Regulations 2004

• Section 3 – Environment

• Section 6 – Energy

• Section 7 – Sustainability

Application to existing Buildings

"As for other standards within Scottish building regulations, the energy standards apply to conversions and also work on existing buildings, such as extensions, conservatories, alterations and replacement work. However in some situations, individual standards may not apply or guidance on compliance with the standards may differ for such work. The latter is usually to recognise constraints that arise when working with existing buildings. It is advisable, in the first instance, to check the functional standard as sometimes a limitation removes certain classes of this type of work. Where not excepted by a limitation to a standard, the provisions of the standard will apply in full to the new work on the existing building, other than where proposed works are wholly categorised as a conversion, where the standard in question may be met as far as is reasonably practicable. This is identified in the introduction to the guidance supporting each standard."

Section 3

3.4.0 Introduction

Every building must be designed and constructed in such a way that there will not be a threat to the building or the health of the occupants as a result of moisture penetration from the ground.

Water is the prime cause of deterioration in building materials and constructions and the presence of moisture encourages growth of mould that is injurious to health. Ground water can penetrate building fabric from below, rising vertically by capillary action. The effects of this rising damp are

immediately recognisable. There may be horizontal 'tidemarks' sometimes several feet above the floor; below it the wall is discoloured with general darkening and patchiness. There may also be loose wallpaper, signs of mould growth and deterioration of plaster. Hygroscopic salts brought up from the ground tend to concentrate in the 'tidemark'.

Dwellings therefore, need to be constructed in such a way that rising damp neither damages the building fabric nor penetrates to the interior where it may constitute a health risk to occupants.

Climate change

Designers should be aware of the impact that climate change could have on

the fabric of buildings through increased rainfall and temperatures. Higher wind speeds and driving rain should focus attention to improved design and quality of construction and to the protection of the building fabric from long term dampness.

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Conversions

In the case of conversions, as specified in regulation 4, the building as converted shall meet the requirements of this standard in so far as is reasonably practicable, and in no case be worse than before the conversion (regulation 12, schedule 6).

3.4.1 Treatment of building elements adjacent to the ground

A floor, wall or other building element adjacent the ground should prevent moisture from the ground reaching the inner surface of any part of a dwelling that it could damage.

Floors, walls or other building elements adjoining the ground should be constructed in accordance with the following recommendations. The dimensions specified are

3.14.0 Ventilation

Ventilation of a dwelling is required to maintain air quality and so contribute to the health and comfort of the occupants. Without ventilation it is possible that carbon dioxide, water vapour, organic impurities, smoking, fumes and gases could reduce the air quality by humidity, dust and odours and also reduce the percentage of oxygen in the air to make the building less comfortable to work or live in.

Well designed natural ventilation has many benefits, not least financial and environmental, although it is also recognised that inside air quality can only be as good as outside air quality and in some cases filtration may be necessary. In other cases mechanical systems or systems that combine natural with mechanical (hybrid) may provide the ventilation solution for the building.

Ventilation can also have a significant affect on energy consumption and performance and so thorough assessment of natural, as against mechanical ventilation, should be made, as the decision could significantly affect the energy efficiency of the building (see section 6, Energy).

Ventilation should not adversely affect comfort and, where necessary, designers might wish to consider security issues and protection against rain penetration prevalent in naturally ventilated buildings when windows are partially open to provide background ventilation.

Reducing air infiltration BR GBG 67

Improved insulation and 'tighter' construction of buildings will reduce the number of natural air changes but can increase the risk of condensation.

However leaky buildings are draughty and uncomfortable. Sealing up air leaks improves comfort and saves energy whilst proper ventilation keeps the indoor air pleasant and healthy. If poor attention to detail occurs air leakage can account for a substantial part of the heating costs. Energy savings from

building 'tighter' could make significant savings on energy bills. There is a common perception that 'tight' construction promotes indoor air pollution.

However both 'tight' and 'leaky' buildings can have air quality problems. Though air leaks can dilute indoor pollutants, there is no control over how much leakage occurs, when it occurs or where it comes from. BRE GBG 67, 'Achieving air tightness: General principles' provides useful guidance on how to build new buildings tighter.

3.15.0 Condensation

Condensation can occur in heated buildings when water vapour, usually produced by the occupants and their activities, condenses on exposed building surfaces (surface condensation) where it supports mould growth, or within building elements (interstitial condensation).

The occurrence of condensation is governed by complex interrelationships between heating, ventilation, moisture production, building layout and properties of materials. Condensation need not always be a problem, for example it regularly occurs on the inner surface of the outer leaf of a cavity wall which receives very much more water from driving rain. However excess condensation can damage the building fabric and contents and the dampness associated with mould growth can be a major cause of respiratory allergies.

Condensation can also affect thermal insulation materials as the measured thermal performance reduces with increased moisture content. For all of the above reasons the control of condensation is an important consideration in building design and construction.

There are buildings designed and constructed for specialist activities, controlled environments or factory processes that normally involve high humidity levels. The guidance to this standard may not be fully appropriate for such buildings as their design is generally by specialist and often involves

distinctive construction methods and materials required to produce buildings that are fit for purpose under the known conditions.

Climate Change

The effects of climate change may exacerbate problems of condensation in buildings due to higher relative humidity. Higher winter temperatures combined with increased vapour pressures could result in more severe problems, particularly in roof spaces. Very careful consideration of the issues

is essential and the correct detailing will therefore be critical.

3.21.0 Combustion

Every building must be designed and constructed in such a way that each fixed combustion appliance installation receives air for combustion and operation of the chimney so that the health of persons within the building is not threatened by the build-up of dangerous gases as a result of incomplete combustion.

All combustion appliances need ventilation to supply them with oxygen for combustion. This air, which must be replaced from outside the dwelling, generally comes from the room in which the combustion appliance is located although many appliances are now located in specially constructed

cupboards or appliance compartments. Ventilation of these cupboards or appliance compartments is essential to ensure proper combustion.

Ventilation is also needed to ensure the proper operation of flues, or in the case of flueless appliances, to ensure the products of combustion are safely dispersed to the outside air.

Failure to provide adequate replacement air to a room can result in the accumulation of poisonous carbon monoxide fumes.

3.21.1 Supply of air for combustion generally

A room containing an open-flued appliance may need permanently open air vents. An open-flued appliance needs to receive a certain amount of air from outside dependant upon its type and rating. Infiltration through the building fabric may be sufficient but above certain appliance ratings permanent openings are necessary.

Ventilators for combustion should be located so that occupants are not provoked into sealing them against draughts and noise. Discomfort from draughts can be avoided by placing vents close to appliances e.g. floor ventilators, by drawing air from intermediate spaces such as hallways or by

ensuring good mixing of incoming air. Air vents should not be located within a fireplace recess except on the basis of specialist advice. Noise attenuated ventilators may be needed in certain circumstances.

APPENDIX 2

Section 6

6.2.7 Conversion of heated buildings

In the case of a building that was previously designed to be heated, the impact on energy efficiency as a result of the conversion, may be either negligible, none whatsoever or in some circumstances even an improvement. A less demanding approach than identified in clause 6.2.6 is recommended which at the same time still ensures that some overall improvements are being made to the existing building stock. Where an extension or conservatory is formed and/or alterations are being made to the building fabric at the same time as the conversion, the guidance given in clauses 6.2.9 to 6.2.12 should also be followed.

U-values Where conversion of a heated building is to be carried out, the existing insulation envelope should be examined and upgraded following the table below:

Type of element	(a) Area-weighted average U-value (W/m²K) for all elements of the same type	Type of element (b) Individual element U-value (W/m2K)
Wall(1) (2)	0.30	0.70
Floor(1) (2)	0.25	0.70
Roof(1)	0.25	0.35
Where new and replacement Windows, doors, rooflights are installed(3)(4)	1.6	3.3

Notes:
1. Where upgrading work is necessary to achieve the recommended U-values, reference should be made to 'Reconstruction of elements' in clause 6.2.11 and more demanding U-values achieved, where reasonably practicable.
2. Excluding separating walls and separating floors between heated areas where thermal transmittance need not be assessed, provided measures to limit heat loss arising from air movement within a cavity separating wall are made (see clause 6.2.1).
3. The total area of windows, doors and rooflights, should not exceed 25% of the floor area of the dwelling created by conversion. Alternatively, a compensatory approach should be taken.
4. Windows with a window Energy rating of Band C or better may also be used (www.bfrc.org)

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6.2.8 Conversion of historic, listed or traditional buildings

With historic, listed or traditional buildings, the energy efficiency improvement measures that should be invoked by conversion can be more complex. Whilst achieving the values recommended in clause 6.2.7 should remain the aim, a flexible approach to improvement should be taken, based upon investigation of the traditional construction, form and character of the building in question and the applicability of improvement methods to that construction. Provisions under other legislation (e.g. planning consent for listed buildings or those within conservation areas, where there is a need to maintain character, form or features) are also relevant. For all buildings, it would be advisable to consider the feasibility of upgrading fabric to at least the U-values given in column c in clause 6.2.9 (individual element U-values). In many cases, specialist advice will be helpful in making an assessment to ensure that, in improving energy efficiency, there is no other, adverse effect to the building fabric. Accordingly, each building will have to be dealt with on its own merits. Improvements to the fabric insulation of the building will often depend on factors such as whether or not improvement work can be carried out in a non-disruptive manner without damaging existing fabric (for example, insulating the ceiling of an accessible roof space) or whether potential solutions are compatible with the existing construction. In certain cases, buildings are given historic or listed status because of specific features present in certain parts of the building. In these circumstances, it may be possible to make greater improvements to other less sensitive areas. In all cases the 'do nothing' approach should not be considered initially. Innovative but sympathetic and practical solutions to energy efficiency, which are beyond the scope of this guidance, can often result in an alternative package of measures being developed for a building. For example, carbon dioxide emissions can be reduced without affecting building fabric through improvements to the heating system (refer to standards 6.3 and 6.4), the lighting system (standard 6.5) or incorporation of low carbon equipment (such as a biomass boiler or heat pump). Consultation on such matters at an early stage with both the verifier and the planning officer of the relevant authority is advised.

6.2.9 Extensions to the insulation envelope

	Area-weighted average U-value (W/m²K) for all elements of the same type		c) Individual element U-value (W/m²K)
Type of element	a)where U-values for wall and roof of the existing dwelling are poorer than 0.7 [1] and 0.25 respectively	(b) where parameters for column (a) do not apply	
Wall(2)	0.19	0..22	0.70
Floor(2)	0.15	0.18	0.70
Pitched Roof (insulation between ceiling ties or collars)	0.13	0.15	0.35
Flat roof or pitched roof (insulation between rafters or roof with integral insulation)	0.15	0.18	
Windows, doors, rooflights	1.4(3)	1.6(4)	3.3

Notes:
1. The Building Standards (Scotland) Amendment Regulations 1982, came into force on 28 March 1983, introduced thermal insulation for an exposed wall broadly equivalent to 0.7 W/m2K.
2. Excluding separating walls and separating floors between heated areas where thermal transmittance need not be assessed, provided measures to limit heat loss arising from air movement within a cavity separating wall are made (see clause 6.2.1).
3. Windows with a Window Energy Rating of Band A may also be used www.bfrc.org
4. Windows with a Window Energy Rating of Band C or better may also be used www.bfrc.org

APPENDIX 2

Section 7

Sustainability

7.0.3 Scope

The measures on sustainability are broadly related to the built form but some matters that are associated with sustainable development such as location and transport cannot be adequately delivered by the building standards system. The scope of the measures can be divided into two sets:

- Climate change, energy and water resources. Promote the more efficient use of energy, fuel and water in buildings. Reducing water use will reduce the energy consumed and the carbon emissions associated with distributing, processing and heating of water. It is also important that building occupants have the opportunity to understand how their behaviour can reduce use of these resources.

- Quality of life; material use and waste. Homes should be designed to accommodate flexible living, working and studying patterns for individuals, groups and families. More aspects of designing for well-being, such as daylighting rooms more effectively and protecting from noise from adjacent buildings, should be promoted for all new home occupants.

7.1.0 Statement of sustainability (sustainability label)

Every building must be designed and constructed in such a way that:

(a) with regard to a dwelling, a level of sustainability specified by the Scottish Ministers in respect of carbon dioxide emissions, resource use, building flexibility, adaptability and occupant well-being is achieved;
(b) with regard to a non-domestic building, a level of sustainability specified by the Scottish Ministers in respect of carbon dioxide emissions is achieved; and
(c) a statement of the level of sustainability achieved is affixed to the dwelling or non-domestic building.
Limitation:
This standard does not apply to:

(a) alterations and extensions to buildings, other than alterations and extensions to stand-alone buildings having an area less than 50 square metres that would increase the area to 50 square metres or more, or alterations to buildings involving the fit-out of the building shell which is the subject of a continuing requirement;
(b) conversions of buildings;
(c) buildings that are ancillary to a dwelling that are stand-alone having an area less than 50 square metres;
(d) buildings which will not be heated or cooled other than by heating provided solely for the purpose of frost protection;
(e) buildings intended to have a life not exceeding the period specified in regulation 6; or
(f) conservatories.

Comparison to Historic Jersey Situation (Nominal % improvement)

See table on first page of Appendix, copied in main text of report.

Potential Historic Building Impacts

The Regulations are clear about the need to balance increased energy efficiency against the potential for loss of character or fabric when Listed Buildings are being considered, this does not remove the need for care or mean that damage will not sometimes happen, but it does mean that the mechanisms are in place to deal with problems should they arise. However, the large size of some the areas being considered combined with a sparse population means the onus falls heavily on a few local government staff to maintain vigilance and experience has shown this has varying levels of application and competence. However, as elsewhere in the UK there is a well-developed conservation movement as a second line of defence in many cases.

It is interesting to note that these regulations also allow leniency when dealing with improving existing constructions, while this may not lead to the most efficient building stock, it would balance the need for energy conservation with the potential lack of areas' character.

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French Building Regulations

Documents Techniques Unifies (DTUs)

- DTU 34 Doors
- DTU 45 Thermal Insulation
- DTU 61 Gas
- DTU 65 Heating

Avis Techniques (technical advisory notes).

Energy efficiency standard: Réglementation Thermique 2005, improved standards include:

- Hautes Performances Energétiques – HPE 2005
- Très Hautes Performances Energétiques –THPE 2005
- Batiment Basse Consommation (BBC)

Construction	U value
Floor	0.27
Wall	0.36
Roof (Pitched)	0.2
Window	2.0
Door	2.0

Comparison to Historic Jersey Situation (Nominal % improvement)

See table on first page of Appendix, copied in main text of report.

Potential Historic Building Impacts

With less stringent building regulation requirements than most other EU member countries, French listed buildings are also protected by the Architect des Batimente de France, noted as guardians of architectural heritage. Their influence and the fact that none of the energy performance regulations are considered mandatory for existing buildings limits the potential impact of the regulations.

Irish Building Regulations

http://www.environ.ie/en/DevelopmentHousing/BuildingStandards/

- Part C - Site preparation and resistance to moisture (1997 Edition)
- Part F – Ventilation (2009 Edition)
- Part J – Heat Producing Appliances (1997 Edition)
- Part L – conservation of fuel and power (2011 Edition)

'In the case of material alterations or change of use of existing buildings, the adoption without modification of the guidance may not, in all circumstances, be appropriate. In particular, the adherence to guidance, including codes, standards or technical specifications, intended for application to new work may be unduly restrictive or impracticable.'

Buildings of architectural or historical interest are especially likely to give rise to such circumstances. In these situations, alternative approaches based on the principles contained in the documents may be more relevant and should be considered

Construction	U value
Floor	0.21
Wall	0.21
Roof (Pitched)	0.16
Window	1.6
Door	1.6

Comparison to Historic Jersey Situation (Nominal % improvement)

See table on first page of Appendix, copied in main text of report.

Potential Historic Building Impacts

Regulations allow for protection of listed buildings by exempting them from Part L. Further, even if not listed, some historic fabric deemed of 'value' may also have relaxed requirements applied.

APPENDIX 2

German Building Regulations

The German EnEV 2009 - Energieeinsparverordnung für Gebäude (Energy saving order for buildings) is the currently applicable regulation set ordered by the Bundestag, or Federal Government. These laws are then applied by the individual Länder through their regional parliaments. The EnEV will be updated and strengthened in 2014

Denkmalshutz gebaude or Listed buildings are exempt when the Land or local government decides that is to be the case. This appears to be universal.

Construction	U value
Floor	0.35
Wall	0.28
Roof (Pitched)	0.2
Window	1.3
Door	1.8

Comparison to Historic Jersey Situation (Nominal % improvement)

See table on first page of Appendix, copied in main text of report.

Potential Historic Building Impacts

Were they to be applied to Germany's listed buildings, these would be some of the most stringent regulations in force in the area examined, however, as elsewhere the regulations do not have to be applied. It is interesting to note however that there is apparently less sentiment about the requirement to preserve the texture of the wider and less protected historic fabric and that building modernisation is more wholeheartedly carried out than is the case in other countries studied, often to the detriment of historic character.

Belgian Building Regulations

In Belgium only fire resistance and energy performance are regulated, neither of which are applicable to existing buildings.

The system of regulations differs between 3 regions, Brussels, Wallonia and Flanders. For all works a building permit is required but work is not checked by the authorities. Some workmanship standards do exist as follows.

- NBN standards, the Belgian standards issued by the Belgian Normalisation Institute (NBN)
- 'PTV's': Prescriptions Techniques (Technical Prescriptions).

Construction	U value
Floor	0.9
Wall	0.35
Roof (Pitched)	0.27
Window	2.2
Door	2.2

Comparison to Historic Jersey Situation (Nominal % improvement)

See table on first page of Appendix, copied in main text of report.

Potential Historic Building Impacts

Belgium has the least ambitious energy efficiency targets of all the countries analysed. As none of the aims apply to existing buildings historic fabric is not at risk.

APPENDIX 2

Danish Building Regulations

http://www.erhvervsstyrelsen.dk/file/155699/BR10_ENGLISH.pdf

- Section 4.6 Moisture and durability
- Section 6.2 Thermal indoor climate
- Section 6.3.1 Ventilation
- Section 7. Energy consumption

Section-1 Administrative provisions

No building permits, building notices or occupancy permits are required for minor conversions or alterations to an existing building which will reduce energy consumption in that building.

Construction	U value
Floor	0.12
Wall	0.2
Roof (Pitched)	0.15
Window	1.6
Door	1.6

Comparison to Historic Jersey Situation (Nominal % improvement)

See table on first page of Appendix, copied in main text of report.

Potential Historic Building Impacts

Relaxation of requirements for listed buildings is included within the Regulations. It is noted that justification must be given to obtain agreement of this relaxation. In such cases consideration must be given to whether there are other means of accommodating the underlying rationale behind the regulations.

Swedish Building Regulations

http://www.boverket.se/Om-Boverket/Webbokhandel/Publikationer/2008/Building-Regulations-BBR/

- Section 6:25 Ventilation
- Section 6:255 Airtightness
- Section 9:2 Dwellings
- Section 9:21 Building envelope's airtightness
- Section 9:9 Energy management requirements for alterations to buildings
- Section 9:92 Building envelope

Alterations to buildings must not result in deteriorating energy efficiency, unless there are exceptional circumstances. However, energy efficiency may deteriorate if the alteration to the building still meets the requirements in Sections 9:2–9:6. (BFS 2011:xx).

Construction	U value
Floor	0.15
Wall	0.18
Roof (Pitched)	0.13
Window	1.3
Door	1.3

Comparison to Historic Jersey Situation (Nominal % improvement)

See table on first page of Appendix, copied in main text of report.

Potential Historic Building Impacts

As well as being the most energy improvement conscious regulations, the official documentation also includes strict guidance for restrictions to alterations to existing buildings. The regulations note that consideration should be given to maintain a building's character.

APPENDIX 3

Organisation	Title	Author	Publication Date
Sustainable Traditional Buildings Alliance (STBA)	Responsible Retrofit of Traditional Buildings	Neil May, Caroline Rye,	2012
SPAB	The SPAB Research Report 1 : U-value Report	Dr Caroline Rye	2012 Rev.
SPAB	The SPAB Research Report 2 : The SPAB Building Performance Survey: Interim Report	Caroline Rye, Cameron Scott & Diane Hubbard	October 2012
SPAB	The SPAB Research Report 3 : Hygrothermal Modelling: Interim Report	Dan Browne	October 2012
ChangeWorks	Energy Heritage : A guide to improving energy efficiency in traditional and historic homes		2008
ChangeWorks	Double Glazing in Listed Buildings		July 2010
ChangeWorks	Renewable Energy : A guide to microgeneration in traditional and historic homes		
Historic Scotland	Short Guide – Fabric Improvements for Energy Efficiency in Traditional Buildings	Moses Jenkins	September 2012
Historic Scotland	Focus Magazine	various	annual
Historic Scotland	Improving Energy Efficiency in Traditional Buildings		
Historic Scotland	Conversion of Traditional Buildings Parts 1 & 2	Dennis Urquhart	2007
Historic Scotland	Refurbishment Case Study 1 : Five Tenement Flats, Edinburgh	Misia Jack & Adam Dudley	2012
Historic Scotland	Refurbishment Case Study 2 : Wells O'Wearie, Edinburgh	Roger Curtis	2012

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Organisation	Title	Author	Publication Date
Historic Scotland	Refurbishment Case Study 3 : Wee Causeway, Culross	Moses Jenkins	2012
Historic Scotland	Refurbishment Case Study 4 : Sword Street, Glasgow	Moses Jenkins	2012
Historic Scotland	Refurbishment Case Study 6 : Kildonan, South Uist	Moses Jenkins	2012
Historic Scotland	Refurbishment Case Study 7 : Scotstarvit Tower Cottage, Cupar	Jessica Snow	2012
Historic Scotland	Refurbishment Case Study 8 : Garden Bothy, Cumnock	Moses Jenkins	2012
Historic Scotland	Tech Paper 1 - Thermal Performance of Traditional Windows	Dr Paul Baker	Rev 2010
Historic Scotland	Tech Paper 2 - In situ U-value Measurements in Traditional Buildings - Preliminary Results	Dr Paul Baker	October 2008
Historic Scotland	Tech Paper 3 - Energy Modelling Analysis of a Scottish Tenement Flat	Bob Barnham, Nicholas Heath & Gary Pearson	October 2008
Historic Scotland	Tech Paper 4 - Energy Modelling in Traditional Scottish Houses	Dr David Jenkins	November 2008
Historic Scotland	Tech Paper 5 - Energy Modelling of a Mid 19th Century Villa	IES	February 2009
Historic Scotland	Tech Paper 6 - Indoor Air Quality and Energy Efficiency in Traditional Buildings	Sandy Halliday	March 2009
Historic Scotland	Tech Paper 7 - Embodied Carbon in Natural	Naeeda Chishna, Dr. Suzy Goodsir, Professor	March 2010

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Organisation	Title	Author	Publication Date
	Building Stone in Scotland	Phil Banfill & Dr. Keith Baker	
Historic Scotland	Tech Paper 8 - Energy Modelling of the Garden Bothy, Dumfries House	Nicholas Heath, Gary Pearson, Bob Barnham & Richard Atkins	May 2010
Historic Scotland	Tech Paper 9 - Slim-profile double glazing	Nicholas Heath, Dr. Paul Baker and Dr. Gillian Menzies	September 2010
Historic Scotland	Tech Paper 10 - U-values and Traditional Buildings	Dr Paul Baker	January 2011
Historic Scotland	Tech Paper 11 - Scottish Renaissance Interiors	Chantal-Helen Thuer	May 2011
Historic Scotland	Tech Paper 12 - Indoor Environmental Quality in Refurbishment	Richard Hobday	July 2011
Historic Scotland	Tech Paper 13 - Embodied energy consideration for existing buildings	Gillian F. Menzies	September 2011
Historic Scotland	Tech Paper 14 - Keeping warm in a cooler house – Creating thermal comfort with background heat and local supplementary warmth	Michael Humphreys, Fergus Nicol and Susan Roaf	September 2011
Historic Scotland	Tech Paper 15 - Assessing insulation retrofits with hygrothermal simulations – Heat and moisture transfer in insulated solid stone walls		to be published shortly
Historic Scotland	Tech Paper 16 - Green Deal Finance Modelling of a Traditional Cottage and Tenement Flat	Nicholas Heath, Tessa Clark & Gary Pearson	2012
The Princes Regeneration	The Green Guide to Historic Buildings		2010

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Organisation	Title	Author	Publication Date
Trust			
The Energy Saving Trust	Energy Efficient Refurbishment of Existing Housing (CE83)		
The Energy Saving Trust	Refurbishing dwellings with solid walls – A summary of best practice (CE58)		
The Energy Saving Trust	Advanced insulation in housing refurbishment (CE97)		
The Energy Saving Trust	Energy Efficient Historic Homes : Case Studies (CE138)		2005
The Energy Saving Trust	Windows for New and Existing Housing (CE66)		2006 Ed.
The Energy Saving Trust	Sustainable Refurbishment (CE309)		2010 Ed.
The Energy Saving Trust	Evaluating energy and carbon performance in the 'Retrofit for the Future' demonstrator projects		August 2009 Ed.
International Energy Agency	Energy Efficiency Requirements in Building Codes, Energy Efficiency Policies for New Buildings		2008
English Heritage	Energy Efficiency and Historic /buildings – Insulating Thatched Roofs	Phil Ogley, Oxley Conservation	March 2012
English Heritage	Energy conservation in traditional buildings		2008
English Heritage	Small Scale Solar Electric (photovoltaics) Energy and Traditional Buildings		October 2010

APPENDIX 3

Organisation	Title	Author	Publication Date
English Heritage	Small Scale Solar Thermal Energy and Traditional Buildings		March 2008
English Heritage	Energy Efficiency and Traditional Buildings – Heat Pumps		February 2012
States of Jersey	Pathway 2050: An Energy Plan for Jersey	Robert Duhamel	November 2012
States of Jersey	Jersey Historic Environment Resurvey – Survey Guide	Dr Aylin Orbasli & Associates	January 2011
States of Jersey	A History of Timber Windows and External Doors in Jersey	Planning and Environment Committee	1999
UK Department of Energy and Climate Change	The Future of Heating: A strategic framework for low carbon heat in the UK		March 2012
Wood Window Alliance	Life Cycle Assessment of timber, modified timber and aluminium clad timber windows	Dr Gillian Menzies	March 2013

APPENDIX 4

EXAMPLES

On the following pages are working examples carried out by Purcell of reviews of measures to improve energy efficiency in listed buildings. These range in scope from whole project overview to detail consideration.

- Appraisal of Sustainable Design Options - London p.85
  A full review of possible improvements to a listed building including water use and ventilation as forms of energy saving measures, and different sources of energy production. These are set against advantages/ disadvantages and feasibility including Planning issues.
- Carbon Cost Benefit Analysis - Edinburgh p. 89
  A full review of both energy saving and energy producing measures set against energy reductions and financial cost.
- Residential Refurbishment - London p.92
  An example detail of improvements installed to a residential listed property.
- Internal Insulation Options - London p.93
  A schedule of options to improve thermal performance of existing walls of a listed building through internal insulation set against 'u'-value improvement, cost and loss of internal floor space.
- Improvements to Existing Sash Window Options - London p.94
  Example improvements options to existing single glazed sash windows with indicative costs.

APPENDIX 4

APPRAISAL OF SUSTAINABLE DESIGN OPTIONS

Sustainable System/Statement	Description	Project Brief Paragraph No.	Advantages	Disadvantages	Planning and Heritage Issues	Feasibility / Option Appraisal	Viable (Y/N)
Rainwater Harvesting	Rainwater harvesting is rainwater collected, normally from roofed areas. Minimal treatment is required for use to provide primarily water for re-use (WC's, irrigation etc)	39, 43, 41	Subject to building roof area and occupancy water requirements rainwater recycling will save significant amounts of water and assist demand on water resources. Minimal water treatment	Duplicate storage and distribution systems required Will not provide flood protection as storage will generally be partially full prior to a storm and full size overflow drain is required	Environment Agency may have a preference as part of an overall site storm water control	A calculation to find the required effective roof area and the quantity of rain water required for this building has proved that a rain water system would not be feasible. In the wettest month of the year the rain water collected would equate to half the population using a WC 1x/day. A primary rainwater tank approximately 30m3 to be buried below ground is required. A secondary tank approximately 2-3m3 at roof level is required. Space allocation for both tanks would be hard to achieve.	N
Grey Water Recycling	Waste water generated from processes such as bathing, washing and laundry, but excludes kitchen wastewater and foul (WC/urinal) black water, is commonly known as 'Grey' water. It can be used generally for WC and urinal flushing although with suitably treatment may be considered for irrigation.	39, 43, 41	Recycled water from whb, showers and baths may be used for flushing toilets and urinals, which has potential to save significant amounts of water usage and assist in lowering demand on potable water resources.	The on site water treatment process is complex. Capital costs are high and space allocation for treatment plant and tanks is required The environmental impacts of this treatment may be high. Duplicate storage and distribution systems required Requires equal or greater raw grey waste water supply to cover the WC flushing water requirement.	None	This technology maybe viable in buildings with high grey water discharge potential (hotels, sports pavilions, leisure centres) not considered viable for buildings with low waste water (offices, schools). A grey water system would not be viable for this type of building.	N
Green Roofs	A green roof is the term for putting vegetation such as sedum, plants and trees on a roof. Sedums are low-growing plants - particularly suitable for growing in the inhospitable conditions found on a roof. A roof with sedums is commonly known as an intensive green roof	40, 44	Green roofs have many economic and environmental benefits, which include: • reducing the urban island heat effect • improving rainwater management • increasing the thermal performance of a building • reducing noise pollution • improving the overall aesthetics of a building	Building structure and rainwater disposal system requires specialist consideration/design. Can require specialist maintenance Best suited for larger roof areas.	The local planning authority will assess the visual impact; if any. The environment agency or local water authority may have a requirement to attenuate rainwater runoff depending on point of discharge	A viable system subject to roof size and planning conditions and use when considered with other sustainable options such as rainwater harvesting.	N
Water efficient fittings	Low flow, aerated and flow restricted water fittings for sink, wash basin taps, shower heads, and electronically controlled taps, low dual flush WC cisterns and controlled urinal flushing will greatly reduce water consumption in the first instance.	39, 43, 41	No detrimental affect to the users, cleaning operatives or maintenance operatives No additional installation costs Financial rewards available (enhanced capital allowance schemes on such fittings) Potable water usage is reduced	May not be suitable for certain applications that require higher flows for processes. Some fittings will be high pressure fittings which may have an affect to pressure duty of a pump set – bigger pump ECA scheme for water efficiency requires consideration in order to assess financial viability.	None	Water efficient fittings should be used in all available applications. Kitchens and catering applications can be excluded.	Y
Solar Thermal Hot Water Generation	Roof mounted solar thermal panels preheat domestic hot water supply.	39, 43, 41	A fully sustainable source of free green energy Potential to generate up to 30% of the annual building hot water energy requirement. Minimal maintenance depending on panel type.	Initial extra capital outlay for plant, (payback over 8yrs approx). Approx 100% increase in hot water generation plant space. A conventional system sized at 100% is required to cope with demand in	The local planning authority will assess the visual impact; if any, the solar collectors would have on the local community. On flat roofs panels require framework to align panels	Viable subject to building orientation and planning conditions due to the visual impact of the panels. Initial calculations suggest there is sufficient south facing roof space at No1 Millbank. We will require extra plant space for buffer cylinders and ancillary equipment in the basement plant room.	Y

APPRAISAL OF SUSTAINABLE DESIGN OPTIONS

Sustainable System/Statement	Description	Project Brief Paragraph No.	Advantages	Disadvantages	Planning and Heritage Issues	Feasibility / Option Appraisal	Viable (Y/N)
				times of low solar irradiation.	to sun azimuth.		
Biomass boilers	Biomass boilers burn renewable fuel to generate hot water for direct use or heating purposes. The fuel they burn is from a renewable source as it is in a constant carbon cycle.	39, 44	Carbon neutral, uses sustainable wood pellets/chips/logs	Requires regular deliveries of fuel from local sustainable source. Large plantroom and storage areas required for boiler and storage silo/pits	Possible Silo sitting if storage isn't underground.	Viable subject to availability of plantroom and storage areas as well as delivery access. Due to this, Biomass boilers should only be considered after other sustainable options have been fully evaluated and found to be no longer suitable.	N
Ground source (geo-thermal) heat collection and store	With ground source systems heat is extracted from the earth using a ground loop. The ground loop is a continuous closed loop ('slinky') of special pipe buried around the building. A mixture of water and food grade anti-freeze is circulated through the buried pipes where it absorbs heat from the surrounding earth. The ground loop is connected to a heat pump inside your building that takes heat out of the circulating mixture and transfers it into your heating circuit and hot water tank.	39, 44	Can provide both heating and low grade heat for hot water. 'Invisible' system once installed You can achieve passive and active cooling from the system. Minimal maintenance	Widespread shallow excavations (1.2m) required to Install pipework loop Initial capital outlay for plant and approx 100% increase in hot/heating water generation plant space.	Major heritage and planning investigations will be required.	Not viable due the area required to extract useful heat from the installation	N
Passive Ventilation	Passive Ventilation relies on the effects of warm air buoyancy and wind driven flow to promote air passage through a space.	39	Energy efficiency, reduction of plant space within occupied rooms and plant areas.	Room depth is too great if external (ie. non-courtyard) facades are to remain closed. Potential for overheating and poor indoor air quality. External shading required, particularly for the South and West facades. Acoustic privacy in cellular offices would require cross talk attenuation for cross flow ventilation, which dramatically reduces the effectiveness.	Possible planning permission required for visible solar shading and major modifications to the building (eg. Stacks).	Viable in some courtyard facing rooms with low solar loading.	Y
BREEAM Assessment	According to Sustainable Development in Government (SDIG) targets refurbishment projects are to achieve at least a 'Very Good' rating (>55%).	43	Meets Government Policy. Demonstrates green credentials and sustainability.	Costs of BREEAM assessor. Possible design changes or testing to meet desired level. Final rating may not meet preliminary assessment.	None.	Provide input to assessment procedures as part of the overall project.	
Wind turbine electrical generation	This technology involves the use of wind energy to produce electricity and is carbon free. The most common design is for three blades to be mounted on a horizontal axis and fixed to a pole free to rotate into the wind direction. However, other innovative designs are now becoming freely available. The blades drive a generator	39, 44	Can be grid connected to allow for export of surplus electricity. Grants may be available from the Low Carbon Buildings Programme (LCBP Phase 2) if >500W. Renewable Obligation Certificates and Levy Exemption Certificate schemes are in place that can raise additional revenue if the generator is grid connected. Makes a sustainable development visible – good for image.	Can produce nuisance noise. Capital investment. Ongoing maintenance access and costs. Exported electricity sold at a reduced rate (this is likely to change). Wind turbines can also cause electromagnetic interference if positioned between a radio, television or microwave transmitter and receiver. The uneven and turbulent wind patterns that occur near buildings and other structures may limit the amount of electrical energy	Planning permission will be required for each location. It is likely that the local planning office will consider any proposal in terms of design, location, size and scale of the project. Also, issues associated with noise transmission, vibration, visual impact and electromagnetic interference will need to be	The average annual wind speed at the site has been recorded as 4.6 m/s (source: wind speed database – DTI); this has the potential to generate useful amounts of energy. Space restrictions, planning/heritage implications and suitability criteria set out in GPG379 (Renewable Energy – A Guide for the Government Estate) make this technology non-viable for this project.	N

APPRAISAL OF SUSTAINABLE DESIGN OPTIONS

Sustainable System/Statement	Description	Project Brief Paragraph No.	Advantages	Disadvantages	Planning and Heritage Issues	Feasibility / Option Appraisal	Viable (Y/N)
	(directly or via gearing) to produce electricity which can be fed into the building electrical system, the grid or storage batteries. Where electricity is fed directly into the building electrical system or grid a controller is required to regulate the energy transferred.			produced. Arduous documentation needs to be completed in order to act as an energy supplier connected to the grid. Heritage and planning difficulties.	considered. Any future developments within the surrounding areas are likely to alter wind patterns and need to be considered in any proposed installation. English Heritage would have serious concerns over any such installation and, in particular, visual and structural impact.		
Photo-Voltaic electrical generation	Photovoltaic (PV) systems are used to convert energy form the sun into electricity through the use of semi conductor cells. The semi conductor cells are electrically connected together to form modules. The modules are then normally connected into an inverter unit which converts the direct current (DC) produced into alternating current (AC) for direct use within the building or for export onto the local electricity grid. PV systems can operate in daylight as well as direct sunlight although the amount of electricity produced will be less. This means that electricity can still be produced in cloudy or overcast conditions.	39, 44	Can be grid connected to allow for export of surplus electricity. Grants may be available from the Low Carbon Buildings Programme (LCBP Phase 2) if >500W.	High capital cost. Long term payback period. Ongoing maintenance costs. Restrictive lifecycle value. Inefficient, when compared with solar thermal units. Will interfere with space that may be beneficial if used for solar thermal units. Roof mounted systems may require anti-bird protection methods to avoid the need for additional cleaning. Photovoltaic modules need to be ventilated from behind as their efficiency reduces with temperature increase – ventilation is easier for bolt-on systems.	The local planning authority will assess the visual impact; if any, the photovoltaic systems would have on the local community. The visual impact can be minimized by integrating PV systems into the building design as cladding and/ or rain screens etc.	Photovoltaics should ideally be positioned to face between south-east and south-west and inclined at an angle of 30-40 degrees. Arrays should not be horizontal as rain will not be able to wash them clean. Systems should be located to avoid shading at all times of the day and care needs to be taken to ensure that any future development to surrounding areas will not be detrimental to the operation of the system. The lifecycle cost, limited area utilised, which would best be used for other sustainable technologies, planning and heritage issues make PVs non-viable for this project.	N
Hydro-Electric generation	Hydroelectric power is the energy generated from rotating a turbine with moving water in rivers or from man-made dam installations.	39, 44			Subject to arduous planning applications and heritage approvals.	The geography of the Millbank Island Site eliminates this as a feasible option. The suitability criteria set out in GPG379 (Renewable Energy – A Guide for the Government Estate) also make this technology non-viable for this project.	N
Fuel Cell Technology	Uses an electrochemical process to generate electricity from hydrogen. Hydrogen is provided either directly or via a reformation process of another fuel such as biomass or natural gas. There are several types of fuel cells use different electrochemical process to generate electricity. The 'waste' heat generated can be used in co-generation mode to improve the systems efficiencies.	39, 44	Lower SOXs and NOXs emissions Theoretically high efficiency Reliable system (used as a replacement for UPS in the USA)	High capital cost. High running cost. Unproven technology. Requires space (200kWe size of a storage container). Maintenance will be problematic due to limited knowledge in the national workforce. CO_2 lifecycle benefit analysis has not been verified. Safe storage of gases will be required. Short stack life which needs to be replaced on a regular basis. This is a significant additional expense to the life of the system. Not suitable for start-stop operation – degrades stack life	Use of flammable materials on site i.e. hydrogen, depending where it can be situated, it is likely to be deemed a security risk. Visual impact - fuel cells ideally situated outdoors	Highly unlikely to be a low risk, cost effective, energy saving option for this high profile site.	N

APPRAISAL OF SUSTAINABLE DESIGN OPTIONS

Sustainable System/Statement	Description	Project Brief Paragraph No.	Advantages	Disadvantages	Planning and Heritage Issues	Feasibility / Option Appraisal	Viable (Y/N)
	The largest fuel cell currently operating in the UK is a 200kWe Phosphoric acid fuel cell.						
Combined Heat and Power (CHP)	Combined Heat and Power (CHP) is the simultaneous generation of usable heat and electricity. This process is also known as co-generation. Trigeneration is the use of CHP to provide cooling as well as heat and power. CHP systems can be utilised over a wide range of fuels and technologies. CHP systems provide local generation either as part of a larger site or as the primary mover in a district heating system. CHP systems are generally sized to the heat base load for a site. As a general rule CHP requires a large steady base load and to operate for at least 5000 hours per year to be cost effective.	39, 44	If sized correctly: • Reduce electric energy and demand costs • Reduce carbon dioxide emissions • Improve power and heat reliability Enables the site to continue operating in the event of a power cut provided a primary energy source is available. Can be used remotely to the site via a district heating system. Can potentially be linked to existing DH schemes in the area. Reliable, proven technology	Performance can degrade if constantly operated below full load	Locating the system. Potential issues with infrastructure logistics. Visual impact. High capital cost.	Further investigation will be required of the current and future planned DH networks (Whitehall Network), alternative locations for a dedicated CHP and the use of biomass and associated infrastructure requirements. Provision for future connections to these systems can be provided as part of the MIS project.	Y
Green Energy Supplier	There is an ever increasing market for the supply of green energy from electricity and gas suppliers. The green energy can be proportional	39, 44	No additional infrastructure or plant required. No additional capital cost. Seamless integration. As more providers emerge, cost of green energy is reducing. Provider may be changed easily to cheaper competitor at any time.	Per unit energy costs can be higher. Not visible. Will not contribute towards meeting the London Plan's CO_2 or government's overall renewable energy supply targets	None	Completely viable and easy to implement.	Y
Occupancy monitoring	The way in which the building is to be occupied is difficult to predict. There will be instances where individual offices and areas will be unoccupied across the site. Modern controls can accurately monitor which offices are in use at any particular time; subsequently, these controls can operate the lighting, heating and ventilation associated with these individual spaces. This will lead to a reduction in the energy consumed by the building..	41	The building can be designed to be dynamically responsive to the occupancy levels. The building's energy consumption will be reduced. Fast payback period. Low capital investment. Can be interfaced with proposed access control and BMS systems. Can be used in conjunction with local controls so that users can control their individual environment.	Office relocation management will need to include for BMS software updates. Initial configuration and software requirements may prove complex.	None.	Viable, once stakeholders have approved the proposed systems.	Y
Daylight	Illumination of internal spaces by the use of daylight. This can be achieved by the use of daylight shelves, internal glazed partitioning and sunpipes.	39, 41	Lowers the energy demand of the building in terms of electric lighting. Offers better working environment. Cost effective, if assessed at design stage. Low capital cost.	Potential heat gains from additional glazing. Higher maintenance and cleaning. Difficult to control.	Fenestration details will form part of the planning application and will be subject to full planning and heritage approval.	Day lighting offers an excellent energy efficient way for illuminating internal spaces and is both practically and financially viable.	Y
Low energy lighting	Ensuring highly efficient, low energy lighting is specified and installed.	38, 41	Lower energy consumed for higher light output. Assists in achieving renewable generation capacity.	Higher capital cost.	Lighting will need to meet the requirements of BR Approved Document L2B.	The lighting system will be designed to meet or, preferably, exceed the building regulations and is totally viable.	Y

APPENDIX 4

EWH/ EEDA

Carbon Cost Benefit Analysis

Proposal to reduce carbon dioxide emissions	Description	Aim	Energy reduction	CO_2 reduction	Cost: £s	Benefit analysis
EXISTING FABRIC IMPROVEMENTS						
Draught strip external street front entrance doors and rear garden doors, closer to garden door	Install seals or brushes to all four edges of door or frame	To reduce loss of warm air and infiltration of cold air around door	Number of air changes per hour reduced, thus reduction in energy required to heat dwelling		£750	**OK**
Draught strip internal flat entrance doors	Install seals or brushes to all four edges of door or frame	To reduce loss of warm air and infiltration of cold air around door	Number of air changes per hour reduced, therefore less energy used to warm air in dwelling		£2,400	**OK**
Draught strip windows	Install seals or brushes to windows or frame	To reduce loss of warm air and infiltration of cold air through gaps between window and frame	Reduce air changes/hour, therefore use less energy to warm air in dwelling	64kg CO2/m2.year	£19,000	**OK**
Install insulated internal shutters to windows using existing panelled reveals as outer leaf	Full working shutters to be provided for nearly all windows	To reduce heat loss through glazing to windows, mostly at night time	U-value improved from 5.4 for large single-glazed window to 1.6 (standard double glazing value is 1.8)	90kg CO2/m2.year	£73,000	**OK**
Install secondary glazing where shutters cannot be fitted	Secondary glazing installed at location of staff bead	To reduce heat loss through original single glazing, 24 hr solution	U-value improved from 5.4 for large single-glazed window to 2.3 (standard double glazing value is 1.8)		£75,000	**Do shutters instead**
Insulate thinner wall below window recess	Remove timber panelling and install 25mm solid foam board insulation and VCL	To reduce heat loss through thinner wall construction	U-value improved from approx 2.1 to approx 0.45w/sqmK BUT the dew point is moved and there have been problems with stone spalling in freezing conditions			**NO**
Insulate attic/roof area	Install min 250mm mineral fibre quilt insulation between ceiling joists in attic	To reduce heat loss through ceiling of upper properties	U-value improved from 2.3 to 0.16	103kg CO2/m2.year	£10,000	**OK**
Insulate suspended timber ground floor	Install either mineral fibre quilt or solid foam board insulation between floor joists	To reduce heat loss down through ground floors	U-value improved from 0.64 to approx 0.22 (current requirement)	16.5 kg CO2/m2.year	£5,000	**OK**
Insulate external walls	A very invasive exercise which would involve removal of existing plaster finishes and disruption of all door and window frames and skirtings.	Not recommended as dew point moves location in wall which has been known to cause spalling of stone on outer face in freezing conditions	U-value of wall would be reduced			**No**
Green wall to rear elevation	Erect frameowrk spaced off external wall to support suitable climbing plants	To reduce convection currents on wall and therefore heat loss from wall	U-value of wall would be reduced			**Too little rear wall**

APPENDIX 4

EWH/ EEDA

Carbon Cost Benefit Analysis

Proposal to reduce carbon dioxide emissions	Description	Aim	Energy reduction	CO_2 reduction	Cost: £s	Benefit analysis
ELECTRICAL SERVICES						
Energy efficient lighting	Install compact fluorescent lamps (CFLs) in all light fittings	To reduce power used to adequately light rooms and spaces in dwellings	Number of kWh elecricity used reduced when compared with use of tungsten lamps to provide adequate ligthing	47 kg CO2/m2.year	£2,000	**OK**
Reduce power use for all electrical equipment in dwelling	Install single point power switch for bank of electrical appliances in lounge	Occupants can turn power off to sevral pieces of equipment at once	Number of kWh elecricity used reduced by turning off equipment when not in use and not leaving on standby.		£3,300	**CO_2 reduction not really measureable**
MECHANICAL SERVICES						
Energy efficient space heating and hot water	Install gas fired condensing boilers and room thermostats	Heat recovered from boiler flue gases	To reduce gas units used per Btu of heating	54.5 kg CO2/m2.year	£15,000	**OK**
Insulate hot water cylinders	Install insulation jacket to all HWCs	To reduce heat loss from hot water in cylinder	Less energy required to maintain hot water in cylinder at required temperature			**Not required**
Wood fuel stoves	Install wood burning stove in one room of property	Exploits potential thermal mass of building by allowing mass to become warm and remain warm by keeping stove alight 24/7	Reduction in amount of other energy source (e.g. gas, electricity) required for space heating	11 kg CO2/m2.year	£8,000	**OK**
Roof mounted solar panels	Install panels on roof to use sun's energy to heat water passing through panels	Hot water created to be fed in to individual or communal tanks where temperature raised, if required, by boiler before use.	Using sun to pre-heat water for washing etc gives reduction in amount of other energy source (e.g. gas, electricity) required to heat water	53 kg CO2/m2.year	£21,000	**OK**
Review all radiators in properties	Install thermostatic radiator valves to all radiators; consider changing to larger radiators	TRVsallow all radiators to be set to sensible temperatures for each space and room; larger rads allow water to move more slowly around system requiring less powerful pump which uses less electricity	If radiators are turned down boiler will work less hard to keep property warm at desired temperature and gas consumption will be lower			**Not required**

APPENDIX 4

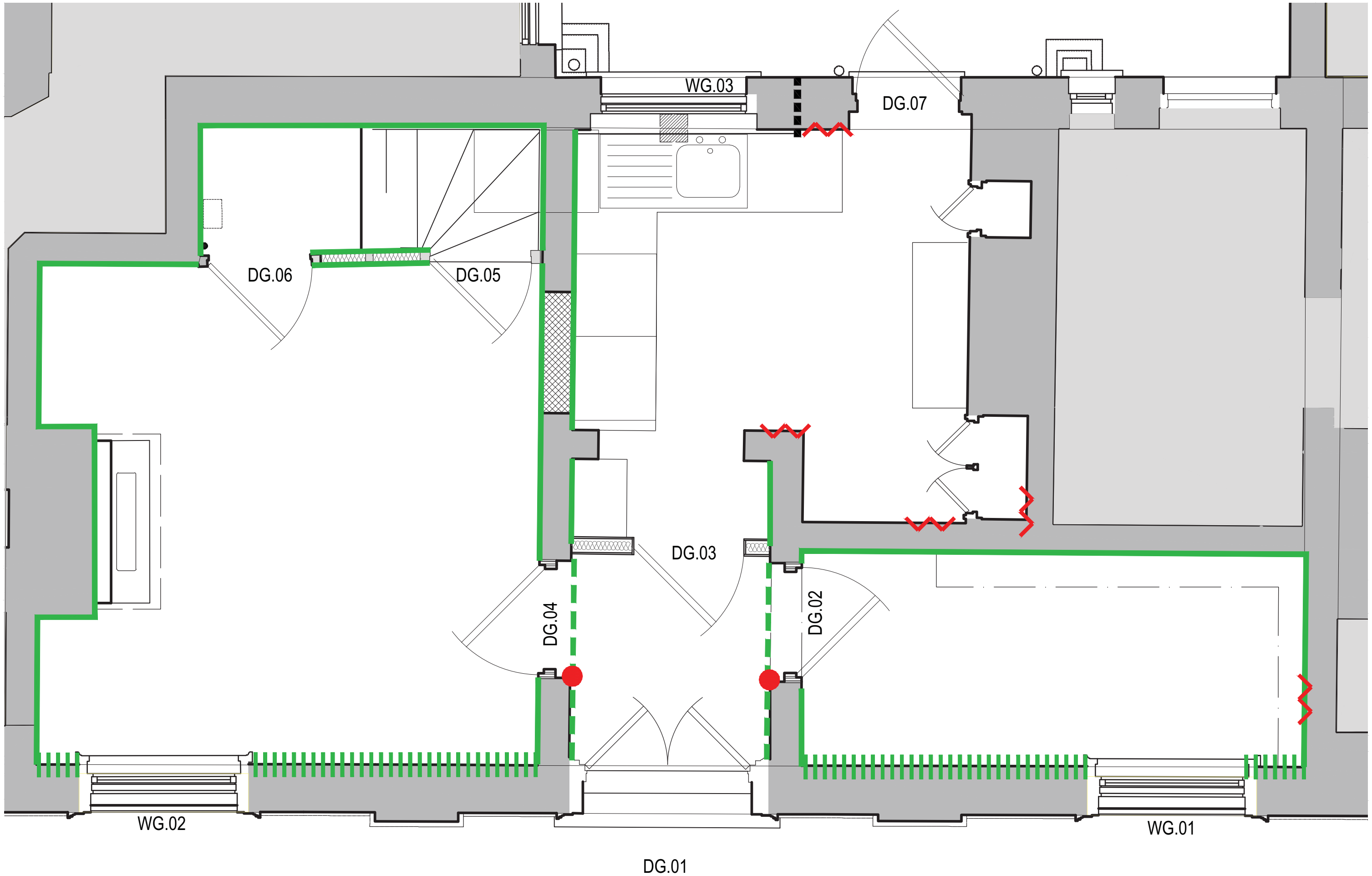
EWH/ EEDA

Carbon Cost Benefit Analysis

Proposal to reduce carbon dioxide emissions	Description	Aim	Energy reduction	CO_2 reduction	Cost: £s	Benefit analysis
ENVIRONMENT						
Grey water recyling	Collect rainwater run off from roofs into tank in roof space and fit water butt to bottom of RWP in rear garden	Use grey water in tank for flushing WCs and in water butt for watering plants	Consumption of potable water reduced thereby reducing energy required at sewage treament plant to treat foul water			**Not possible in this case**
Materials recycling	Encourage recycling at the property of paper, card, plastics and glass	To reduce quantity of general waster going in to landfill and production of quantity new materials for packaging	Reduction in CO2 generated by production of materials for packaging			**Already happening**
TRAVEL						
Encourage use of forms of transport other than private car	Encourage or provide incentives for use of bus, bicycles (install racks in stairwell if room), City Car Club (need rank nearby for this to work well)	Reduce dependence on use of private car by demonstrating efficency of other types of transport	Reduction in CO2 generated by private cars and reduction in parking areas required, some of which could be given over tp green spaces with trees			**Already happening, cycle use & car club**

KEY

Denotes works being done	(green)
Denotes works worth considering but less good than others or unmeasurable	(amber)
Denotes works not being done in this case	(red)



KEY:

- Crack repair to wall / plaster
- Joinery repair
- Localised repair
- Damp treatment
- New blockwork partition
- New stud partition with insulation
- New plasterboard
- New lime plaster
- New insulated plasterboard

INSTALLED MEASURES:

- Stabilisation of exiting historic structure to maintain use of residences
- Ventrolla draft proofing system to existing timber sash windows
- Insulation introduced to external walls and internal partitions
- New A rated boiler to supply central heating and hot water
- Existing historic features maintained and repaired

APPENDIX 4

Option		U-value	Cost (linings only)	Add. build-up	Average floor area lost	Comments
-	Existing	1.94	-	-	-	-
1A	Insulated Plasterboard	0.45	£60,890	65mm	4.4%	Lack of clear secure fixings for shelves etc
1B	Insulated Plasterboard	0.44	£68,212	85mm	6.5%	
2A	Multilayer Foil	0.42	£65,267	63mm	4.4%	Lack of clear secure fixings for shelves etc Not tested like a regular insulation material
2B	Multilayer Foil	0.41	£72,589	83mm	6.5%	Not tested like a regular insulation material
3	Aerogel backed Fermacell Board	0.43	£104, 618	41mm	1.8%	Unrestricted heavy fixings
4	Insulating Plaster	0.76 (0.45)	£56,513	40mm	1.8%	Unrestricted heavy fixings Partial insulation of window reveals possible Wet Trade

Case Study Example: Internal insulation options to upgrade an uninsulated occupied roof space with solid wall construction carried out by Purcell on a project located in central London

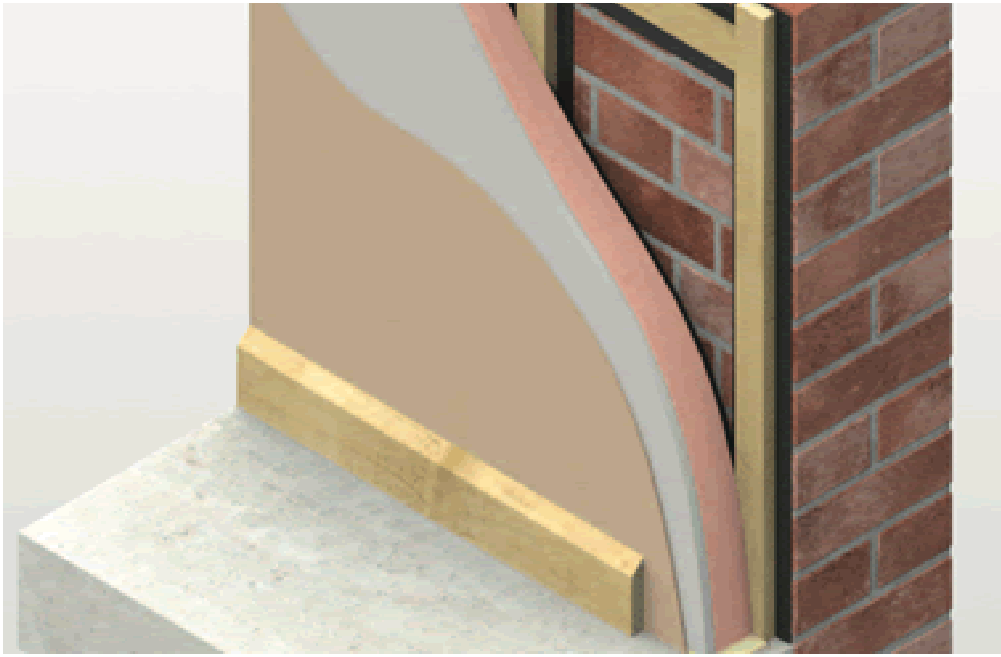
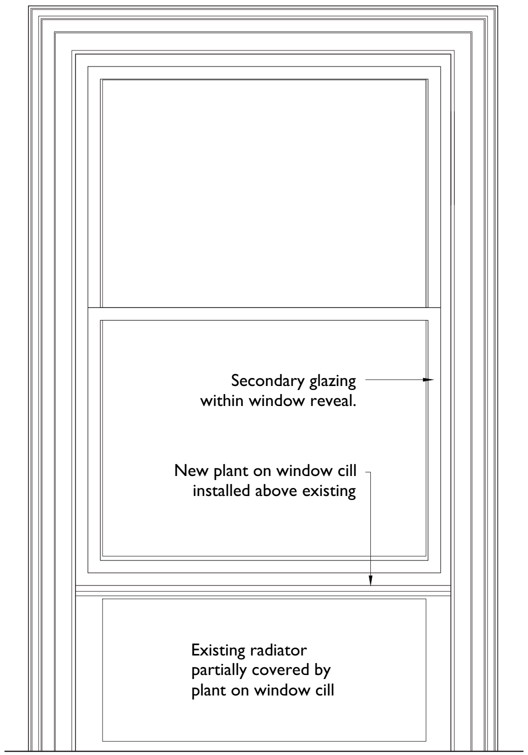
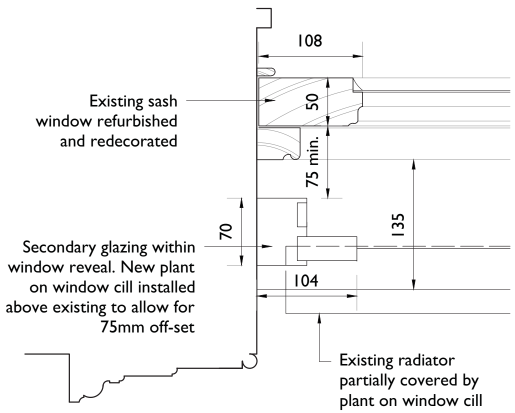


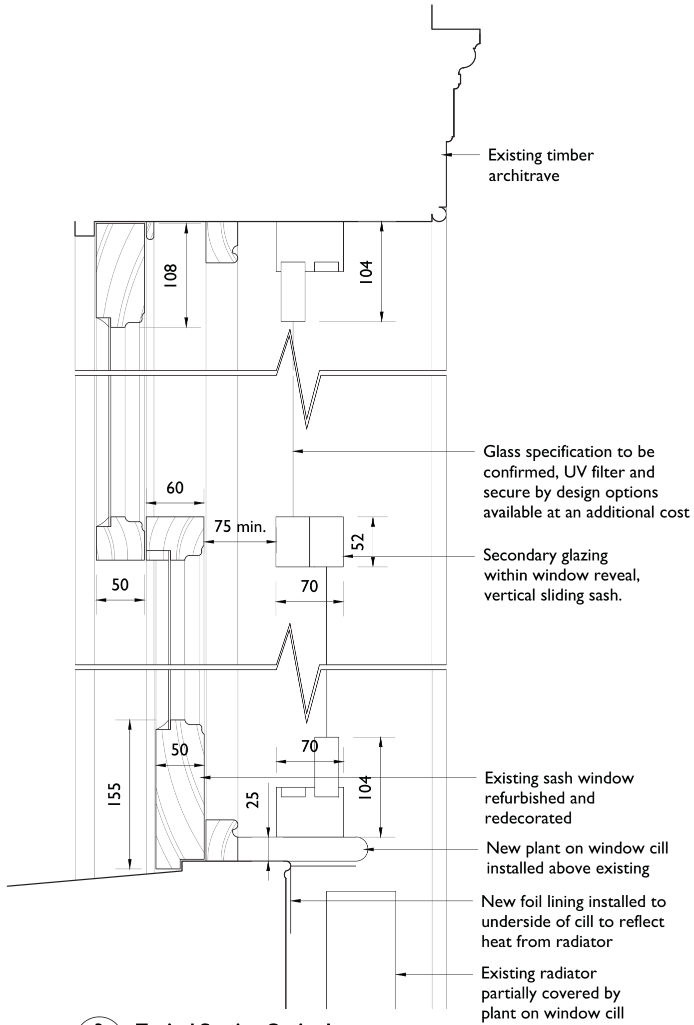
Diagram showing installation of internal wall thermal insulation



1
132
Typical Elevation Option 1
1:20



2
132
Typical Plan Option 1
1:5



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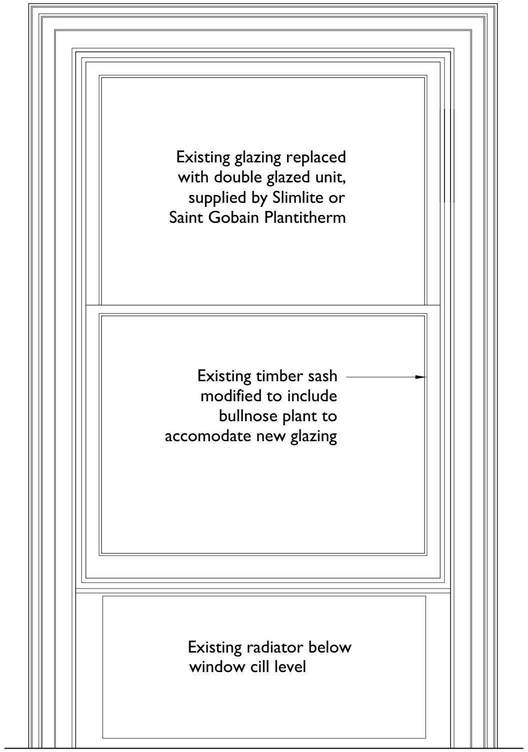
132
Typical Section Option1
1:5

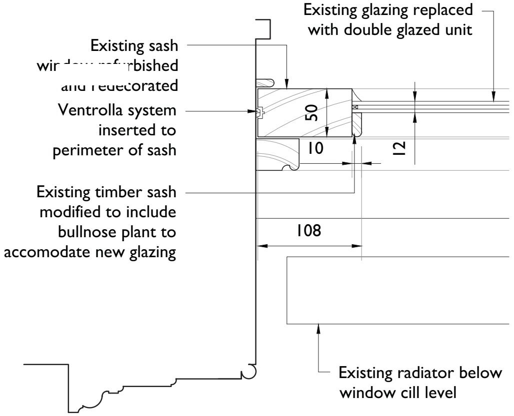
Option 1
- Installation of secondary glazing within window reveal by Selectaglaze.
- Overhaul of existing windows including redecoration.
- Projected costs - £48,000

Items to note
1. New cill to be installed over existing partially covering existing radiator.
2. Shutters to Office S1 to be sealed shut stopping possible use of security shutters. Existing blinds to be moved to edge of reveal.
3. Listed Building Consent required for alterations to cill and installation of secondary glazing.

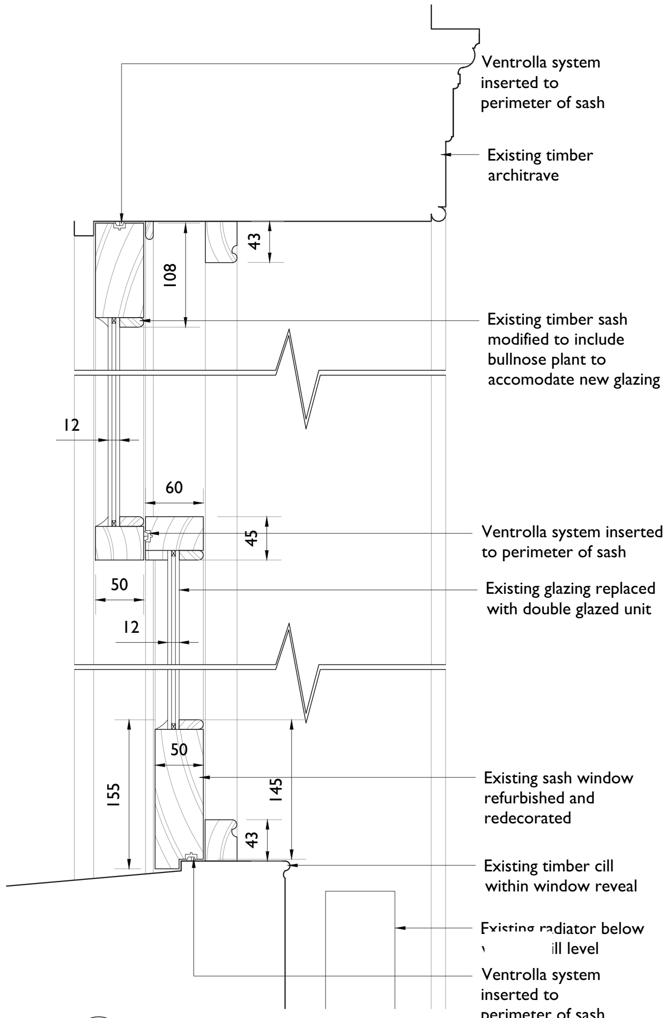
Example Purcell project comparison secondary glazing against slim double glazed units and draught proofing 2010



1 / 133 **Typical Elevation Option 2**
1:20



2 / 133 **Typical Plan Option 2**
1:5



3 / 133 **Typical Section Option2**
1:5

Option 2
- Replacement of single glazing with slim profile double glazed units supplied at 12mm thickness by Slimlite or Saint Gobain Plantitherm One.
- Installation of Ventrolla system to perimeter of sashes.
- Projected costs - £64,000

Items to note
1. Windows to be generally refurbished and decorated.
2. Option 2 is subject to investigation to ensure new weights can be installed to accommodate increased weight of glass.
3. Listed Building Consent required for alterations to window sash and installation of bullnose plant

Example Purcell project comparison secondary glazing against slim double glazed units and draught proofing