Step 4

Energy efficiency measures in heritage buildings

4. Energy efficiency measures in heritage buildings

After having explored all that can be done with the building through maintenance, and simple changes in the way the building is operated, there is a full range of low to high investment measures that can be implemented in a heritage building, with minimal disturbance to its historic fabric and features.

Before implementing any changes, it is advisable to go through the following checklist:

- **I have completed the *Building Heritage Assessment Template* in STEP 1 and the *Historic Building Health Check* in STEP 2 of this guide.**
- **The proposed energy-efficiency measures do not disturb or disturb very marginally the existing building fabric and its features.**
- **The proposed changes are reversible and will not damage the building's fabric.**
- **The proposed changes allow my building to "breathe" and to ventilate properly.**
- **I understand that some buildings or parts of buildings are of such quality, importance or completeness that they should not be altered, except in exceptional circumstances.**

The following table will give you an overview of the sort of technologies / measures that are generally compatible with historic buildings. Use the HEET website to understand which ones are most suitable for your building's age and construction.

In addition to a simple "happy, grumpy, neutral" face coding (**J L K**) to help you orientate among the potential heritage-compatible energy efficiency solutions for your building (which you will find in the HEET online), we have added a few extra information in this section if you want to know more.

Please note: the information contained in this guide and in the HEET online should not substitute the advice given by the Planning Office or an approved Conservation Specialist (a directory of approved professionals can be found on: http://www.ihbc.org.uk/). The following information is based on a typical domestic 3 to 4 bedroom property, either detached or semidetached. For non-domestic solutions, or for other sized properties, the ranges below should be proportionally increased or decreased.

Legend:

Heritage Impact: This is the likely impact the chosen retrofit option will have on the building's character as a whole.

Any change to an historic building should have the smallest possible impact, and be reversible. Special attention needs to be paid to the materials used in the retrofit, to ensure they do not compromise the "breathability" of the building.

Energy Efficiency: This is the capacity of the chosen retrofit option to reduce heat losses (which will lessen the need for using as much energy to heat the building and will improve comfort levels) and making the most out of the building's structure and existing elements to regulate the indoor temperature.

In this guide and in the HEET website a generic indication of High / Medium / Low energy efficiency is provided, as every product used will have a different performance. Specific energy efficiency data can be obtained from manufacturers or through a conservation specialist.

Initial Cost: This is the investment needed at the start to purchase and install the chosen retrofit option.

A few notes:

Some technologies are relatively cheaper to users than their actual market value due to subsidy schemes like Green Deal, Feed in Tariffs or the Renewable Heat Incentives, which are available at the time of writing (for more information visit: www.energysavingtrust.org.uk). Actual prices can be obtained from manufacturers and distributors. In Oxford HEET we have consider the market value of the technologies without taking into consideration subsidy schemes, however in the table below we have highlighted the most common technologies that can be subsidised by those.

We have considered the ratio value for money of the selected technologies; so, for instance, in the heating and energy generation sections, although many options' cost is in the order of thousands, they may be relatively more convenient than others that would not deliver the same results (from an energy saving / comfort point of view) at those prices, therefore we have marked them with a 'happy face'.

Ranges:

££ - between £0 and £99

£££ - between £100 and £999

£££££ - between £10,000 and £50,000

Time to Pay Back: This is the number of years needed to recover the initial investment, which is calculated by dividing the initial cost by the money saved every year after the installation of the retrofit option.

Ranges:

Short – up to 5 years

Medium – 5 to 10 years

Long – over 10 years

Building element	Retrofit Option	Heritage Impact	Energy Efficiency	Initial Cost	Time to Pay Back	Permission required	Things to consider
1. Walls							
Walls	Internal Insulation	**K** *Does the internal wall present special features that would be damaged or hidden by the works? Does it alter the internal character of the building? If not, than this is a neutral option.*	**K**	**L** **£££££**	**L** **Long**	Listed Building Consent	• Thick solid walls have already the capacity to absorb heat over time and release it relatively slowly as the surrounding cool down, which will have a stabilising effect to the indoor conditions. • Are the walls free from moisture/damp? • Loss of internal area • Make sure you minimise *cold bridges*, especially around windows and doors and at the junction between walls and floors • May be convenient when other, more effective solutions are not feasible • Only use vapour-permeable insulating materials (e.g. wood-fibre boards) • It may exacerbate existing condensation issues; not great insulating performance overall as it will only reduce short-term heat losses to the exterior, while isolating the indoor environment from the benefits of solid walls' thermal mass. • Subsidised insulation schemes may be available.
Walls	External Insulation	**L** *Would the insulation change the appearance of*	**K**	**L** **£££££**	**L** **Long**	Planning permission; Listed Building Consent	• Thick solid walls have already the capacity to absorb heat over time and release it relatively slowly as the surrounding cool down, which will have a stabilising effect to the indoor conditions.

Building element	Retrofit Option	Heritage Impact	Energy Efficiency	Initial Cost	Time to Pay Back	Permission required	Things to consider
		the building, and potentially alter its character, even when already rendered?					• Are the walls free from moisture/damp? • The increased depth of the external render will require adaptation of the roof and wall junctions, the repositioning of rainwater downpipes and potentially the repositioning of windows and doors; scaffolding access will be required. • Only use vapour-permeable insulating materials (e.g. wood-fibre boards, mineral wool, hemp-lime composites) with a moisture-permeable protective finish (e.g. lime render, tile rain-screen cladding) • It may exacerbate existing condensation issues; it will be more effective than internal insulation at keeping comfortable levels of warmth over the day/night heating and cooling cycles. • Subsidised insulation schemes are available
Walls	Cavity insulation *(where a cavity is present)*	**J**	**J**	**J** **£££/ ££££**	**J** **Short**	Listed Building consent	• Used from early in the Victorian period • Early cavity walls had a special bonding brick to connect the layers of bricks: this may be a potential moisture path and *thermal bridge.* If there is a bonding brick, the wall needs to be treated as a solid wall; therefore the cavity cannot be filled with insulation. Often this construction type is not easily recognisable from the outside; measurement of the wall thickness as well as a careful analysis of the construction needs to be carried out to ensure the wall has a continuous cavity • Subsidised cavity wall insulation schemes are

Building element	Retrofit Option	Heritage Impact	Energy Efficiency	Initial Cost	Time to Pay Back	Permission required	Things to consider
							available • May not be suitable for areas liable to driven rain
2. Roofs							
Pitched Roofs	Warm roof *(i.e. Insulation is placed underneath or in between the roof rafters, above the roof space, which is not ventilated, and vapour barrier is placed under the insulation)*	**K** *Does the ceiling finish present special features that would be damaged or hidden? If not, this is a neutral option.*	**J**	**J** **£££/ ££££**	**J** **Short**	**Listed Building Consent**	• Only advisable when already planning to replace the roof finish. • If the building has a vaulted or ornate ceiling this would have to be carried out as part of already planned roof replacement works top protect the special features. • Only use vapour-permeable insulating materials and keep ventilation patterns to prevent mould / condensation • Beware of cold bridges forming at junctions between roof and walls. • Subsidised insulation schemes are available • Sloping ceiling insulation: this must be applied from the underside retaining ventilation above.
Pitched Roofs	Cold roof *(i.e. Insulation is placed above or in the between the ceiling joists, with a ventilated roof space above it)*	**J**	**J**	**J** **£££**	**J** **Short**		• Subsidised insulation schemes are available. • The main risk of a cold roof is condensation caused by the warm air rising from the building below and meeting the cold air above the insulation layer. Condensation is prevented by using vapour-permeable insulating materials and by keeping ventilation patterns. • Maintain ventilation at eaves level (e.g. using soffit vents or tile vents) • Insulate water tanks in the loft space and

Building element	Retrofit Option	Heritage Impact	Energy Efficiency	Initial Cost	Time to Pay Back	Permission required	Things to consider
							pipework.
Thatched roofs	Insulating sarking boards in between rafters and/or above rafters	**J**	**J**	**J** **£££**	**J** **Short**		• To be considered as an option only if replacing thatch. • Many thatched buildings already provide adequate thermal performance; additional measures to improve the energy efficiency of thatched buildings should only be considered if strictly necessary and the measures do not compromise the traditional 'breathing' performance of the building. • Only use vapour-permeable insulating materials and keep ventilation patterns to prevent mould / condensation: where insulation would restrict the drying of the underside of the thatch it would accelerate rotting including a process known as "heat pumping" that draws moisture into the heart of the thatch.
Thatched roofs	Insulating sarking boards below rafters	**K** *Does the ceiling finish present special features*	**J**	**J** **£££**	**J** **Short**	Listed Building Consent	• To be considered as an option when not replacing thatch and when the internal finish is not of historical value. • Many thatched buildings already provide

Building element	Retrofit Option	Heritage Impact	Energy Efficiency	Initial Cost	Time to Pay Back	Permission required	Things to consider
		that would be damaged or hidden by the works? Does it alter the internal character of the building? If not, than this is a neutral option.					adequate thermal performance; additional measures to improve the energy efficiency of thatched buildings should only be considered if strictly necessary and the measures do not compromise the traditional 'breathing' performance of the building. • Only use vapour-permeable insulating materials and keep ventilation patterns to prevent mould / condensation: where insulation would restrict the drying of the underside of the thatch it would accelerate rotting including a process known as "heat pumping" that draws moisture into the heart of the thatch.
Flat Roofs	Insulation above existing structure	**K**	**J**	**J** **£££**	**J** **Short**	Listed Building Consent / Planning Permission (for the replaced roof)	• This would be an option if the roof covering is being replaced. • Attention to be given to the gaps between insulation and structure, through which moisture vapour can penetrate and condense; • Maintain ventilation patterns to avoid condensation and mould • The finished roof may be higher than the original, this may be an issue from a planning / listed building point of view, in which case this is would have negative impact on the heritage.
Flat Roofs	Insulation in between existing structure	**K**	**J**	**J** **£££**	**J** **Short**	Listed Building Consent	• Does the ceiling finish present special features that would be damaged or hidden by the works? Does it alter the internal character of the building? If not, this is a neutral option. • This is an option if the ceiling is not historical

Building element	Retrofit Option	Heritage Impact	Energy Efficiency	Initial Cost	Time to Pay Back	Permission required	Things to consider
							and can be / is going to be replaced, and when the roof covering is not being replaced. • Attention to be given to the gaps between insulation and structure, through which moisture vapour can penetrate and condense. • Maintain ventilation patterns to avoid condensation and mould • Ventilation is a vital part of flat roof systems, appropriate proprietary systems can be used which still allow ventilation.
Flat Roofs	Insulation below existing structure	**K** *Does the ceiling finish present special features that would be damaged or hidden by the works? Does it alter the internal character of the building? If not, this is a neutral option.*	**J**	**J** **£££**	**J** **Short**	Listed Building Consent	• This is an option if the ceiling is not historical and can be / is going to be replaced, and when the roof covering is not being replaced. • Attention to be given to the gaps between insulation and structure, through which moisture vapour can penetrate and condense; • Maintain ventilation patterns to avoid condensation and mould • Ventilation is a vital part of flat roof systems, appropriate proprietary systems can be used which still allow ventilation.
Dormer windows	Insulation between and/or above the rafters of the roof plus insulating board inside or outside the cheeks	**K** *Does the ceiling finish present special features that would be damaged or hidden by the works? Does it alter the internal*	**K**	**J** **£££**	**J** **Short**	Listed Building Consent	• Use vapour-breathable insulation • Special attention should be paid to the junctions of roof / cheeks / window for air tightness • Insulating the cheeks internally would only be an option if the finish is not of historical value.

Building element	Retrofit Option	Heritage Impact	Energy Efficiency	Initial Cost	Time to Pay Back	Permission required	Things to consider
		character of the building? If not, this is a neutral option.					
Rooflights	Renovate seals and draught-proof	**J**	**J**	**J** **£££**	**J** **Short**		• Periodic checking of draught-proofing system should be part of maintenance regime
Rooflights	Upgrade to a heritage-compatible, high performance new rooflight	**K**	**J**	**K** **££££**	**K** **Medium**	Listed building consent	• This option should only be considered when the existing rooflight is beyond repair and not of historical value. • Membranes and flashing must tie in with roof finish and sarking to optimise airtightness of fitting.
Chimneys	Permanent / temporary blocking up chimney e.g. chimney balloon	**J**	**J**	**J** **££ / £££**	**J** **Low**		• For permanent solution blockage should be made at low level, with a vent installed in the loft up to the pot. • Flue balloons can offer temporary draught restriction, as can wood burners over open hearths. • Need to consider ventilation to prevent internal condensation issues
3. Windows							
Windows	Draught-proofing	**J**	**J**	**J** **££/ £££**	**J** **Short**	0	• Prioritise repair of windows and doors before draught-proofing them. • Poorly fitting timber sash frames could cause

Building element	Retrofit Option	Heritage Impact	Energy Efficiency	Initial Cost	Time to Pay Back	Permission required	Things to consider
							major heat losses. • Periodic checking of draught-proofing system should be part of maintenance regime • Not as effective in leaded windows, where heat losses can also come from around the lead. • Before draught-proofing, a fan pressurisation test may be needed to identify the extent of air infiltration and to locate draughts, although older buildings need a certain degree of ventilation and cannot be expected to be completely air tight.
Windows	Secondary glazing	**J** *Would the sight-line be affected?*	**J**	**K** **££££**	**J** **Short**	Listed Building Consent	• Carefully designed and installed secondary glazing is an option that has a low heritage impact and is easily reversible. • Heat losses from a window could be reduced by over 60% by using secondary glazing with a low emissivity (low-E) hard coating facing the outside. • An additional benefit is the reduction of transmitted noise. • When secondary glazing is the preferred option, draught-proofing should not be applied to the original window to allow ventilation and therefore avoid condensation.
Windows	Reinstate missing shutters or use thick curtains	**J**	**K**	**K** **££££**	**L** **Long**		• Main use would be at night. • Can restrict natural light. • Not as effective as other solutions.
Windows	Vacuum, thin-profile double	**K**	**J**	**L**	**K**	Listed Building Consent	• This is a very innovative product developed especially for historical buildings. It has the

Building element	Retrofit Option	Heritage Impact	Energy Efficiency	Initial Cost	Time to Pay Back	Permission required	Things to consider
	glazing *(in original frames, where possible)*			**£££££**	**Medium**		energy efficiency performance of an ordinary double glazed unit with the slim profile of single glazing. • Balance needs to be struck between historic value and best possible U-Value. • Replacement of the window or historic glass should only be considered when the original windows have no historical value and are obviously beyond repair.
Doors	Draught-proof and add thick curtain	**J**	**J**	**J** **£££**	**J** **Low**		• Curtains' main use would be at night • Can restrict natural light
4. Floors							
Solid Ground Floors	Insulating layer below earth floor under bricks, stone flags or decorative floor tiles; consider underfloor heating	**J**	**J**	**K** **£££/ ££££** *If installing underfloor heating*	**K** **Medium**		• Heat loss through solid floor is significantly less than from other elements. Unless the floor is in poor conditions and needs to be taken up or re-laid, it may be better to focus on measures that will give greater benefits. • If the works imply already lifting stone floor, vermiculite or clay beads can provide an insulating layer below bricks, stone or flags • If earth or stone floors have no damp proof membrane, then any measure adopted must retain the breathable qualities of the original floor system. • Need permeable but water resistant system • Consider underfloor heating with lime concrete insulation underneath, and a permeable floor finish (original or sympathetic replacement)

Building element	Retrofit Option	Heritage Impact	Energy Efficiency	Initial Cost	Time to Pay Back	Permission required	Things to consider
Timber Ground Floors	New heritage-compatible flooring to modern standards	**L**	**J**	**K** **££££**	**K** **Medium**	Listed Building Consent	• Only where existing suspended timber flooring is beyond repairs
Timber Ground Floors	Vapour-permeable insulation	**J**	**J**	**J** **£££**	**J** **Low**		• Lift boards and place vapour-permeable insulation suspended in netting between joists • If the flooring is accessible from underneath (e.g. from a basement) can place vapour-permeable insulation tight-fit in between joists with, if needed, additional vapour-permeable insulation board below • Marginal cost when plumbing / other works are already planned
Timber Ground Floors	Draught-proof gaps between boards	**J**	**J**	**J** **£££**	**J** **Low**		• Good, affordable option where gaps in flooring have been identified as a major source of heat loss
5. Heating							
Heating	A or better rated mains Gas Boiler	**J**	**J**	**K** **£££/ ££££**	**J** **Low**		• Consider replacement when existing system is Oil / LPG / Electric Convection / Electric Storage / Solid Fuel systems / old gas boiler (rating E or worst) • Consider also installing heating controls: many types of programmers are now available, some with software applications for controlling remotely to adjust settings if circumstances/diaries change. • A shorter or longer pay back will depend on the system that this new technology is

Building element	Retrofit Option	Heritage Impact	Energy Efficiency	Initial Cost	Time to Pay Back	Permission required	Things to consider
							replacing. It will also depend on how big your property is and on how well it is insulated.
Heating	Electric Storage Heaters	**K**	**J**	**J** **£££**	**K** **Medium**		• Not a renewable energy source, it still use electricity to run but it stores thermal energy during the evening, or at night, when base load electricity is available at lower cost, and releases the heat during the day as required.
Heating	Wood-Fuel Heating	**J**	**J***	**K*** **££££**	**J*** **Short**	Planning Permission, Listed Building Consent	• A shorter or longer pay back will depend on the system that this new technology is replacing: for instance if you replace a gas heating system with a wood-burning system you might save £100 a year, but if you are replacing electric heating you could save as much as £580 per year *(source: Energy Saving Trust*). It will also depend on how big your property is and on how well it is insulated. ** Assume a log stove replacing electric heating in a well insulate property.* *Consent would be required especially if a new flue is required.*

Find out more:

- **English Heritage – Energy Conservation in Traditional Buildings:** www.english-heritage.org.uk/publications/energy-conservation-in-traditional-buildings/
- **Energy Efficiency and Historic Buildings: Application of Part L – English Heritage:** www.english-heritage.org.uk/publications/energy-efficiency-historic-buildings-ptl/

- **Energy Saving Trust:**
- www.energysavingtrust.org.uk/

- **City of Westminster – Retrofitting historic buildings:**
  http://www.westminster.gov.uk/services/environment/greencity/retrofitting-historic-buildings/

- **Society for Protection of Ancient Buildings – U-values research:**
  http://www.spab.org.uk/media-centre/press-releases/press-release/?ContentID=172

- **IHBC Guide: A Stitch in Time:**

  http://www.ihbc.org.uk/publications/stitch/stitch.html