INDUSTRY INSIGHT

BBP | BETTER BUILDINGS PARTNERSHIP

MINIMUM ENERGY EFFICIENCY STANDARDS AND HERITAGE PROPERTIES

Mitigating risks through the procurement and interpretation of Energy Performance Certificates

MAY 2018

Executive Summary

The introduction of Minimum Energy Efficiency Standards (MEES) has significantly raised the importance of Energy Performance Certificates (EPCs) for commercial property owners, with EPC ratings now having a direct impact on leasing and investment decisions.

The regulatory requirements of MEES impact all commercially rented property. However, heritage properties are arguably one of the most affected property types as studies suggest that older properties typically have poorer EPC ratings.

In order to comply with MEES, heritage properties across the country will require improvement works to upgrade their EPC ratings. However, specific challenges exist for commercial owners of heritage properties. Heritage properties differ significantly from modern buildings in terms of their design, materials and construction method. Upgrading them requires special expertise and consideration. Yet, the current EPC methodology is designed with modern construction methods in mind and does not always accurately take into consideration the traditional characteristics of heritage properties or recommend the most appropriate improvement measures.

This is not to say that heritage properties should be ignored. In fact, significant improvements in energy efficiency and carbon reductions can be achieved and aspired to within most heritage properties. For example, Grosvenor Britain and Ireland, whose portfolio contains a significant proportion of heritage properties, has the ambitious aim to reduce carbon emissions by 50% across its directly managed London estate portfolio by 2023. It has also implemented a very efficient retrofit program that extends to the highest environmental certification targets (EnerPhit PassivHaus and BREEAM).

Compliance with MEES does, however, pose a genuine risk to commercial owners of heritage properties. The installation of inappropriate improvement measures can result in unintended consequences that compromise the historic value of these properties, as well as cause physical damage.

The following steps are recommended to reduce these risks:

1. **Get to know your property:** collating as much information as possible regarding the fabric, roof and systems will provide energy assessors and consultants with the evidence required for them to deliver an accurate and high-quality EPC.

2. **Select an energy assessor with experience of heritage properties:** reviewing their knowledge, experience and ability to outline a bespoke approach that addresses limitations within the EPC methodology when assessing heritage properties.

3. **Review the EPC carefully:** before committing to any improvement works, assess the quality of the EPC by checking that key information is correct. For example, main building characteristics, the inclusion of historic renovations, the software model used and the number of default values applied.

4. **Select appropriate improvement measures:** it is likely that almost all heritage properties can benefit from energy efficiency improvement measures that do not harm the property's historical and architectural value. Whilst specialist advice is recommended, the risk of damage can be reduced by starting with low-cost, non-intrusive retrofitting works, followed by building services, before finally approaching building fabric improvements.

A balance between historic conservation and necessary improvements is required when upgrading heritage properties. It is hoped that this guidance supports commercial property owners in taking the simple steps towards compliance with MEES, whilst simultaneously taking into consideration the special requirements of heritage properties and limiting any potentially adverse damage.

Introduction

Heritage properties represent a significant proportion of the UK's building stock, with estimates suggesting 25% of buildings were built before 1919.[1] Yet, this property type is becoming increasingly at odds with evolving environmental legislation and perceived market standards. This is exemplified by Minimum Energy Efficiency Standards (MEES) where, since April 2018, all private rented properties are required to meet an Energy Performance Certificate (EPC) rating of E or better in order to be let.[2]

EPCs are, therefore, becoming increasingly important performance indicators for commercial property owners of heritage properties, which directly affect investment and leasing decisions. Moreover, given that evidence suggests historic properties are amongst the worst performing in terms of EPC ratings, their significance only increases further. In a study looking at domestic EPCs in the UK, only 6% of dwellings built before 1900 had an EPC rating of C or better and over half of dwellings built before 1929 have an EPC rating of E or worse.[3]

In order to comply with MEES, heritage properties across the country will require improvement works to upgrade their EPC ratings. However, it needs to be appreciated that these properties provide unique social and cultural value in terms of their historical and architectural significance. Their construction also differs significantly from modern construction, using different materials, construction methods and design. As a result, there is a significant risk that works undertaken could have unintended consequences that compromise the historic value of these properties and cause physical damage.

The challenge is to ensure the right balance between historic conservation and necessary improvements when upgrading heritage properties to modern environmental performance standards, so as to avoid lasting damage to both the property's significance and fabric.

Contents

What is a Heritage Property?

For the purposes of this document, the term 'Heritage Property' refers to the Sustainable Traditional Buildings Alliance (SBTA) definition of *'a property that is generally of solid wall or solid timber frame construction, built before 1919'*. Typical construction features also include single glazed windows and no damp-proof course.[1]

For clarity, the phrase does not relate to a property's status in terms of being listed or situated in a conservation area. Additionally, the focus of the document is on non-domestic heritage properties, however, reference is made to domestic properties where relevant.

This Industry Insight has been developed to support commercial property owners in mitigating these risks and ensure the retrofit works undertaken in response to MEES are appropriate and sensitive to the special demands of heritage properties.

EPCs and Minimum Energy Efficiency Standards – a Brief Summary

Energy Performance Certificates

An Energy Performance Certificate (EPC) provides an energy efficiency rating for a property based on the predicted performance of the building geometry, fabric and services. The rating allows different properties to be compared based on their theoretical energy efficiency performance. Ratings are graded from A (best) to G (worst) and include a numerical score. Separate methodologies exist for non-domestic and domestic properties. It is important to note that, unlike Display Energy Certificates (DECs), EPC ratings do not reflect actual operational energy performance.

EPCs are required by law when a property is built, sold or let under the Energy Performance of Buildings (England and Wales) Regulation 2007 and are valid for a period of 10 years. In addition, new EPCs are also required following any major retrofits or extensions that involve space heating. All EPCs must be carried out by an accredited assessor.

An EPC includes:

- Information about a property's regulated energy consumption and typical energy costs.
- Recommendations on how to improve the energy performance of a property and the estimated payback period of each measure suggested by the assessor.

Where to find your property's EPC?

EPCs for properties in England & Wales can be sourced via their respective national registers:

Domestic: www.epcregister.com

Non-Domestic: www.ndepcregister.com

For properties in Scotland visit:
www.scottishepcregister.org.uk

How are Energy Performance Certificates produced?

Energy Performance Certificates are produced by accredited assessors and lodged on a national register. Commercial Energy Assessors (CEA) use the Simplified Building Energy Model (SBEM) to undertake non-domestic assessments; whereas Domestic Energy Assessors (DEA) use the Standard Assessment Procedure (SAP) to calculate the Energy Performance Rating of residential properties. Assessors get access to the approved methodologies and are able to produce EPCs through Government approved software tools: iSBEM, or other Government approved Dynamic Simulation Modelling software, for non-domestic properties and RdSAP for domestic.

Irrespective of property type, all EPCs are produced in a similar format and follow a process designed to facilitate a swift and consistent assessment across as broad a segment of the UK building stock as possible. A rating system is provided to allow comparison between the energy performance of different properties.

To produce EPCs, assessors are required to:

- Conduct a site survey and collect all relevant information, such as photos and measurements of building services and building construction materials etc.
- Analyse the collected information and identify the internal dimensions, layout, zones, usage, etc.
- Enter the information into a Government approved software tool (e.g. RdSAP / iSBEM).
- Follow the National Calculation Methodology (NCM) and formal conventions guidance for all the energy modelling assumptions.

To ensure the veracity of registered EPCs, all assessors are exposed to occasional quality checks, performed by Government approved certification schemes, on a random sampling of lodged certificates.

Are Listed Buildings exempt from Minimum Energy Efficiency Standards?

Whilst not the focus of this report, there are also heritage properties that will have a listed status. Such properties will require additional considerations when assessing compliance requirements and any potential improvement works.

There is a common misunderstanding that all listed properties are exempt from requiring an EPC and, in turn, from meeting requirements set under MEES. The Department for Business, Energy & Industrial Strategy's recently published guidance for non-domestic properties[5] states: *"Listed properties, and buildings within a conservation area, will not necessarily be exempt from the requirements to have a valid EPC and it will be up to the owner to understand whether or not their property is required to have an EPC". "Where character or appearance would not be altered by compliance with energy performance requirements, an EPC may be legally required".* This clearly places the 'burden of proof' for exemptions on the shoulders of the property owner, and expert advice should be sought in cases of uncertainty.

Additional information on Minimum Energy Efficiency Standards

- The Private Rented Property minimum standard – landlord guidance (for properties in England & Wales).
- S63-001 - Improving Energy Performance and Emissions in existing Non-Domestic Buildings – a guide for owners (for properties in Scotland).
- RICS Minimum Energy Efficiency Standards (MEES) Impact on UK property management and valuation.
- BBP Acquisitions Sustainability Toolkit.
- Sustainability Bites? The impact of Minimum Energy Efficiency Standards on real estate lending.

Minimum Energy Efficiency Standards

For properties in England & Wales, Minimum Energy Efficiency Standards (MEES) make it unlawful to let residential or business premises that do not reach a minimum energy efficiency standard of EPC rating E. From 1st April 2018, landlords of privately rented domestic and non-domestic property must ensure that their properties reach at least an EPC rating of E before granting a new lease to new or existing occupier. These requirements will then apply to all private rented properties (i.e. existing leases) from 1st April 2020 for domestic properties, and from 1st April 2023 for non-domestic properties.

MEES Regulations apply to all properties that legally require an EPC, however, an exemption register is available for properties that can demonstrate that achieving the Minimum Energy Efficiency Standard is not economically feasible or would be detrimental to the property. It should be noted that for properties in Scotland, regulations are different, whereby from October 2016 all new leases and lease renewals over 1,000m^2 are required to meet 2002 Building Regulations.

As a result of MEES Regulations, understanding EPC ratings and identifying the suitable measures to achieve compliance is becoming an essential task for commercial property owners, as failure to do so can:

- Negatively impact on property values.
- Increase void rates.
- Require capital expenditure to ensure compliance.
- Result in legal sanctions and non-compliance penalties.[4]

With research indicating that older properties have poorer EPC ratings, the issue is even more pertinent for owners of heritage properties.

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Challenges

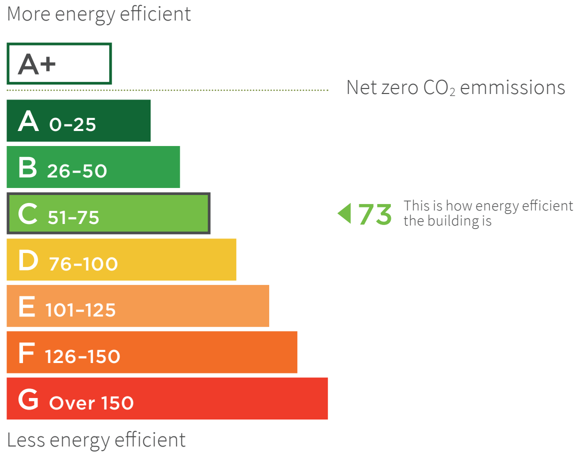
The introduction of Minimum Energy Efficiency Standards (MEES) has raised the importance of Energy Performance Certificates (EPCs) for commercial property owners. Therefore, it is important owners are aware of the limitations that can impact the EPC ratings of heritage properties, and how to implement risk mitigation strategies to ensure accurate and reliable results that support informed decision making.

Gaining accurate information on building characteristics

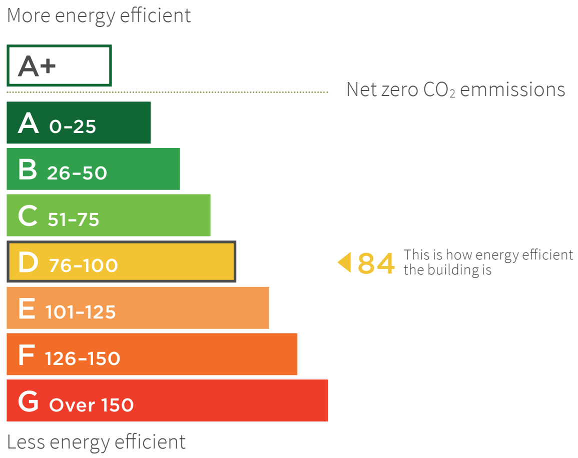
In the absence of adequate information, knowledge and evidence of building elements, EPCs are typically produced by using the default values provided by the EPC calculation software. These default values assume a 'worst case' scenario. For example, two different EPCs of the same property are provided in Figure 1.

Figure 1: Comparison of EPC ratings using actual and default lighting specifications.

EPC 1, produced by entering the correct specification of LED lighting, has a rating of C (73).



EPC 2, produced by entering the default LED values, assuming the assessor did not obtain any additional information besides what was available during the site survey, has a rating of D (84).



Energy assessors should acknowledge the key measures that will impact the EPC rating and request and collect evidence to back up any assumptions made during the site survey. Failure, however, to provide evidence can significantly affect the overall EPC rating. Furthermore, the prevalent use of default values to estimate energy performance is likely to give a much worse reflection, and therefore rating, than is actually the case.

This is relevant for all EPC assessments, irrespective of property type, however, there are two main reasons why heritage properties are at a greater disadvantage.

- Firstly, given the age of the property, detailed records of construction methods and materials used can be much more challenging to evidence than those of modern construction methods.

- Secondly, the default values used within the calculation methodology are based on the year of construction of the property, and the assumptions used for older buildings are worse than for modern ones. In practice, this is not always true. In fact, research by the STBA states that default U-values assumed within the EPC methodology tend to overestimate the amount of heat loss from traditional walls.[6]

Specific assumptions that are automatically applied to the EPC methodology for heritage properties (i.e. selecting a year of construction before buildings regulations) that commercial property owners should be aware of include:

- All ground floors are suspended timber and unsealed, unless an alternative is specifically selected by the assessor.

- The building envelope has poor levels of air-tightness. i.e. significant heat leakages through floor, roof and walls.
- No draught proofing for doors and windows.
- Timber-framed walls are un-insulated but well-sealed.
- External elements (walls, floor and roof) in all buildings constructed before 1900 have the same thickness and U-Value.
- No walls are made of earth.

Whilst the above illustrate constraints within the EPC methodology, commercial property owners can help reduce this uncertainty by providing relevant information to the assessor at the point of instruction.

It is in owners' interests to ensure that information on previous improvements to the property are complete and available, in order to reduce the use of default values, especially if those works are not visible in a site survey. Insulation is a good example; even though it might be present in the property, the assessor will not be able to include it in the software calculation unless evidence can be provided.

To support this process, a summary of the documentation that could be provided by the owner to an EPC assessor at the time of instruction is provided in Appendix 1.

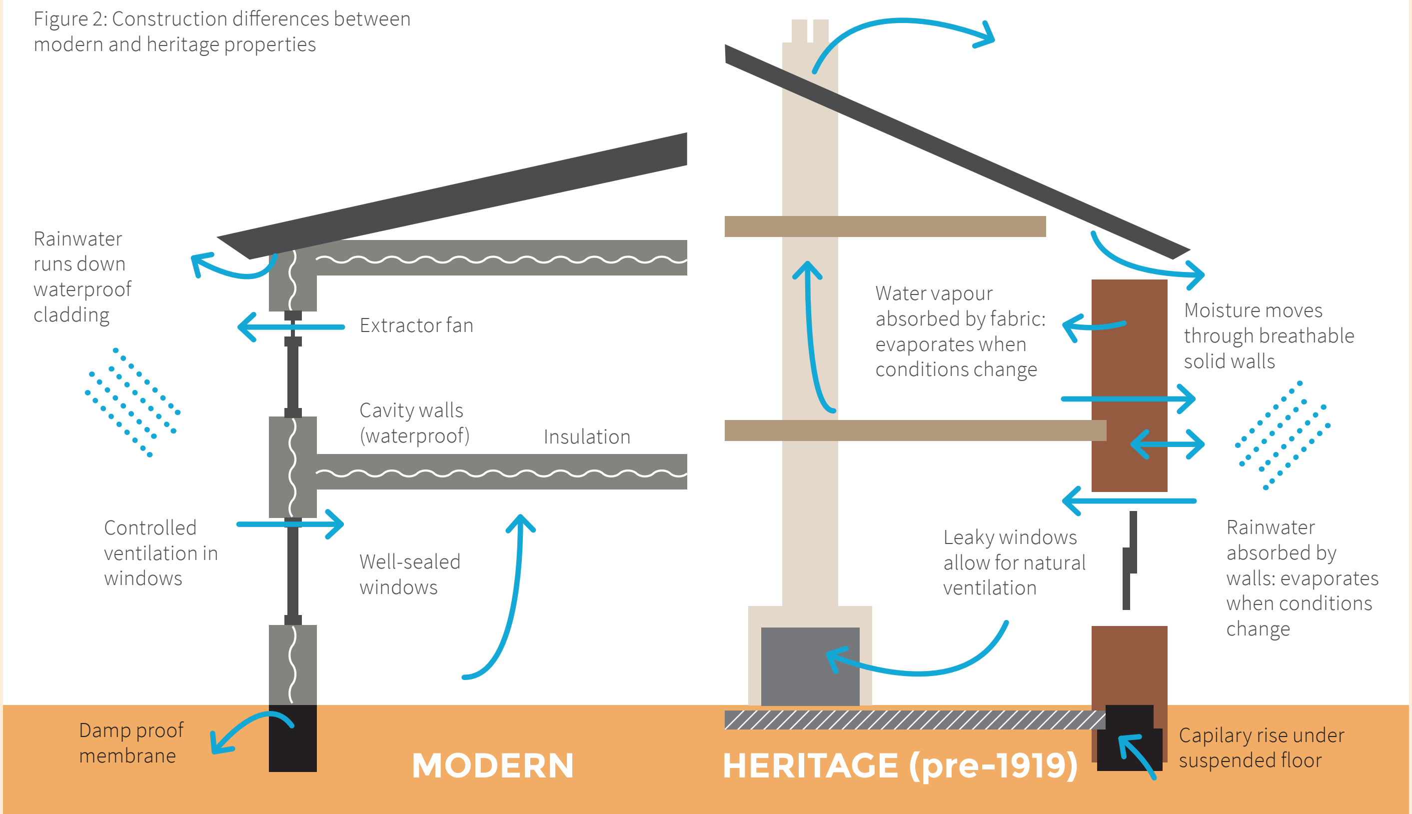
Finding energy assessors that have skills specific to heritage properties

Government approved certification schemes do not provide special assessor training that highlights the typical construction techniques and materials used within heritage properties. Therefore, it is important for any commercial property owner to ensure an assessor has sufficient knowledge and experience of traditional construction methods to ensure they enter appropriate variables into the software and will consider sensible recommendations.[7]

Recognising heritage construction techniques

Heritage properties often have characteristics that challenge contemporary technical interpretations of energy efficiency. For example, most of them are not insulated and have a high rate of air permeabilty, but are built using high-quality construction techniques and heavy thermal mass materials that are designed to breathe. In contrast, modern buildings are very well insulated and use mechanical ventilation to control moisture. Figure 2 below shows the main differences between modern and heritage properties.[8]

Figure 2: Construction differences between modern and heritage properties



Source: adapted from The National Trust[8]

Current SAP and SBEM methodologies do not fully recognise the impact of thermal mass and breathability on building performance; they encourage ambitious U-values and air-tightness. In other words, EPC ratings strongly depend on the level of insulation included in the building while the positive thermal benefit of heavy thermal mass walls is disregarded.

The current EPC methodology underestimates the performance of elements like solid walls and breathability and reduces the accuracy of EPC ratings of heritage properties.

The embodied carbon[9] of the property is also left out from the scope of the EPC assessment, ignoring the fact that maintenance and retention of fabric will provide tangible benefits; something that is also related to contemporary practice of carbon reduction and sustainability (see RICS Professional Statement: Whole Life Carbon measurement; implementation in the built environment).[10]

Untailored and potentially detrimental recommendations

EPCs include a set of recommendations that can enable owners to improve the rating of properties. These recommendations are standard sets of measures included in the methodology database, classified into three categories: short, medium or long-term payback.

Based on the year of construction of the property and the building characteristics, the software provides a list of relevant measures for an assessor to choose from. For example, if a property has cavity walls, 'solid wall insulation' as a measure will be excluded from the recommendation choices provided by the software. It should be noted that domestic assessments do not provide the opportunity for tailored recommendations; even if there is the need to include a specific non-standard suggestion.

Heritage properties are often thought to be draughty and energy inefficient, but they can vary greatly in their energy performance depending on how they are constructed, refurbished and maintained. Current standards and building regulations aim to reduce fabric heat losses by insulating solid walls and improving the performance of building services, yet not all are relevant or encourage the most appropriate course of action for heritage properties. For example, insulating a heritage property may not be the right approach, and it can be a very high-risk measure to install without using the correct materials and procedures. It can cause significant damage to the property by reducing air permeability, increasing condensation risk and the potential for detrimental effects on the internal environmental conditions.

EPCs also give a low weighting to activities and improvements that could benefit heritage properties without harming their historical character, such as secondary glazing or draught-proofing. In addition, they do not include any indications on how major improvements should be implemented to avoid detrimental outcomes. It is essential that adaptations made to improve the energy efficiency of a heritage property take into account the traditional construction methods and characteristic behaviour of the building fabric to avoid serious damage and unintended consequences.

For further details, an analysis of the main heritage property characteristics is provided in Appendix 2, and a risk analysis of the main EPC recommendations for domestic and non-domestic heritage properties are provided in Appendix 3 and Appendix 4 respectively.

Recommendations

The primary objective of Energy Performance Certificates and Minimum Energy Efficiency Standards is to improve the energy performance of buildings, yet there are many associated challenges for heritage properties, as highlighted in the previous section. The following recommendations are provided for commercial property owners to support them in overcoming those challenges and identifying the most appropriate measures to meet compliance requirements.

GET TO KNOW YOUR HERITAGE PROPERTY

In assessing risks associated with Minimum Energy Efficiency Standards, it is recommended that a new, thorough EPC assessment is undertaken. However, before even appointing an energy assessor to carry out an assessment, the first step for any commercial property owner, and their advisors, is to review the information they hold regarding the key architectural and physical features of the property and assess whether knowledge gaps exist.

The key features that property owners should have a firm understanding of, and evidence base for, are laid out below. For further detail, a summary of the characteristics typically found within heritages properties is provided in Appendix 2. If additional information and evidence is needed, third party support in undertaking relevant building surveys may be required.

External walls

Heritage properties are typically made of solid masonry or solid brick walls with high levels of air permeability. To be able to determine the wall type, the thickness and the material of external walls has to be assessed.

Heritage buildings with solid walls usually have the following technical characteristics:

- **Heavy thermal mass:** Solid walls have heavy thermal mass elements that are able to absorb heat during daytime and release it later when temperatures drop. They typically take a longer time to heat up, but are able to release heat internally for a longer period compared to materials with a low thermal mass.
- **Low thermal resistance:** Insulation materials provide good thermal resistance and minimise heat losses. Building elements in heritage properties are usually not insulated, and therefore, have lower thermal resistance figures than insulated modern buildings. This causes them to lose space heating at a greater rate than modern buildings do and require a higher heating demand.
- **Good vapour permeability:** Solid masonry and brick walls typically have good vapour permeability factors and therefore, allow moisture to pass through and evaporate. Adding a new layer of insulation that creates a vapour resistant barrier can cause condensation and damage the building elements.

Roof

There are a variety of roof structures and cladding materials that can be found in heritage properties. Since most heat losses occur through the roof, identifying the shape, makeup and covering material is essential for the assessment. Flat roofs covered with metal or zinc, pitched roofs with timber truss structure and mansard or thatched roofs are all commonly found in heritage properties.

Windows

Windows are usually key architectural features of heritage properties. The framing material, glazing type and opening mechanism of a window can significantly affect both the architectural value and the thermal performance of a property.

Single glazed timber sash window, steel or cast-iron side-hung casement windows are commonly found in heritage properties. These windows do not perform to modern construction standards due to their high thermal transmittance and low air-tightness.

Replacing or altering the original conditions of windows will most likely require the approval of planning regulatory bodies.

Building Services Systems and Lighting

Unlike building envelope elements, building services systems (e.g. HVAC) and lighting may not be those originally installed and may have been replaced several times. However, a clear understanding of the source of energy for heating, cooling, hot water and lighting is essential for the assessment.

SELECT THE RIGHT ASSESSOR AND PROVIDE THEM WITH DETAILED INFORMATION

When undertaking a new EPC assessment, to assess MEES risks or to comply with legal requirements, before appointing an energy assessor, check their expertise and ensure that they have sufficient knowledge and experience in surveying and assessing heritage properties. Some helpful areas where questions could be posed include:

- Their primary built-environment background i.e. professional, technical, building surveyor, construction industry, product manufacturer, etc.
- Their knowledge of heritage properties e.g. ability to describe the main characteristics of traditional construction.
- Period of experience producing EPCs.
- Direct experience of assessing heritage properties.
- Their ability to outline the bespoke approach needed when undertaking EPC assessments for heritage properties and how limitations within the methodology can be most appropriately addressed.

When selecting a preferred energy assessor, it is the responsibility of the owner to provide as much detail and evidence as possible to allow the assessor to produce an accurate assessment. Appendix 1 provides a list of the key parameters that can affect an EPC rating and examples of documentation that could be provided by owners as supporting evidence.

REVIEW THE EPC CAREFULLY

Once an EPC has been produced, it is recommended that the EPC is reviewed carefully and checked to ensure that key information is correct, before commissioning any improvement works. Key items to review include:

- **Property details:** e.g. address, floor area, location in the building (in the case of flats, offices and retail units). Failure for such basic information to be correct may raise questions regarding the overall quality of the rest of the assessment.
- **Main heating fuel identified:** This item has one of the greatest overall impacts to an EPC rating.
- **Main building characteristics:** e.g. wall type, windows, roof, etc.
- **All improvements and changes carried out since the building was originally built have been included:** e.g. additional insulation.
- **The software model used:** For the purposes of producing an EPC certificate, commercial buildings are divided into three levels - Level 3, Level 4 and Level 5. The level which a property falls under will be determined by the sophistication and complexity of the building envelope, installed HVAC systems and services. EPCs for small to medium sized buildings (Levels 3 and 4) can use a Simplified Building Energy Model (SBEM) whilst Level 5 buildings require the more comprehensive Dynamic Simulation Model. It is important to check the EPC certificate to ensure that the software package used was appropriate for the property in question.
- **Level of default values used:** As part of the EPC assessment, specify that a summary sheet outlining modelling assumptions and the number of default values used are provided by the assessor. Higher levels of default values used will result in a less accurate assessment and, typically, a poorer rating.

SELECT APPROPRIATE IMPROVEMENT MEASURES

It is probably true to say that most heritage properties can benefit from energy efficiency improvements that do not harm the building's historic interest; however, professional advice must be obtained to reduce the risks of incurring unintended damage from improvement works. Rather than starting with building fabric improvements, it is first recommended that property owners and their consultants begin by considering maintenance activities and non-intrusive retrofitting works, as outlined in the order below. A best-practice example of what can be achieved when retrofitting a heritage property is demonstrated in the case study of 13 Adams Row EnerPhit retrofit on p14.

Maintenance activities

Heritage properties require regular maintenance works. Cracked external walls, leaky windows and/or poorly maintained mechanical plant can significantly increase the running costs of a building. Although maintenance works will not directly affect the EPC rating, they will increase the life expectancy of the property. Before undertaking any major retrofitting works, consider the following maintenance tasks.

Building Envelope:

- **External walls:** Ensure that there is no significant damage to the external walls such as decay, mould or cracks.
- **Roof:** Ensure that the roof and associated gutters, valleys, etc. are well maintained and there is no significant damage due to structural problems or external weather conditions.
- **Ground floor and basement/cellar:** Check that the ground floor is not damp. Unheated basements and cellars are excluded from any EPC assessment.

Heating, Cooling and Ventilation Systems:

- **Emitters:** Make sure radiators, baseboard heaters and warm-air emitters are not blocked by furniture, are cleaned regularly and are set to appropriate temperature set-points.
- **Mechanical ventilation:** Ensure that any mechanical ventilation system is efficient and inspected/serviced regularly.
- **Local extract fans:** Ensure that ventilation units and/or local extract/exhaust fans are regularly inspected and that filters are clean and functional.
- **Building Management System (BMS):** Ensure that the control or BMS system is regularly commissioned.
- **Boilers:** Ensure that boilers are inspected/ serviced once a year and temperature set points are adjusted carefully. Check the age of the boiler and replace if necessary.
- **Fireplace:** Ensure that any flue damper is closed when not in operation.

Low cost, non-intrusive retrofitting works

Implementation of low-cost and non-intrusive measures should be considered before carrying out any major intervention works. Every property behaves in a different way and will require bespoke advice according to its potential; however, when implemented properly, the following interventions could improve the EPC rating:

- **Energy efficient lighting:** Lighting has a great influence over the energy consumption of a property, especially in non-domestic properties. It is essential to replace old incandescent and halogen lamps with new generation low energy light bulbs and fittings.
- **Lighting controls:** In non-domestic buildings, consider installing occupancy sensors or solar control devices in appropriate areas. In many cases, controls will need to be part of a wider lighting strategy.
- **Control system upgrade:** If space heating is provided via radiators, ensure that thermostatic radiator valves (TRVs), room thermostats and/or a programmer are installed. If the property is heated by electric radiators, make sure that units are controlled via suitable thermostats and a programmer.

Doors/Windows:

- **Draught-proofing:** Ensure that external doors and windows are weather-sealed to minimise infiltration and do not cause any draughts. Special attention should be given to the amount of ventilation provided to control internal levels of moisture and consequentially damp and mould. It is recommended to seek expert advice before undertaking improvement measures.

Building services systems

Boilers, heat pumps, fans and chillers provide space heating and cooling and consume a significant amount of energy. Choosing the correct system will have a dramatic impact on a property's EPC rating, whilst likely having a minimal impact on the building's fabric.

When retrofitting a heritage property, heating and cooling systems must be assessed carefully and relevant actions must be taken. Unfortunately, the same measure will have a different effect in each building:

- **System efficiency:** Use heating and cooling equipment with high efficiency ratings. It is recommended that the minimum efficiency figures stated in the Building Services Compliance Guide[11] that support the 2013 editions of Approved Documents L1A and L2A and the 2010 editions of Approved Documents L1B and L2B (as amended) are achieved.

- **System enhancement:** Consider installing Thermostatic Regulator Valves, a weather compensation system and/or Building Management System (BMS) where appropriate.

- **Monitoring and targeting:** Monitor the energy consumption and identify changes in operation or deterioration in performance.

- **Domestic hot water:** Ensure that the domestic hot water storage system is controlled via thermostat. Ensure that the storage tank and pipes are well-insulated. In properties with large hot water demand, avoid using instantaneous electric water heaters; consider installing a gas-boiler backed with hot water cylinders.

- **Heat recovery:** Consider using heat recovery devices to reduce the energy used to pre-heat the fresh air supply by warming it with the outgoing exhaust air. This is particularly beneficial for properties with low-levels of air-tightness.

Building fabric

The EPC rating of a property is highly dependent on the estimated fabric heat loss rate. The larger the exposed area, the greater the heat loss rate. Heritage properties typically lack insulation although they benefit from high thermal capacity. When it is not designed and implemented correctly, insulating a heritage property may negatively affect its internal conditions and cause significant damage to the fabric. However, if insulation is implemented correctly, it will reduce energy consumption and improve internal conditions.

Before insulating a heritage property, it is important to work with an accredited professional and obtain technical advice. If possible, carry out a condensation risk assessment. Planning requirements and Building Regulations must be considered before carrying out any major works.

- **Roof insulation:** If the property has an exposed roof area, insulation can reduce the space heating demand of the property.

- **External wall insulation:** If the property has solid walls, interior insulation can reduce the heat loss and therefore, reduce the space heating demand. Walls in most heritage properties are built with breathable materials that absorb moisture and release it slowly as it dries out without damaging the building. Therefore, issues such as damp can occur in heritage properties when modern materials are used incorrectly, and walls are unable to dry out. It is recommended that professional advice is sought to carry out thermal bridging and condensation risk assessments before insulating any external walls.

- **Ground floor insulation:** In comparison to roof and external wall insulation, ground floor insulation is likely to provide lower energy savings. However, in cases where the ground floor structure is being replaced, insulation should be considered to improve performance.

- **Glazing:** Consider adding secondary glazing to single glazed windows or replacing single glazed windows with double glazing. Before replacing the windows, the architectural significance of the existing windows must be carefully assessed.

- **Air-tightness:** Air-tightness is one of the key parameters that can improve the energy performance of the building, yet, can also cause considerable harm.It is recommended professional advice is sought when undertaking insulation and draught-proofing works. It is important relevant pressure tests are carried out and appropriate consideration is given to the risk of moisture build up.

  It should be noted that evidence obtained from carrying out an air-tightness test may improve an EPC rating on its own, if resultant values are better than the EPC software default values.

Renewable and low-carbon energy generation technologies

Renewable and low-carbon energy generation technologies provide opportunities to produce on-site energy. Photovoltaic panels, solar thermal collectors, air and ground source heat pumps and combined heat and power units are power generation technologies currently available in the UK market.

Although implementing such technology may create additional installation and maintenance costs (as well as listed building consent if the property is listed), it can provide energy savings and contribute to the decarbonisation of the grid. When installing an alternative energy generation technology, consider the following:

- Planning requirements and Building Regulations approval.
- Location: Photovoltaic panels should be located as discreetly as possible, avoiding main roof elevations. Thatched roofs are not suitable for solar panels. The height of existing chimneys and the proportion of shading on the roof should also be reviewed to ensure photovoltaic and solar panels will not have their performance adversely affected.
- Weight load calculation of new equipment and existing condition of the structural features in the property.
- Possible damage caused to historical features during installation.

Additional information on upgrading heritage properties

The following organisations have a wealth of information on the most appropriate approaches to improving heritage properties:

- Historic England
- Historic Scotland
- Sustainable Traditional Buildings Alliance
- Grosvenor Sustainable Retrofit Toolkit

STBA Responsible Retrofit Guidance Wheel

In order to reduce the installation of inappropriate energy efficiency measures that result in unintended consequences, the STBA have developed a Responsible Retrofit Guidance Wheel for owners of heritage properties. The wheel depicts more than 50 measures that can be used for the retrofitting or refurbishing of traditional buildings. It enables users to explore the advantages and risks relating to each measure, and highlights potential interactions with other aspects of building fabric and services. The wheel is underpinned by a peer-reviewed knowledge base of relevant research.

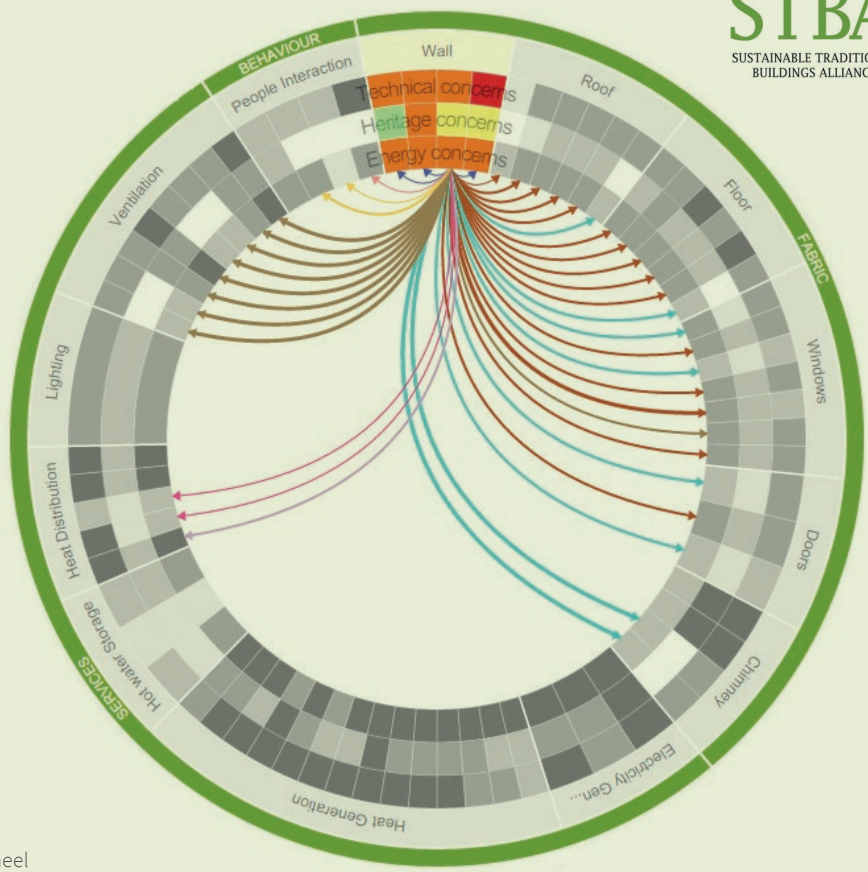


Figure 3: STBA Responsible Retrofit Guidance Wheel

Case Study: 13 Adams Row EnerPhit Retrofit

Owner: Grosvenor Great Britain & Ireland
Architect and PH Designer: Sturgis Carbon Profiling LLP
Structural Engineer: Hurt Pierce + Malcolm
Contractor: Gaysha Ltd

13 Adams Row is a three storey Victorian house located in Mayfair, London. It was built in 1720 as a stable and coach house and converted to a dwelling in 1892.
In 2015, the property was refurbished to the highest environmental standards (PassivHaus EnerPHit), whilst maintaining all of its historical and architectural features. The key energy efficiency measures applied to the property include:

- Super-efficient internal insulation.
- New triple glazed windows.
- Very high air-tightness.
- Mechanical ventilation with heat recovery.

Currently the occupiers benefit from improved thermal comfort and wellbeing, as well as reduced energy bills of up to 86% compared to the building before.

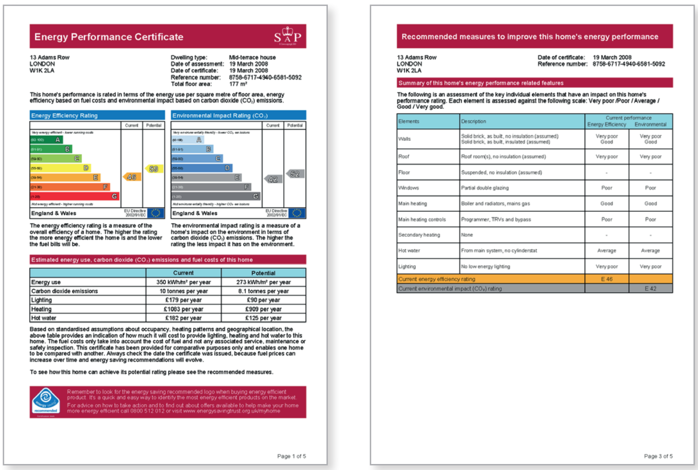
The previous EPC of the property shows an EPC rating of E45 with a potential rating of D59. The property had solid brick walls and single glazed windows.

The recommendations included in the EPC (such as installing low energy lighting and a high efficiency boiler) were relevant. However, potential improvements such as wall insulation or draught-proofing were not included in the EPC.

After careful consideration of all possible design solutions, ambitious design specifications were chosen and implemented. Planning permission was necessary to include measures such as: wall insulation, roof insulation, ground floor insulation, triple glazed windows, new gas heating system and MVHR.

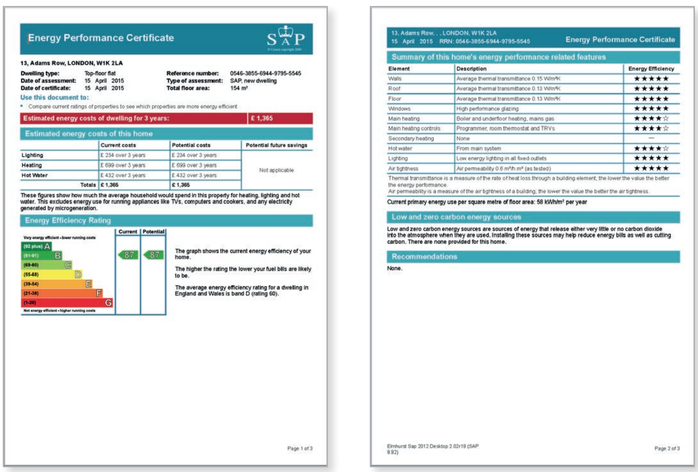
During construction works, the project team collected and submitted all the evidence required for the production of an EPC.

Once the retrofit of the property was completed, an EPC rating of B87 was achieved. It was only possible to improve it with the help of renewable technologies. Apart from achieving a very good EPC rating, Adams Row also achieved the PassivHaus EnerPhit Certification in 2015.


Energy Performance Certificate

Recommended measures to improve this home's energy performance

Figure 4: EPC for 13 Adams Row before retrofitting


Energy Performance Certificate

Energy Performance Certificate

Figure 5: EPC for 13 Adams Row after retrofitting

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Table 1: 13 Adam's Row - Design Specifications

13 Adam's Row - Design Specifications		Before	After
EPC Rating		E 45	B 87
Fabric	U-Values	Front wall: 2.1 W/m²K Rear wall: 2.1 W/m²K Roof: 2.3 W/m²K Floor: 0.59 W/m²K	Front wall: 0.2 W/m²K Rear wall: 0.13 W/m²K Roof: 0.14 W/m²K Floor: 0.13 W/m²K
	Air-tightness	Unknown	0.62 m³/m²-hr @ 50 Pa
Windows	U-Values	Main: 4.8 W/m²K Roof lights: 4.8 W/m²K	Main: 0.79 W/m²K Roof lights: 0.70 W/m²K

Achieving ambitious U-values and air-tightness is a very complex task. If not designed properly, it may reduce the indoor air quality and cause damage to the building fabric.

To prevent these problems at Adam's Row, breathable materials (such as aerogel insulation) and mechanical ventilation with heat recovery (MVHR) were installed. Following the hand-over stage, Sturgis Carbon Profiling continued to monitor and assess the moisture level within the front wall section of the building.

After monitoring the moisture levels for 24 months, results showed the design assumptions were accurate and there was a very low risk of condensation at the monitored locations. High levels of insulation combined with adequate ventilation have effectively reduced energy consumption, whilst maintaining the original features of the property.

This project demonstrates that it is possible for heritage properties to achieve a very good EPC rating when appropriate design and construction methods are followed. This requires:

- A good understanding of the key architectural and technical features of the building.
- The setting of realistic environmental targets aligned with planning requirements and building regulations.
- Early involvement of energy assessors and environmental design consultants.
- The implementation of appropriate construction techniques and collection of appropriate on-site evidence such as photos of installed insulation materials and air-tightness test reports etc.

Figure 6: Main elevation of 13 Adams Row, London W1K 2LA

Conclusion

Heritage properties account for a significant proportion of the building stock in the UK. With the introduction of Minimum Energy Efficiency Standards, the EPC rating of these properties will very likely have a direct, although not necessarily immediate, impact on their capital and rental values, and ultimately, affect investment decisions.

In complying with the legislation and uplifting heritage properties to ensure their long-term attractiveness as an investment class, commercial property owners need to understand and appreciate the unique nature of this property type.

The installation of inappropriate measures that result in an imbalance between environmental improvements and historic significance can devalue a property from both a financial and cultural perspective, causing damage and requiring future investment for repairs.

Upgrading heritage properties requires special expertise, however, achieving good, or even high energy efficiency standards is certainly possible. Strategies should be incorporated that maximise improvements to an EPC rating whilst minimising detrimental impacts to building fabric, internal conditions and historic value. Engaging with competent and accredited industry professionals from an early stage, before carrying out any improvement works, is always recommended.

Taking a considered approach, which achieves the correct balance between environmental and historical significance, can result in a more efficient and comfortable property, with a prosperous long-term future. In turn, protecting valuable cultural and architectural assets within our cities and communities for years to come.

Appendix 1: Key Parameters Affecting EPCs

The following table illustrates the key parameters affecting an EPC rating and the supporting documentation and evidence that should be gathered and provided to assessors to support the delivery of an accurate and reliable assessment.

Key input	Notes	Impact on the EPC rating	Evidence collected by assessors	Supporting activities/documents that can be provided by owners
Access	Inspect all the spaces inside the property and collect the required photographic evidence. Surveying all the spaces/rooms enables assessors to choose the most suitable model inputs and avoid using the worst-case energy scenarios.	**High**	– Walk through of the property – Identify the construction type, building services and lighting systems found in each room/ zone – Take relevant photographs	– Ensure that all the rooms (including plant rooms, cupboards, loft spaces) are accessible – Communicate with the assessor before the survey and determine the scope of the site survey in advance – Site Plans / Building Survey
Building age	Default values and design assumptions are based on the age of the building.	**High**	– No evidence required	– Age of construction, if known – Details of any retrofitting works carried out (including extensions and alterations)
Building Services Systems	Buildings services systems such as space heating systems, hot water, cooling or mechanical ventilation play the most important role in determining the EPC rating of a property. Inefficient and poorly maintained building systems can significantly increase the energy consumption and cause damage to the property.	**High**	– Identify the brand and model of heating and hot water systems – Photos and manufacturer details	– If available, as-built drawings and manufacturer details of space heating, cooling and hot water systems can be shared with the assessor. Sources may include an asset register for the property or previous M&E survey
Wall, roof and ground floor build-up	Insulating the external building elements can reduce the heat losses resulting in significant energy savings. To be able to reflect the positive impact of insulation in the energy rating, relevant documentation is required.	**High**	– Photos, invoices and U-Value calculations	– Building Survey – Insulation type and thickness – Photographic evidence – U-value calculations carried by accredited professionals – Invoices of insulation purchased – As-build drawings with the location of insulation and details of the build-up
Source of energy	The assessor is required to indicate if gas is available in the property. Electricity is 2.5 times more carbon intensive than gas (subject to grid decarbonisation).	**High**	– Inspect and provide evidence of gas meters	– Indicate if gas connections are not available in the property

Key input	Notes	Impact on the EPC rating	Evidence collected by assessors	Supporting activities/documents that can be provided by owners
System controls	Control systems can significantly improve the efficiency of the main system. There is a wide variety on the market.	**Medium**	– Inspect and record all types of controls in the property – Photos of the controls	– M&E survey, BMS schedules
Air-tightness	Energy assessors are only allowed to enter an air-tightness value if permeability tests have been carried out by accredited professionals.	**Medium**	– Test results, when default values are not selected	– Air-tightness test report
Windows	Thermal performance of windows varies depending on their characteristics and frame types.	**Medium (domestic) Low (non-domestic)**	– Photographic evidence – Installation date as stamped in between panes	– Provide installation date of any secondary, double or triple glazed windows if available
Renewable technologies	Solar thermal collectors, PV panels and wind turbines are examples of possible renewable technologies included in the EPC assessment.	**Medium**	– Photographic Evidence	– M&E report – Energy Audit – Manufacturer details – Microgeneration Certification Scheme (MSC) report
Mechanical Ventilation	Mechanical Ventilation is essential if the property achieves air-tightness values below 5 ACH. Regular change of filters is required after installation.	**Medium**	– Identify the mechanically ventilated zones – Photos of the units	– Manufacturer details, including specific fan power of the systems
Lighting	Lighting is responsible for nearly 30% of annual energy consumption in non-domestic buildings.	**Low (domestic) High (non-domestic)**	– Record the type of lighting system in each zone – Photos of the bulbs/fixtures	– Design and specification of light fittings – M&E Report – Energy Audit
Metering	The importance of provision of monitoring and energy metering systems is emphasised in Building Regulations Part L Document. This will only influence Non-domestic EPCs.	**Low**	– Photographic Evidence	– Metering Plan
Power factor correction	For buildings with significant electricity consumption, improving the power correction factor will have a positive impact on the EPC rating. This will only influence Non-domestic EPCs.	**Low**	– Photographic Evidence	– Specifications of the power correction unit

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Appendix 2: Characteristics of Heritage Properties

This section is designed to provide a snapshot of typical building elements found within heritage properties and to compare their key physical characteristics. Measures are compared based on the technical and performance indicators explained below:

- Thermal mass: the ability of materials to absorb and release heat. Solid walls present in heritage properties are heavy thermal mass elements that are able to absorb heat during daytime and release it later when temperatures drop. Solid walls typically take more time to heat up, but can provide good periods of thermal comfort.

- Thermal resistance: the ability of materials to resist a heat flow. Insulation materials provide good thermal resistance and minimise heat losses. Building elements in heritage properties are usually not insulated, and therefore, have lower thermal resistance figures than insulated modern buildings. This causes them to lose space heating energy at a greater rate than modern buildings.

- Vapour permeability: the ability of a material to permit the passage of moisture from oneside to another. This is an important aspect of heritage properties. Solid masonry and brick walls typically have good vapour permeability factors; therefore, allowing moisture to pass through them and evaporate. Adding a new layer of a vapour resistant barrier into solid walls can cause condensation and damage the building elements if not installed correctly.

- System efficiency: Boilers, heat pumps or unit heaters convert energy from one form to another. Efficiency of equipment mitigates the amount of energy lost during the energy conversion process. A high efficiency heat pump is likely to consume less energy than a low efficiency back boiler.

- Health and wellbeing: Equipment such as gas boilers may emit a significant number of particles to the surrounding environment. NOx and particle emission ratings found in manufacturer details should be taken into account when evaluating the performance of building services equipment.

Walls

Type	Sub-category	Emerged in	Approx. thickness	Thermal mass	Thermal resistance	Vapour permeability
Solid	Stone Masonry	Pre 1900	450-500 mm	Good	Low	Average
	Brick	Pre 1900	230-250 mm	Good	Low	Average
Cavity	Brick	Early 1900's	300-350 mm	Average	Low	Good
	Stone	Early 1900's	300-350 mm	Average	Low	Good
Cob		Pre 1800	450-500 mm	Good	Average	Average

Roofs

Type	Sub-category	Emerged in	Thermal resistance
Flat	Metal, lead, copper, zinc, aluminum	Pre 1900	Low
	Bituminous coverings	Pre 1900	Low
	Modern synthetic membranes	Post 1950	Average
Mono-pitched	'lean-to roofs'	Pre 1900	Low
Pitched	Closed couple roof, purlin roof, Queen post truss, King post truss, hipped roof	Pre 1900	Low
	Truss roof	Post 1940	Low
Mansard	Mansard	Pre 1900	Average
Thatch	Thatch	Pre 1900	Good

Ground Floor

Type	Sub-category	Emerged in	Approx. thickness	Thermal mass	Thermal resistance
Solid	'Earth' Floor	Pre 1800	50-100 mm	Average	Low
	Concrete	Post 1900	100-200 mm	Average	Average
Suspended	Timber	Pre 1900	Varies	Low	Average
	Non-timber	Post 1950	Varies	Average	Average

Windows

Type	Sub-category	Examples	Emerged in	Thermal performance	Durability
Single	Timber	Sash	Pre 1900	Average	Low
		Side-hung casement	Pre 1900	Average	Low
	Cast-Iron	Side-hung casement	Pre 1900	Low	Average
	Lead	Leaded lights	Pre 1900	Low	Low
	Steel	Side-hung casement	Early 1900s	Low	Average
	Aluminium	Side-hung casement	Post 1930	Low	Good
Double	Timber	Sash	Post 1900	Average	Average
	Aluminium	Side-hung casement	Post 1930	Average	Good
	PVCu	Side-hung casement	Post 1970	Good	Good

Notes: Many other window types are available in the market today (such as triple glazing, argon-filled double glazing etc). This table only covers the most common types of windows found in heritage properties.

Building Services: Hot Water System

Type	Source	Examples	System efficiency	Operational cost performance	Health and wellbeing
Direct hot water system	Electricity	Single immersion	Average	Average	Good
		Dual immersion	Average	Average	Good
		Instantaneous	Good	Low	Good
	Gas	Single-point gas	Average	Good	Average
		Multi-point gas	Good	Good	Average
Hot water cylinder (Combination with gas boiler)	Electricity	Single immersion	Average	Good	Good
		Dual immersion	Good	Good	Good

Building Services: Space Heating

Type	Source	Examples	System efficiency	Operational cost efficiency	Health and wellbeing
Boiler system	Gas	Non condensing	Average	Average	Average
		Condensing	Good	Good	Good
		Condensing combi	Good	Good	Good
		Combined primary storage unit (CPSU)	Average	Average	Average
		Back boiler	Low	Low	Low
	Electricity	Direct action boiler	Average	Low	Good
	Oil	Oil boiler	Low	Average	Average
Unit heaters	Electricity	Electric panels	Good	Low	Good
		Storage heaters	Average	Average	Good
Heat pump	Electricity	Air source heat pump	Good	Average	Good
District heating	Gas	Community gas boiler	Average	Good	Good
	Electricity	Community heat pumps	Average	Good	Good
Room heater	Solid fuel	Open fire	Low	Average	Low
		Closed fire	Low	Average	Low

Lighting

Type	Examples	Notes	Energy performance
Halogen	Halogen spot light	Conventional spot light commonly found in properties.	Low
Tungsten	Tungsten bulb	Conventional light bulb commonly found in properties. Can be clear or white.	Low
Metal halide	Metal halide lamp	Metal halide lamps consist of an arc tube inside the bulb. 'Cold' metal halide lamps may not produce its full lighting and therefore have long start up times.	Low
Fluorescent	Compact Fluorescent (CFL)	Bent or coiled fluorescent lights. Typically have white coating.	Average
	T12 Halophosphate	Tube fluorescent with a diameter of 38 mm.	Average
	T8 Halophosphate	Tube fluorescent with a diameter of 25 mm.	Average
	T5 Triphosphor	Tube fluorescent with a diameter of 16 mm.	Good
LED	LED bulb	LED bulbs are highly efficient and available in many different colours and shapes such as candle bulbs, globe bulbs etc.	Good
	LED T5	LED tube lights are becoming increasingly popular due to their high efficiency. LED tube light with a diameter of 16 mm.	Good

Appendix 3: EPC Recommendations and Risk Analysis for Domestic Properties

This section includes the standard measures found in domestic EPCs. Each measure is assessed in terms of planning limitations, their likely impact on the exterior aesthetic value of heritage properties, and likely structural and condensation risks.

It must be noted that this risk assessment is indicative only. Before making any investment decisions or before retrofitting a heritage property, consult a technical advisor and obtain further guidance.

Recommendations for the Envelope

Element	Recommendation	Planning limitations may apply	Likely impact on aesthetic heritage	Likely structural risk	Likely condensation risk
Roof	Loft insulation: Increase loft insulation to 270 mm.	Yes	Low	Moderate	Moderate
Roof	Flat roof insulation (external).	Yes	Moderate	Moderate	Low
Roof	Room-in-roof insulation (Internal).	Yes	Low	Moderate	Moderate
External Wall	External solid wall insulation.	Yes	High	Moderate	Moderate
External wall	Internal solid wall insulation.	Yes	Moderate	Moderate	High
External Wall	Cavity wall insulation.	Yes	Low	Moderate	Low
Floor	Floor insulation.	Yes	Low	Low	Low
Window	Double glazing: Replace all single glazed windows with low-e double glazing.	Yes	High	Low	Moderate
Window	Secondary glazing: Secondary glazing to single glazed windows.	Yes	Moderate	Low	Moderate
Draught proofing	Draught proofing.	No	Low	Low	Moderate

Recommendations for Heating

Element	Recommendation	Planning limitations may apply	Likely impact on aesthetic heritage	Likely structural risk
Heating system	Change heating to gas condensing boiler.	Yes	Low	Low
Heating system	Upgrade boiler – same power fuel.	No	Low	Low
Heating system	Flue gas heat recovery.	No	Low	Low
Heating system	New or replacement storage heaters: High heat retention storage heaters.	No	Low	Low
Heating system	Replacement of warm air unit.	No	Low	Low
Controls	Heating controls for wet central heating system.	No	Low	Low
Controls	Heating controls (thermostatic radiator valves and room thermostat).	No	Low	Low

Recommendations for Hot Water

Element	Recommendation	Planning limitations may apply	Likely impact on aesthetic heritage	Likely structural risk
DHW	Hot water cylinder insulation.	No	Low	Low
DHW	Cylinder thermostat.	No	Low	Low

Recommendations for Renewables

Element	Recommendation	Planning limitations may apply	Likely impact on aesthetic heritage	Likely structural risk
PV	Solar photovoltaics panels.	Yes	Moderate	Moderate
Solar thermal	Solar water heating.	Yes	Moderate	Moderate
Waste water	Heat recovery system for mixer showers.	No	Low	Low
Wind	Wind turbine.	Yes	High	High

Alternative Measures

Element	Recommendation	Planning limitations may apply	Likely impact on aesthetic heritage	Likely structural risk	Likely condensation risk
External wall	External insulation with cavity wall insulation.	Yes	High	Moderate	High
Heating system	Biomass boiler.	Yes	Low	Low	Low
Heating system	Air or ground source heat pump.	Yes	Moderate	Low	Low
Heating system	Air or ground source heat pump with underfloor heating.	Yes	Moderate	Moderate	Low
Heating system	Micro-CHP.	Yes	Low	Low	Low

Recommendations for Lighting

Element	Recommendation	Planning limitations may apply	Likely impact on aesthetic heritage	Likely structural risk
Lighting	Low energy lighting for all fixed outlets.	No	Low	Low

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Appendix 4: EPC Recommendations and Risk Analysis for Non-Domestic Properties

This section includes the standard measures found in non-domestic EPCs. Each measure is assessed in terms of planning limitations, their likely impact on the exterior aesthetic value of heritage properties, and likely structural and condensation risks.

It must be noted that this risk assessment is indicative only. Before making any investment decisions or before retrofitting a heritage property, consult a technical advisor and obtain further guidance.

Recommendations for the Envelope

Element	Recommendation	Planning limitations may apply	Likely impact on aesthetic heritage	Likely structural risk	Likely condensation risk
Roof	Roof is poorly insulated. Install or improve insulation of roof.	Yes	Low	Moderate	Moderate
Roof	Some loft spaces are poorly insulated. Install or improve insulation.	Yes	Low	Moderate	Moderate
External Wall	Some walls have uninsulated cavities. Introduce cavity wall insulation.	Yes	Low	Moderate	Low
External Wall	Some solid walls are poorly insulated. Introduce or improve internal insulation.	Yes	Low	Moderate	High
Floor	Some floors are poorly insulated. Introduce and/or improve insulation. Add insulation to the exposed surfaces of floors adjacent to underground or unheated spaces.	No	Low	Low	Low
Window	Some windows have high U-values. Consider installing secondary glazing.	Yes	Low	Low	Moderate
Window	Some glazing is poorly performing. Replace/ improve glazing and/or frames.	Yes	High	Low	Moderate
Air-tightness	Carry out a pressure test. Identify and treat air leakage. Enter result in EPC calculation.	No	Low	Low	Low

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Recommendations for Lighting

Element	Recommendation	Planning limitations may apply	Likely impact on aesthetic heritage	Likely structural risk
Lighting	Consider replacing T8 lamps with retrofit T5 conversion kit.	No	Low	Low
Lighting	Introduce HF ballasts for fluorescent tubes. Reduced number of fittings required.	No	Low	Low
Lighting	Replace 38mm diameter (T12) fluorescent tubes on failure with 26mm (T8) tubes.	No	Low	Low
Lighting	Replace 38mm high-pressure mercury discharge lamps with complete new lamp/gear SON (DL).	No	Low	Low
Lighting	Replace high-pressure mercury discharge lamps with plug-in SON replacements.	No	Low	Low
Lighting	Replace tungsten GLS lamps with CFLs: Payback period dependent on hours of use.	No	Low	Low
Lighting	Replace tungsten GLS spotlights with low-voltage tungsten halogen. Payback period dependent on hours of use.	No	Low	Low

Recommendations for Heating

Element	Recommendation	Planning limitations may apply	Likely impact on aesthetic heritage	Likely structural risk
Heating system	Consider replacing heating boiler plant with a condensing type.	No	Low	Low
Heating system	Consider replacing heating boiler plant with high efficiency type.	No	Low	Low
Heating system	The default heat generator efficiency is chosen. It is recommended that the heat generator system be investigated to gain an understanding of its efficiency and possible improvements.	No	N/A	N/A
Controls	Add time control to heating system.	No	Low	Low
Controls	Add local time control to heating system.	No	Low	Low
Controls	Add local temperature control to the heating system.	No	Low	Low
Controls	Add optimum start/stop to the heating system.	No	Low	Low
Controls	Add weather compensation controls to heating system.	No	Low	Low

Recommendations for Cooling

Element	Recommendation	Planning limitations may apply	Likely impact on aesthetic heritage	Likely structural risk
Cooling system	Chiller efficiency is low. Consider upgrading chiller.	Yes	Moderate	Moderate
Cooling system	Ductwork leakage is greater than 10%. Inspect and seal ductwork.	No	Low	Low
Cooling system	The default chiller efficiency is chosen. It is recommended that the chiller system be investigated to gain an understanding of its efficiency and possible improvements.	No	N/A	N/A

Recommendations for Hot Water

Element	Recommendation	Planning limitations may apply	Likely impact on aesthetic heritage	Likely structural risk
Domestic hot water	Add time switch to hot water system secondary circulation.	No	Low	Low
Domestic hot water	Consider installing or replacing hot water system with point of use system.	No	Low	Low
Domestic hot water	Improve insulation on hot water system storage.	No	Low	Low
Domestic hot water	Install more efficient water heater.	No	Low	Low

Recommendations for Renewables

Element	Recommendation	Planning limitations may apply	Likely impact on aesthetic heritage	Likely structural risk
Heating system	Consider installing a ground source heat pump.	Yes	Moderate	Moderate
Heating system	Consider installing an air source heat pump.	Yes	Moderate	Moderate
Wind turbine	Consider installing building mounted wind turbine.	Yes	High	Moderate
Solar heating	Consider installing solar water heating.	Yes	Moderate	Moderate
PV	Consider installing PV.	Yes	Moderate	Moderate

Recommendations for Fuel Switching

Element	Recommendation	Planning limitations may apply	Likely impact on aesthetic heritage	Likely structural risk
Heating system	Consider converting the existing boiler from coal to natural gas.	No	Low	Low
Heating system	Consider switching from coal to biomass.	No	Low	Moderate
Heating system	Consider switching from coal to oil.	No	Low	Low
Heating system	Consider switching from gas to biomass.	No	Low	Moderate
Heating system	Consider switching from oil or LPG to biomass.	No	Low	Moderate
Heating system	Consider switching from oil or LPG to natural gas.	No	Low	Low

Recommendations for Overheating

Element	Recommendation	Application to heritage properties	Likely impact on aesthetic heritage	Likely structural risk	Likely condensation risk
Window	Some spaces have a significant risk of overheating. Consider solar control measures such as the application of a reflective coating or shading devices to windows.	Yes	Moderate	Low	Low

Glossary

Air-tightness: Control of inward leakage of air through the fabric, caused by pressure effects of the wind and/or stack affect.

Embodied carbon: CO_2 emitted during the manufacture, transport and construction of building materials, together with end of life emissions.

EnerPhit retrofit: Is the standard used by the PassivHaus Institute that focuses on retrofit projects. Significant energy and CO_2 savings between 75% and 90% can be achieved.

Feed-in-tariff: A UK Government scheme designed to promote the use of small-scale and low carbon energy generation technologies.

MEES: For properties in England & Wales, Minimum Energy Efficiency Standards (MEES) make it unlawful to let residential or business premises that do not reach a minimum energy efficiency standard of EPC rating E. From 1st April 2018, landlords of privately rented domestic and non-domestic property must ensure that their properties reach at least an EPC rating of E before granting a new lease to new or existing occupier.

RdSAP: The Reduced Standard Assessment Procedure is a simplified version of the SAP assessment tool used by energy assessors to produce domestic EPCs.

Photovoltaic (PV) panels: Method for generating electric power using solar cells to convert energy form the sun into a flow of electrons by the photovoltaic effect.

Renewable Heat Incentive: A UK Government financial incentive to promote the use of renewable heat technologies amongst householders, communities and businesses.

SAP: The Standard Assessment Procedure is the methodology used by the UK Government to assess and compare the energy and environmental performance of dwellings.

SBEM: Simplified Building Energy Modelling is a software tool developed to provide an analysis of a building's energy consumption; used for non-domestic buildings.

Solar transmittance: Percentage of solar energy that can pass through glazing.

Thermal mass: The ability of a material to absorb and release heat.

Thermal performance: It refers to how well a structure or building responds to changes in external temperature during the daily and seasonal cycles.

Thermal resistance: The ability of a material to resist a heat flow.

Vapour permeability: The ability of a material to permit the passage of moisture from one side to another.

Weather compensation system: A system that communicates between the boiler and the outside temperature in order to optimise the energy consumption.

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2 Energy Efficiency (Private Rented Property) (England and Wales) Regulations 2015.

3 Department of Energy and Climate Change, 2013. Final Project Report: An Investigation of the effect of EPC ratings on housing prices.

4 The MEES regulations will be enforced by Local Weights and Measures Authorities (LWMAs). A property owner can be fined between £5,000 and £50,000 based on the rateable value of the building if they do not make an EPC available to any prospective buyer or tenant.

5 Department for Business, Energy and Industrial Strategy, 2017. The Non-Domestic Private Rented Property Minimum Standard.

6 Sustainable Traditional Buildings Alliance, 2012. Responsible retrofit of traditional buildings. London, UK

7 Recommendations on the EPC are automatically generated. Non-domestic assessors can amend and propose new recommendations, whilst domestic procedure does not allow alterations; alternative advise can only be given aside from the EPC.

8 National Trust, Centre for Sustainable Energy and Good Energy. Love your home – Energy advise to help protect your own special place.

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Capital & Regional
CLS Holdings plc
Cording Real Estate Group
The Crown Estate
DWS
Great Portland Estates
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