Historic England

EPCs and the Whole House Approach

A Scoping Study

A report prepared by the Sustainable Traditional Buildings Alliance (STBA) on behalf of Historic England and the National Trust

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STBA

SUSTAINABLE TRADITIONAL BUILDINGS ALLIANCE

EPCs and the Whole House Approach: A scoping study

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This report has been prepared by the Sustainable Traditional Buildings Alliance (STBA) on behalf of Historic England and the National Trust, in response to the growing use of Energy Performance Certificates (EPCs) in UK Energy Policy. It provides an overview of the key issues, constraints and opportunities surrounding EPCs, identifying ways in which they could be better aligned with the 'whole-house' approach to retrofit developed by the STBA and recommended in the Each Home Counts report.

Historic England

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Contents

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Executive Summary

Energy Performance Certificates (EPCs) were originally introduced as a benchmarking and compliance tool. However, they are now being used in government policy and programmes to drive improvements in the energy efficiency performance of buildings, including the recently introduced minimum energy efficiency standards for the private rented sector. As a result, EPCs are increasingly being used as retrofit design tools - a purpose for which they were not intended[1] and for which they are inadequate.

There are particular concerns relating to the use of EPCs in traditionally-constructed dwellings - which constitute 25% of the UK's housing stock. While most traditional dwellings should be able to reach band E with relatively safe measures, the Clean Growth Strategy contains an 'aspiration' for all dwellings to reach EPC band C by 2035, *'where practical, cost effective and affordable'*. There is a danger that this could drive the installation of measures which are inappropriate to the context, which damage building fabric, heritage and health, and which are ultimately both costly and ineffective.

The Each Home Counts report recommends a 'Whole House' approach to domestic retrofit. The ensuing (draft) '*Specification for the energy retrofit of domestic buildings'* (PAS 2035), which will initially apply to ECO-funded work, takes the same approach. This new industry-led standard includes consideration of moisture risk, ventilation and heritage in addition to a building's energy performance, in order to avoid unintended consequences. The narrow metrics of EPCs are at odds with this approach, so this scoping study considers the potential for domestic EPCs to be improved or to become one aspect of a wider energy or sustainability assessment.

This study reveals that there are significant opportunities in the short term to improve clarity and understanding about the nature and limitations of EPCs. For example, they are not a measure of energy performance but an estimation of energy cost, so even the title may be misleading. There needs to be a clear recognition that the EPC is not a substitute for an energy audit. Changes to presentation and the inclusion of key caveats concerning moisture, ventilation and heritage would also help to reduce the risks of misunderstanding and misuse.

In the longer term, it is becoming increasingly recognised that we need to deliver a sustainable built environment and not just a low carbon one, so a broader assessment is needed which has a wider set of goals. A Whole House assessment which covers these other critical factors will mean investing in additional training for assessors, but this is the only way to prevent unintended consequences and it will be more cost-effective in the medium term. An EPC can, however, inform this wider assessment and contains much of the basic data required.

The study concludes by setting out the key research which will be required in order to inform change. This includes quantitative research into the effects of making changes to domestic EPCs (especially for older buildings) and the impact of the Band C targets for 2030 and 2035, research into the feasibility of changing legislation, further research into the assumptions underlying SAP and lastly research to determine the potential impact on training and capacity.

[1] Implementing the EPBD (CA EPBD, 2016)

1. Introduction

This scoping study has been commissioned by Historic England and National Trust. Its aims are to:

- consider the effectiveness of domestic EPCs as a compliance tool
- clarify issues with regard to EPC assessments for traditional and other dwellings
- identify improvements for EPCs
- examine how EPCs could be aligned with a Whole House approach to retrofit
- set out the further research required to provide the evidence necessary to prompt change

The essential functions of the domestic EPC are likely to remain largely unchanged in the foreseeable future, and this report is not seeking to suggest any major shift in this respect. Rather, it is identifying a range of ways in which EPCs can be made more robust without changing their essential function. This will help prevent the growing number of failures in retrofit, which led to the commissioning of the Each Home Counts report[2] (published Dec 2016). This report acknowledged unintended consequences and recommended the use of the Whole House approach to retrofit (developed by the STBA).

Concerns have also been raised about the effectiveness of EPCs. To quote the Country Land and Business Association (CLA) as a recent example: *'The EPC confounds cost-effectiveness, energy efficiency and environmental performance, giving an inadequate estimate of all three. For it to improve it must focus solely on one of these issues, only then can it be an effective baseline for policy interventions'*[3]. At the same time, the use of EPCs has increased and the Private Rented Sector (PRS) legislation mandates achieving an EPC banding of 'E' for all domestic tenancies (new and existing) by April 2020. In the Clean Growth Strategy, the Government has now suggested that it may go further than this and extend the requirement to fuel poor homes and require all properties in fuel poverty or the PRS to reach Band C by 2030. Other trigger points for EPCs are also to be investigated.

The EU's own report on EPCs states that '*there is a need for independent evaluation of the effectiveness of the EPC scheme*'[4]. This independent study therefore covers the origins and original intentions of EPCs; their use (in the UK) within energy funding mechanisms; their structure, function, assessment process and recommendations; assessor training and knowledge levels; the impacts associated with inaccurate EPCs; a wide range of improvement opportunities. While some of the analysis inevitably identifies negative aspects of the current system, the study is intended as a positive tool for change. The study then examines how EPCs could become better aligned with the Whole House approach recommended by Each Home Counts and sets out a scope for the further research needed to demonstrate that a fresh approach would be feasible, effective and ultimately sustainable.

This study reinforces the importance of understanding both what EPCs are and what they are not. They are largely a compliance tool, with a relatively narrow focus and assessment mechanism. However, with the growing use of EPCs as a regulatory mechanism to push buildings into achieving minimum ratings, the lines of definition are becoming blurred and a simple compliance tool is being used to inform and even lead design. EPCs are not a design tool, and their use as such is contributing to an increase in the incidence of unintended consequences that can affect not only individual buildings and householders but even entire areas.

[2] Each Home Counts (BEIS & CLG, 2016).
[3] The Retro Fit-up (CLA, 2017).
[4] Energy Performance Certificates across the EU: A mapping of national approaches (BPIE, 2014).

2. EPCs and the Regulatory Context

This section examines the origins of the EPC document and summarises its development and use up to the present day.

2.1 Origins: the Energy Performance of Buildings Directive (EPBD)

The EU Energy Performance of Buildings Directive (EPBD) 2002 came into force in January 2003. It was inspired directly by the Kyoto protocol, so its focus from the outset was to reduce greenhouse gas emissions.

Article 7 of the EPBD introduced a mandatory requirement to produce an energy certificate whenever a building is constructed, sold or rented. This certificate had to detail the current energy efficiency level of the building and to set out recommendations for improvements in energy performance. According to the Building Performance Institute Europe, *'the ultimate goal of EPCs is to create a demand-driven market for energy efficiency in the building sector'*[5].

To begin to comply with this, in England and Wales, the Energy Performance Certificate (EPC) was introduced in 2007 as part of the Home Information Pack, designed to improve the conveyancing process, but the requirement was limited to properties with 4+ bedrooms (subsequently extended to 3). The Home Information Pack was withdrawn in 2010, but the requirement for an EPC was retained and extended to all dwellings. From 2008, an EPC was also required whenever a non-domestic building over 50m^2 was constructed, sold or rented.

The EPBD was 'recast' in 2010 and included (in addition to various 'zero carbon' aspirations) a requirement that *'for buildings offered for sale or rent, the energy performance certificates shall be stated in the advertisements'*.

2.2 The requirement to produce an EPC

The requirement to produce an EPC is contained within the Energy Performance of Buildings (England & Wales) Regulations 2012. These Regulations set out the Duties relating to EPCs and specifically how an EPC is required upon sale or rent of a building, what the report must contain, and certain exemptions including that discussed in Section 2.5.

Although this paper focuses upon domestic buildings, it is worth noting that, for existing buildings other than dwellings, (Building Regulations Part L2B), Table 6 (Consequential Improvements) lists nine items. The first seven are improvement measures which are considered likely to meet the economic feasibility criterion - earlier defined as a simple payback of 15 years. The eighth is Low and Zero-carbon (LZC) energy generation systems and the ninth is 'Measures specified in the Recommendations Report produced in parallel with a valid EPC'. This refers to the fact that some EPC measures do not meet the economic feasibility criterion set out in the Building Regulations - solid wall insulation is a good example.

[5] Energy Performance Certificates across the EU: A mapping of national approaches (BPIE, 2014).

2.3 Existing building context: EPCs as a tool

While EPCs are also required for new dwellings, this report focuses on their application to existing dwellings, their use in retrofit and the potential for an improved system.

Aside from their use in relation to Government programmes (see Section 3), the principal use of EPCs in existing buildings is as a ready source of information on energy performance for building owners and occupiers whenever buildings are sold or rented. The EPC is now included in the conveyancing process and estate agents' details normally include at least the EPC rating, with the full EPC readily available. The structure and content of EPCs is set out in Section 4.

EPCs are increasingly used as a benchmarking tool, for example in the new Minimum Energy Efficiency Standards (MEES) legislation for privately rented buildings. This is covered in the section below.

2.4 EPCs and the Private Rented Sector: Minimum Energy Efficiency Standards (MEES)

The requirement to introduce Minimum Energy Efficiency Standards (MEES) is set out in Article 1 of the EPBD. In the UK, the groundwork for MEES was laid by the 2011 Energy Act. The Energy Efficiency (Private Rented Property) (England & Wales) Regulations 2015 made provision for their introduction. These regulations did not set the minimum standard – this was left to secondary legislation.

From 2016, under this legislation, tenants have been able to request of their landlords improvements that were fundable under the Green Deal. However, by this time government funding for the Green Deal had already been withdrawn (though the Green Deal itself remains in place).

From April 2018, landlords of privately rented domestic and non-domestic property in England or Wales must ensure that their properties reach a minimum EPC rating of 'E' before granting a new tenancy to new or existing tenants; this is generally known as the Minimum Energy Efficiency Standard (MEES). For private tenancies, the requirement is extended to include all domestic tenancies (i.e. all existing tenancies that are legally required to have an EPC[6]) as of 1st April 2020. Assuming that landlords become aware of this requirement, it would be instructive to assess what this might do to the renovation market in the run-up to this date - when there would be greater volume of work with a sharp deadline - and what would happen to trade after the deadline.

In Scotland, the legislation[7] has not yet been finalised but the proposal is to introduce minimum standards for new private domestic tenancies from 1st April 2019, with a backstop date for all other existing tenancies of April 2022. The same document proposes a move to a minimum 'D' rating for new tenancies from April 2022, extending to all tenancies by 31st March 2025.

The Government's 2017 Clean Growth Strategy[8] contains a commitment to bring all fuel poor housing up to an EPC 'C' rating by 2030. This is a particular challenge for the rural and off-gas housing stock, especially for older properties (reasons for this are set out in Section 4); it also ignores the fact that

[6] If a property is let on a relevant tenancy type but is *not* legally required to have an EPC, or if it is required to have an EPC but is *not* let on a relevant tenancy, that property will not be required to comply with the Regulations. Examples include those let continuously to the same tenant since before EPCs were introduced and properties let as HMOs.
[7] Energy efficiency and condition standards in private rented housing (Scottish Government, 2017).
[8] The clean growth strategy: Leading the way to a low carbon future (HM Government, 2017).

many people are comfortable living at lower temperatures than those assumed by EPC software (see Section 4) or may rely on wood for their main source of space heating. Also see Section 2.7 on Potential Future Uses).

2.5 'Exemptions'

Private rented properties are only required to comply with the MEES if they are legally required[9] to have an EPC. There are certain circumstances where a property may not be required to have an EPC and therefore do not need to meet any minimum standard.

The Private Rented Sector (PRS) Guidance 2017 (confirmed by official websites and a Ministerial statement in 2012) cites the Guidance issued by DCLG in stating that an EPC is not required where the landlord (or the seller, if relevant) can demonstrate that the building is '*any of the following*:'. The first of these[10] is where *'a building is officially protected as part of a designated environment or because of their special architectural or historic merit where compliance with certain minimum energy efficiency requirements would unacceptably alter their character or appearance'*. The Guidance document does not specify which requirements are covered; the Guidance does define 'official protection' as listing, but the 2017 guidance from MHCLG[11] also makes reference to dwellings in Conservation Areas.

The simple problem is that a property owner cannot know whether compliance would 'unacceptably alter' character or appearance unless they know what the recommended improvement measures are, i.e. unless an EPC is commissioned. Even once the EPC recommendations are known, the question of who determines what is 'acceptable' or 'unacceptable' remains unclear: usually this would be a Local Authority Conservation Officer (or possibly a Planning Officer in the absence of a Conservation Officer), but this then requires negotiation and possible planning / listed building applications to achieve absolute clarity. We can, then, see that while this clause is often interpreted as a blanket 'exemption' for listed buildings and buildings in conservation areas, this is not actually the case. Clarity is therefore required regarding the evidence required to back up the decision made by the property owner.

The language of this clause originates from Article 4 of the EPBD, and is used in the original 2007 Energy Performance Regulations (which require landlords or agents to make an EPC available to any prospective tenant). As above, this applies to the need simply to have an EPC, not the need to comply with any minimum energy efficiency requirements.

The ambiguity of this wording has led to considerable confusion, and many organisations have called on Government to clarify the position. To date the wording remains unchanged, but during recent negotiations[12] the Government's current position seems to be that property owners are free to make a judgement themselves (seemingly without evidence) as to whether complying with minimum energy performance requirements would unacceptably alter their property, and therefore as to whether they need to have an EPC[13]. The Government's view also seems to be that the majority of listed buildings

[9] Voluntarily obtained EPCs do not impose a requirement on the landlord to comply with MEES.
[10] Other exemptions from MEES (which do not relate specifically to EPCs) include the 5% property devaluation exemption and the solid wall exemption where SWI might damage the property. Domestic Private Landlord Guidance (BEIS March 2018)
[11] A guide to Energy Performance Certificates for the marketing, sale or let of dwellings (MHCLG 2017).
[12] Source: meeting between Historic England and the Ministry of Housing, Communities and Local Government (MHCLG) on 15 March 2018.
[13] *Ibid*.

are likely to fall into this category[14], but the situation is not yet clear for conservation areas. This also ignores the fact that there is character and significance in most traditional buildings, the majority of which are not in conservation areas. This is an intrinsic problem with the narrow focus of the EPBD, and one which would of course be solved by a 'whole-building approach' to sustainable renovation.

N.B. the above applies only to properties in England and Wales; Scotland has no such 'exemption'. There is indeed an argument that no buildings should be exempt from having to have an EPC, as exemptions could risk increasing the negative view of heritage buildings being inefficient and expensive to live in. Of course this is a separate argument from that of what should be done to improve listed buildings and whether they should be subject to MEES: simply having an EPC is unlikely to do a building any harm, as long as it accurately reflects the building and the recommended measures are appropriate for the building and its context – which is often not the case at present.

2.6 Use of EPCs elsewhere in Europe

Examining how EPCs are used in Europe is instructive because other countries have clearly interpreted the requirements of the EPBD differently. This suggests that there is scope for change, even within the limited focus of the Directive. Implementation of the Directive is carried out at regional level in some Member States and at national level in others.

EPCs in other Member States appear quite different from ours and contain different information. For example, most seem to focus mainly on the Environmental Impact Rating (EIR). By contrast, the UK EPC document places most emphasis on the Energy Efficiency Rating (EER) and highlights this with a large front-page graphic. This is actually a measure of fuel cost, not 'efficiency' - see Section 4. The Environmental Impact Rating (expressed in CO_2) is shown with far less prominence on the last page.

It is worth noting at this point that the cost of carrying out an EPC is significantly lower than in most Member States, by a multiple in some cases. The comparative lack of depth may reflect the introduction of the EPC in the UK as part of the Home Information Pack, and a desire to keep costs down. Obviously, clients get what they pay for and a broader, more detailed report from a better-trained surveyor will cost more, but it seems from elsewhere in Europe that the market will bear this.

Calculation methodologies also vary. Some countries include 'outdoor climate', internal loads, passive solar gain, local solar exposure, building position, natural ventilation and mechanical ventilation in their assessment methodologies[15]. The calculation methodology in the UK, RdSAP, is known for being a relatively basic, low-level assessment tool and does not fully account for many of these areas (see Section 4 for more details).

Lastly, there is also variation in the importance allocated to EPCs in different countries. For example, despite the provision of the 2010 Recast, not all Member States have implemented the requirement to include EPCs in estate agents' details[16]; 50% of Member States use EPC scores as a condition of entry to renewable energy programmes (the UK approach to this is covered in Section 3).

[14] *Ibid*.
[15] Technical assessment of national/regional calculation methodologies for the energy performance of buildings, Table 1 (European Commission, 2015).
[16] Implementing the EPBD (CA EPBD, 2016)

2.7 Potential future uses

The requirement to produce an EPC is currently triggered by a property rental or sales transaction - though from 2020 all tenancies in the Private Rented Sector (where already legally required to have an EPC) will have to have meet the MEES, irrespective of there being a new lease. The concept of a trigger parallels Building Regulations Part L1B and L2B on the energy efficiency of existing buildings, where requirements to upgrade are triggered by, for example, change of use or renovation of key thermal elements (e.g. roof replacement).

In addition to an aim to raise the MEES for the PRS to EPC band C by 2030, The Clean Growth Strategy (2017) also contains an aspiration for as many homes as possible to reach this standard by 2035 – *'where practical, cost effective and affordable'*. This last point is significant, but the wider issue – explored in more depth in this report – is that EPC rating targets may not be the best tool to improve the overall sustainability of the housing stock in the safest and most cost-effective way. The same document mentions that consideration is also to be given to *'extend EPCs to other trigger points'* and a Call for Evidence on this topic is expected in Spring 2018.

Either way, it is clear that the use of EPCs as a policy lever is increasing at present. In England and Scotland EPCs may have been the only assessment tool available, but in Wales the Housing Quality Standard (used for social housing) may provide an alternative.

2.8 Wider Policy Context

The departure of the UK from the European Union raises the question of whether policy on change regarding existing buildings should still be driven by the narrow-focused goal of carbon emissions reductions from buildings in use. Brexit is an opportunity to break from the EPBD and grapple with a wider, plural agenda and, in doing so, to avoid unintended consequences such as damage to buildings and to health, and to include community regeneration as part of the aims of retrofit. For many years, the UK had a Department of Energy and Climate Change, rather than a Department for Sustainability. This compounded the problem by following the European model, and it was difficult to fit even consideration of the impact of work and materials (embodied impact) into this structure.

However, change is occurring. The draft PAS 2035 (Specification for the energy retrofit of domestic buildings)[17] which will cover retrofit survey and design has multiple objectives, including:

- Improved functionality, usability and durability of buildings
- Improved comfort, health and well-being of building occupants and visitors
- Improved energy efficiency, leading to reduced fuel use, fuel costs and pollution
- Reduced environmental impacts of buildings
- Protection and enhancement of the architectural and cultural heritage
- Avoidance of unintended consequences

This is a major development as it is the first time a UK energy standard has required the consideration of factors other than emissions from buildings in use. Of course, PAS 2035 will only initially apply to work commissioned through the Energy Company Obligation ECO3 (see Section 3.2), but it is hoped that this standard will become more widely adopted as a contractual requirement in refurbishment

[17] See Energy Efficiency in buildings: Update on Standards development and 'Each Home Counts' (BSI, 2017)

projects. Many corporations and institutions regard the climate change agenda as only one of many sustainability goals, and are structured accordingly.

3. The use of EPCs in Funding Mechanisms

Funded and loan-based energy programmes in the UK both use EPCs - in some cases as an assessment tool, and in other cases as a means of levering in energy efficiency measures as a condition of installing renewable energy technologies. This latter approach follows the energy hierarchy, as it is usually more cost-effective (and therefore likely to be more sustainable) to reduce energy demand than to invest in cleaner energy generation.[18]

3.1 Green Deal

The Green Deal was introduced in 2012 but government funding was withdrawn in 2015 due to high costs and low take-up. While it was running, it contributed towards embedding the use of EPCs in the energy efficiency industry. As of May 2017, loans are now being offered again through the Green Deal Finance Company.

Importantly, to be eligible for funding under the Green Deal, a measure has to be recommended in an EPC assessment. Both the Green Deal and the EPC assessments are based on RdSAP (explored in Section 4). The Green Deal Assessment includes a 'calculation' of typical savings, which used the standard savings assumptions from the EPC, *'adjusted down to reflect variation in buildings, products and installation techniques'*[19] Once work has been completed, a new EPC has to be produced, showing the new energy efficiency rating.

3.2 Energy Company Obligation (ECO)

The Energy Company Obligation (ECO) is a levy on energy suppliers (funded via a levy on homeowners' fuel bills) which is used to fund energy efficiency measures. These are commonly focused on the poorest and most vulnerable households, and those living in homes deemed 'hard to treat'.

The selection of properties for ECO-funded measures is a complex process, but EPC ratings are now used as one route to qualification for ECO funding. The Government's response to the 2016 ECO: Help to Heat consultation stated that *'eligibility for certain measures under Affordable Warmth will be extended to social housing in EPC bands E, F or G'*[20]. This covers the current period up to the end of ECO2.

From April 2017, the calculation of savings achieved under the ECO will no longer be based on the EPC but on 'deemed' scores[21]. An extensive set of predicted savings has been developed by the BRE based on different house types and different measures. As yet, there is no procedure in place to measure actual savings and calibrate these deemed scores according to empirical evidence.

[18] Funding programmes and their eligibility criteria are continually evolving, so the information presented is only accurate at the time of writing.
[19] Green Deal Provider Guidance, Step 3, p8 footnote (DECC, 2012)
[20] The Government response to the ECO: Help to Heat Consultation (BEIS, 2017).
[21] https://www.ofgem.gov.uk/publications-and-updates/eco2-consultation-deemed-scores

Perhaps more importantly, under ECO3 which is due to run from October 2018, retrofit must be carried out in accordance with PAS 2035. This standard is not yet in place, but the draft standard covers many aspects of a building which the EPC does not, including the importance of assessing 'significance' before even considering retrofit measures, and the avoidance of 'unintended consequences' including moisture-related risks. A fuller explanation of PAS 2035 is provided in Section 2.8.

3.3 Feed-In Tariff (FIT)

The Feed-In Tariff (FIT) supports renewable electricity generation at domestic and non-domestic properties. For householders, to be eligible for the higher generation tariff (which is now very modest and ends altogether in April 2019), the property to which the generation equipment is fitted must have an EPC rating of 'D' or better.

3.4 Renewable Heat Incentive (RHI)

The Renewable Heat Incentive (RHI) supports renewable heat generation. For the domestic RHI, to be eligible for the FIT, the property is required to have an EPC and this must be less than 2 years old at the time of application to the RHI. If the EPC contains any recommendations for loft or cavity wall insulation then these must be completed and a fresh EPC produced before households can apply to join the RHI.

The EPC determines the amount of subsidy payable for heat pump and biomass installations under the domestic RHI. The estimated energy demand figures on the EPC are used, meaning that the amount of money a householder receives is not dependent on the amount of energy actually consumed. For solar water heating, the subsidy is not based on the EPC's assumed hot water demand but instead on the predicted generation stated on the MCS certificate.

4. EPC Function, Structure, Assessment Process & Recommendations

4.1 Overarching function

In the UK, EPCs assess running costs for space heating, lighting and hot water and provide a list of recommended measures to reduce these costs. They do not account for elements such as portable heaters or electric showers, or aspects that are more controllable by occupants such as cooking, plug-in lighting or appliances; they also do not include broader aspects of building performance such as maintenance or fabric condition.

EPCs for existing buildings are predominantly a compliance tool, i.e. they are produced where there is a legal requirement to do so (e.g. where a property is sold or rented); they also allow one house to be compared with another under standardised conditions. They are rarely produced specifically in order to inform improvement works (other than for Green Deal plans, which have serious questions of their own). However, in reality – and particularly where there is a requirement to meet a minimum performance rating (e.g. for MEES compliance) – they are often used to inform and even lead decisions regarding improvement measures and associated design work. This fundamentally – and inappropriately – changes their use from a compliance tool to a design tool, and this is where much of the concern over their robustness stems from. This is explored in more detail throughout this section.

It is interesting also that the EU's own report on the EPBD (CA EPBD 2016) states that 'The detailed energy audit is not regarded as part of the EPC scheme, but as a necessary next step after having completed the EPC. This distinction is necessary for clients' acceptance: an EPC cannot substitute for detailed refurbishment planning, nor has it been designed to do so.'

For most purposes, the Energy Efficiency Rating (EER) is the most important output of an EPC. However, since this rating is based upon cost of fuel rather than 'energy efficiency' per se, the terms 'Energy Efficiency Rating' and 'Energy Performance Certificate' are both something of a misnomer and can even be misleading. While broadly related to thermal performance, the EER does not actually state the energy efficiency of a property, but rather the estimated running costs to occupy it at assumed comfort levels. (As an example, a traditionally-built property with good levels of insulation and comfort and an efficient heating system may be widely deemed to be efficient, but it can still be allocated a very poor EER if it uses a fuel other than mains gas[22].) This raises a fundamental question of whether an EPC is appropriately named.

4.2 Structure and content of the EPC document

The current EPC format is a 4-page document. The front page contains headline information: estimated energy costs; the property's 'energy efficiency' rating (EER); and the top three measures recommended by the EPC software to improve efficiency and reduce running costs, together with indicative costs and savings. Pages 2-4 provide further basic details, including: an energy 'performance' summary of the various building elements and services; a fuller list of recommended improvement measures; a note on

[22] Technical Paper 8: Energy modelling of the Garden Bothy, Dumfries House (Historic Environment Scotland, 2010) provides a detailed example of this, where a stone-built detached cottage was modelled with a comprehensive set of upgrade measures (including wall, roof and floor insulation, new windows and a new biomass boiler) and still achieved only an 'E' rating under RdSAP modelling.

Green Deal finance; background information on the EPC document; the property's' environmental impact; and brief addenda as required.

It is reasonable to assume that most readers will look primarily at (a) the EER and (b) the recommended improvement measures, and that little attention is paid to the rest of the content. As such, it is likely that the various caveats and explanatory notes contained in an EPC document are often overlooked. This observation is important, as it leads to much of the misunderstanding and/or scepticism surrounding EPCs.

The Environmental Impact Rating (EIR) has far less prominence than in previous iterations of the EPC document, being relegated to the last page and having a more discreet design. While this perhaps makes it less confusing to householders than the previous format, this negates the importance of this rating and places less emphasis on the environmental impact of a building and more emphasis on its fuel costs. This is at odds with the original drivers of the EPC document (the EPBD and Kyoto Protocol) which had at their heart environmental sustainability; as noted previously, the EPC structure in many other European countries places far more importance on the EIR.

It should also be noted that the estimated costs on an EPC are all given for a 3-year period rather than a single year (savings projections are annual). This is likely to make the figures more confusing for householders, who are unlikely to think in 3-year timescales and will have to reverse engineer the figures to make sense of them. It also smacks somewhat of a marketing strategy, i.e. to inflate the figures (by using cumulative 3-year costs and savings) to make energy costs seem more startling and the predicted savings seem larger and more attractive.

4.3 RdSAP assessment process

EPCs for existing dwellings are generated by the RdSAP assessment methodology, a condensed version of full SAP (which is primarily used for new dwellings). While SAP assessments are desk-based, an RdSAP assessment includes a site visit to take details of the property; these are then fed into a software programme which generates the EPC and associated EER. The assessor draws on guidance documents to inform the survey and data entry processes[23].

The aim of the site visit is to take as many details of the property as possible, all of which must be backed up by a combination of visual, photographic and documentary evidence[24]. However, the site visit is a non-invasive, check-list 'survey' and the majority of evidence is likely to be visual/photographic, as documents relating to property upgrades or thermal performance are rarely likely to be available to the assessor. Given that performance characteristics, insulation and so on are rarely visible, this inevitably leads to many assumptions being made by the RdSAP methodology. While assessor training makes evidence requirements explicit, in reality (and backed up by anecdotal and first-hand evidence) it is unlikely that much time will be spent accessing documentary evidence. This is an important learning point: access to full documentary evidence regarding the property would often result in a much more accurate assessment.

[23] These include: Appendices S and T of the SAP 2012 manual (BRE); an RdSAP Conventions document (BRE); and an RdSAP guidance manual produced by approved software providers (example here). These explain the calculations and assumption processes of the RdSAP methodology and provide DEAs with guidance and rules on how to take decisions and enter information throughout an assessment.

[24] Documentary evidence must be dated and property-specific, and show the details of what has been installed. Relevant documents include receipts for works done; guarantees or warranties; installer letters or certificates; and Building Control sign-off.

Due to a combination of performance characteristics and assumptions, certain property types are more likely than others to have a low EER. These include detached properties, bungalows, older properties (see Section 5.2), flat roofs, rooms in roof (where insulation details are not known), and properties off the gas network (particularly where heating is electric). Other property types are likely to score higher, e.g. more modern properties, mid-floor mid-terrace flats, and properties with gas central heating. Some of this is inevitable as certain build types are more efficient than others, but RdSAP processes can also affect this. Assumptions in RdSAP tend to be negative, i.e. to assume worst-case scenario – not to penalise a property unnecessarily but to reduce the risk of over-inflated performance predictions. Of course, this is counteracted somewhat if people do not heat their homes to the temperature assumed in RdSAP.

RdSAP assessments are able to account for some common property variants, such as extensions of different construction or building areas with differing wall depths or insulation properties. However, there are limits to what nuances can be modelled and varying degrees of averaging are common.

The following table summarises some of the main assumptions and calculation processes within RdSAP (further discussion is provided later in this report):

Area	**Assumption Details**
Fuel cost	▪ Taken from fuel cost tables within SAP 2012 manual (periodically updated)[25]
Occupancy	▪ Automatically calculated according to floor area
Heating patterns	▪ 21°C in living area and 18°C elsewhere ▪ 9hrs/day on weekdays and 16hrs/day on weekend days
Thermal mass	▪ 'Medium' (250 kJ/m^{2}K)[26]
Property age	▪ Assessed by a combination of visual inspection, sight of owner documents, reference to RdSAP manual and other research e.g. internet searches (N.B. The latter is encouraged but there is no definition of type or extent of research needed) ▪ Appropriate age band selected by assessor (bands generally correlate with updates to Building Regulations)
Thermal performance: General	▪ With the exception of loft insulation which can often be measured, construction elements are generally entered as 'as built' (or sometimes 'unknown') and default U-values are assigned automatically by RdSAP (see below) ▪ Where there is visual or documentary evidence of additional insulation, the assessor can enter more detailed information; they can also overwrite the default U-value but only where there is suitable documentary evidence
Thermal performance: Walls	▪ Brick: calculated using default assumptions according to wall depth (measured by assessor); default (unmeasured) performance is depth 220mm, U-value 1.7 W/m^{2}K ▪ Stone: calculated using default assumptions according to wall depth (measured by assessor); default (unmeasured) performance is depth 500mm, U-value 2.0 W/m^{2}K (sandstone) / 2.3 W/m^{2}K (granite / whinstone)

[25] See SAP 2012 manual, Table 12, p. 225 (BRE, 2013)
[26] In full SAP, assessors may choose from 'Low', 'Medium' or High', or enter more detailed and accurate figures.

	▪ Internal linings with an airspace behind them (e.g. plasterboard, lath & plaster): calculated using default assumptions (e.g. the above 500mm sandstone wall with an internal lining is assumed to have a U-value of 1.49 W/m^{2}K) ▪ Solid masonry party wall: 0.0 W/m^{2}K
Thermal performance: Roofs	▪ Assumed according to depth of insulation (where measurable). For example, a slate/tile roof with no insulation is assumed to have a U-value of 2.3 W/m^{2}K; with 100mm insulation the assumed U-value is 0.4 W/m^{2}K ▪ Insulation type assumed to be mineral wool. For foam or foil insulation, the measured depth is doubled before being entered to account for its greater thermal performance ▪ Where insulation is present but depth cannot be measured, 50mm is assumed
Thermal performance: Floors	▪ Calculated using equation in SAP 2012 manual using measurements of area, exposed perimeter & wall thickness
Thermal performance: Windows	▪ Single glazing: 4.8 W/m^{2}K ▪ Secondary glazing: 2.4 W/m^{2}K ▪ Pre-2002 double glazing: 3.1-2.6 W/m^{2}K depending on glazing gap (N.B. for a non-PVC frame with an unknown install date, the U-value is assumed as 3.1 W/m^{2}K regardless of glazing gap) ▪ 2002 or later double glazing: 2.0 W/m^{2}K ▪ Multiple glazing age determined by assessor based on visual inspection, sight of documentary evidence & related research e.g. internet searches ▪ Draught proofing: entered based on visual inspection where possible; where not possible, assumed to be absent for single glazing and present for multiple glazing types
Window type	▪ Two options, 'single' or 'multiple' ('multiple' covers different types of secondary, double and triple glazing) ▪ Where more than one type of multiple glazing is present (e.g. double glazing and secondary glazing), the most prevalent type is entered
Window area	▪ Generally not measured, but assumed to be 'typical' ('typical' being assumed according to property age); may also be entered as 'more than typical', 'less than typical', 'much more than typical' or 'much less than typical' ▪ - Actual window area is only measured where it is deemed to be 'much more' or 'much less' than typical[27]
Window orientation (& solar gain)	▪ Assumed East-West, unless all windows are measured
External doors	▪ For pre-1929 dwelling: 3.0 W/m^{2}K unless documentary evidence available
Ventilation	▪ Number of open fireplaces and open flues counted by assessor (under certain conditions) ▪ For pre-1929 dwellings, extract fans disregarded ▪ For pre-1929 dwellings, suspended timber floors entered as 'unsealed' unless U-value entered by assessor is <0.5 W/m^{2}K or floor insulation has been retrofitted ▪ Ventilation system deemed to be natural, unless continuous

[27] The RdSAP manual seems to allow for all windows to be measured where a dwelling has a mixture of glazing types (e.g. single and double) or a mixture of glazing gaps – which is commonly the case, particularly for older buildings – but in reality this practice seems to be virtually nonexistent.

	mechanical system clearly identified ▪ Limited options to account for mechanical systems
Main heating: boiler details	▪ Individual model details used (taken from database) where available; otherwise default type & performance assumed ▪ Limited choice of biomass systems available in database
Secondary heating: wood stoves	▪ Assumed efficiencies: logs 60%, pellets 63%
Secondary heating: open fireplaces	▪ Counted in heating details (under certain conditions) where they are capable of supporting an open fire, even if not used ▪ Temporary blocking methods (e.g. chimney balloons) discounted ▪ Omitted when in bedrooms

Where the assessor has access to sufficient evidence (generally documentary) some of the assumptions in the above table may be over-written. However, this is unlikely to be the norm (unless the homeowner is both present and particularly well prepared) and RdSAP more commonly reverts to assumptions. Some examples are set out below:

- Insulation levels: Generally assumed to be 'as built' (i.e. in line with performance standards at the time of construction) where insulation cannot be seen and measured and documentary evidence is not available. Room-in-roof conversions are at particular risk in this respect, as rafter-level insulation is rarely visible
- Insulation types: there is no database of insulation systems and relatively few options to choose from
- Barn conversion: if the assessor cannot see documentary evidence that all thermal elements were upgraded to the building regulation standards applicable at the conversion date, the original construction date (and accompanying performance values) is assumed
- Secondary glazing: if units have been removed at the time of the assessment (e.g. during summer months), they can only be recorded if the assessor can confirm they exist and can be re-fitted; this may not be possible if the occupant is not present during the site visit

In some cases it may be possible for the assessor to generate documentary evidence, e.g. U-value calculations, but only if they are qualified to do so and the homeowner is willing to pay for this additional service, so in practice this is unlikely to occur often.

4.4 Recommendations within an EPC

The RdSAP software tests for the relevance of a range of improvement measures and includes them automatically where deemed appropriate. Recommendations are applied in a fixed order, as set out in Appendix T of the guidance manual[28]; the reasons behind the ordering of measures are unclear. An improvement measure will be considered / recommended under certain given conditions, and the predicted impact of a measure is based on assumed performance. Assumed cost data is included, and many of the measures are shown to incur high capital costs (which in many cases would be higher still for the tailored approaches likely to be required for traditional buildings).

There are many possible improvement measures. The top ten are shown below, in the order in which they are recommended on an EPC. (Note that this is a summary only).

[28] RdSAP 2012 version 9.93, Appendix T (BRE, 2017).

Rec. number	Measure
1	Loft insulation
2	Flat roof insulation
3	Roof room insulation
4	Cavity wall insulation
5	Party wall insulation
6	Solid wall insulation
7	External insulation with cavity wall insulation
8	Suspended floor insulation
9	Solid floor insulation
10	Hot water cylinder insulation

The ordering of recommendations shows a clear promotion of the 'fabric-first' approach through a range of insulation measures although, as discussed elsewhere in this report, in many cases recommendation of many of these measures is very over-simplified and does not consider appropriateness. These 'top ten' measures are followed by a range of lower-cost measures (draught-proofing, lighting, heating controls), then renewable heating technologies, conventional boiler systems, other heating system replacements, glazing upgrades and finally renewable electricity technologies (e.g. photovoltaics). It is interesting to note that the simpler measures do not come first, that renewable technologies precede conventional boiler upgrades and that window upgrades are near the bottom of the list (this last measure presumably due to the perceived long payback period and/or relatively low thermal impact allocated in SAP modelling).

In some cases a recommendation will be automatically suppressed if an assessor enters certain information relating to the property – for example, where the insulation status is entered as 'unknown' – but assessors are encouraged to avoid entering 'unknown' where possible, so recommendations are not commonly suppressed.

In principle, recommendations may also be removed by the assessor where there is *'documentary evidence showing that a specific recommendation is not appropriate'*[29]. (Note that *'a listed building or a property in a conservation area is not sufficient grounds in its own right to suppress a recommendation'*[30].) In reality, however, this effectively never happens[31]. The main reason for this seems to be[32] that, while some recommended measures may not be appropriate for a property – PV on a heavily shaded roof, for example, or cavity wall insulation in a poorly-maintained wall – the reason for the unsuitability is at a point in time, and an EPC is valid for 10 years; as such, if the 'defect' can be made good then the recommendation becomes valid, and may be able to access related funding. If the assessor has removed the recommendation, access to related funding may not be possible. This is not, however, made clear in the RdSAP guidance documents.

Regardless of suppression or removal, each recommended measure in the full SAP appendix has additional notes and/or qualifying criteria (e.g. loft insulation *'is assumed to include insulation of the loft*

[29] *Ibid*.
[30] *Ibid*.
[31] As confirmed by qualified DEA trainers and RdSAP software provider technical support (accessed March 2018).
[32] *Ibid*.

hatch'; solid wall insulation is considered for any 'as built' stone or brick wall, recommended where the wall U-value is >0.6, and the assumed post-insulation U-value (in England) is 0.3 W/m^{2}K). Of particular note (and discussed later in this report) is the text relating to cavity wall insulation: *'When cavity fill is recommended the data collection includes whether there might be issues of cavity less than 50mm, high exposure or difficulties of access. If any of those apply an addendum is included on the EPC saying that the issues should be investigated to establish the best treatment for the walls'*. The significance of this is discussed in Section 5.2.

4.5 Training & knowledge of EPC Assessors

'The competence of the certifier is considered among the most influential factors affecting the quality and cost of the certificates' (BPIE, 2014)[33].

EPC assessors are more commonly known as Domestic Energy Assessors (DEAs). They are qualified to carry out the RdSAP assessment process, which includes a site visit and the inputting of data into the software programme that generates the EPC. Note that this does not constitute a building survey in the full sense of the word. Unless they have other qualifications DEAs are not surveyors, and cannot be assumed to have any detailed understanding of how to assess buildings holistically; neither can they be assumed to have any sound understanding of heritage, building condition, building physics, moisture in buildings, energy efficiency measures, renewable energy technologies, ventilation services, the impact of behaviour on energy performance, and so on. These are all areas where a good understanding is critical to success in a robust retrofit project, as touched upon previously.

This is not to say that all DEAs lack this knowledge. Some will have come from a background of building surveying or energy analysis, and will have an expert knowledge of some or all of these areas. The point is that none of this can be assumed and, rather like the RdSAP defaults, in order not to miss risks the default assumption must be to assume low knowledge levels in the 'average' DEA.

Training and follow-on support is not consistent across all accrediting bodies, and training courses are not always free from errors. Incorrect information can include: the provision of out-of-date guidance manuals; misinformation on the legal status of listed properties in relation to EPCs; incorrect assertions of how/when certain measures or building characteristics can be included in the assessment; incorrect identification of heating systems; and incorrect instructions with regard to certain software entry processes. More fundamentally, such training courses may place more focus on the basic compliance function of EPCs and how to make processing more streamlined; they are unlikely to make trainee DEAs fully aware of the assumptions and inaccuracies of the process and how they can have a role in making them more accurate. The reasons for this are evident: for the vast majority of clients EPCs are purely a legal requirement, to be obtained as quickly, cheaply and painlessly as possible; this dictates market forces and inevitably drives the cost, time investment and attention to detail towards the bottom line.

It must be made very clear to householders and landlords what EPC assessments are – a simple, pared-down process that gives an estimate of running costs based on certain averaged conditions – and what they are not – a detailed property or retrofit survey in line with the 'whole-house approach'

[33] Energy Performance Certificates across the EU: A mapping of national approaches (BPIE, 2014).

pioneered by the STBA and supported by industry and Government. Section 6 looks at ways in which EPCs and the RdSAP assessment process could be improved and considers how they could be made more consistent with this more robust, holistic approach.

5. Impact of EPC Limitations

RdSAP is periodically updated (along with SAP) and these updates should increase its accuracy somewhat – for example, the most recent revision, in late 2017, included improved default U-values for solid brick walls (from 2.1 to 1.7 W/m^{2}K) and greater account taken of the impact of open chimneys on ventilation. However, accuracy does not necessarily bring with it improved performance predictions[34]. This section identifies particular issues in respect to accuracy and consequences.

5.1 Accuracy & limitations

The front page of an EPC makes clear that it is only an estimation: *'The EPC rating shown…is based on standard assumptions about occupancy and energy use and may not reflect how energy is consumed by individual occupants'*. However, the placement of this text and the typical reader tendency to focus only on the large graphic images means this is often overlooked. As such, EPCs can present a misleading picture of both current performance and of the most appropriate improvement options for the building. The examples below are illustrative rather than exhaustive.

Cost & occupancy

- An EER is based on cost, not on energy efficiency, and so is fundamentally misleading
- The cost bias makes it much harder for non-gas-fuelled properties to achieve a good EER
- The standardised occupancy sizes and relatively intense heating patterns will commonly over-estimate fuel consumption

Thermal performance

- The performance of certain building elements (e.g. solid walls) will commonly exceed that assumed by the software[35]
- Many insulation elements / types will not be credited, due to lack of visual or documentary evidence and a lack of options in the software
- Window sizes are generally assumed rather than measured; they are also assumed to face East-West for the purposes of assessing solar gain
- If the window installation date is not known, modern timber-framed double glazing (including slim-profile systems used in listed buildings) will be assumed to have a relatively poor performance regardless of glazing gap
- A midway point is assumed for thermal mass, reducing the associated benefits for denser construction types
- Open fireplaces are commonly allocated as poorly-performing secondary heating, even where they are not used and have temporary blocking measures installed

Building & occupant health

- Continuous mechanical ventilation systems, which may be required in order to maintain a healthy indoor environment and manage moisture and pollutants (particularly where airtightness and insulation levels are good), are penalised under the EER

[34] In 2012 the focus of RdSAP shifted more towards a 'fabric-first' approach, which can lead to worsened performance predictions for some properties where fabric assumptions are poor.
[35] There is a wealth of evidence (from SPAB, Historic England, Historic Environment Scotland, UCL and the BRE, among others) suggesting this to be the case, despite the recent revisions which have somewhat improved the default U-value for solid brick walls.

Fuel cost vs environmental impact

- Little weight is given to the Environmental Impact Rating (EIR), which has been moved to the last page of the EPC and made less visible
- Cost is the overriding assessment mechanism, although it is presented in terms of 'efficiency'
- Biomass boilers and stoves often score badly on the EER as the number of models included in the database is limited, default efficiencies are poor and fuel costs are higher than oil, even though they generate a fraction of the CO_2 emissions of oil, coal or gas per kWh

The cumulative impact of just one of these inaccuracies is significant. A UCL study analysed the impact of using more realistic u-values for solid brick walls: *'When taken in aggregate, the impact … of changing the solid wall U-value from the standard value of 2.1 to 1.3 is that … approximately one-third of all solid-wall dwellings move one EPC band'*[36].

These impacts continue into the recommendations made by EPCs, as follows.

- On occasion some or even many of the recommendations may already have been carried out, but a lack of documentary or other evidence meant that they could not be included in the RdSAP assessment; this renders any such recommendations irrelevant
- Recommendations may not be viable for a property if they adversely affect its significance, which includes context[37]
- Recommendations may also not be viable on technical grounds, i.e. they may be detrimental to a property and/or its internal environment, for example where its condition – which is not covered by the RdSAP assessment – would give rise to moisture-related problems if certain measures were installed (e.g. poorly-installed loft insulation in a poorly-ventilated roof space; cavity or solid wall insulation on wet / structurally impaired / very exposed walls, particularly where ventilation provision is poor)
- Capital costs, particular for higher-quality or specialist versions of any given measure, are likely to exceed those suggested within the recommendations
- Running cost savings are likely to be lower than those suggested within the recommendations, due to the intensive 'standardised' heating patterns used by the software and an optimistic view of savings
- As noted above, measures like biomass boilers may be 'penalised' due to fuel cost and the difficulty in allocating them a high efficiency in the software, with more environmentally-damaging measures such as oil boilers being presented as a more efficient alternative that would generate a higher EER.

The cumulative impact of these issues is significant. At the national/global scale, the improvement measures will not have the required impact on environment or on fuel poverty. At the same time, property owners are likely to become disenchanted with a document that recommends measures that are not appropriate for their home, are extremely expensive or which do not deliver the promised savings. There is a real risk that this could contribute to a negative view of energy efficiency and the wider environmental agenda.

5.2 EPCs and traditional buildings

Much of the above text relates to traditional buildings as well as other construction types, but there are certain characteristics of older, traditionally-constructed dwellings that merit a separate section. Note

[36] Solid wall U-values: heat flux measurements compared with standard assumptions (UCL, 2014).
[37] BS7913 sets out the need for the assessment of significance on all relevant buildings (not just listed buildings or those in conservation areas) and this would include houses in terraced streets, for example.

that much has already been published on this subject[38]. Perhaps the most significant challenge is summed up in the CLA's retrofit-up briefing:

> *'Traditional properties are part of our cultural heritage and are often sought after for their special character. While steps can be taken to improve them, pursuing a blanket approach to energy efficiency that ignores the significant diversity of our housing stock could lead to the loss of special parts of our cultural heritage'*[39].

Thermal performance – Age plays an important role in RdSAP's assessment of a dwelling. Generally speaking, the older the property the poorer the assumed thermal performance of its elements. To an extent this is justified, but there is a growing body of evidence suggesting that some elements perform better than has historically been assumed[40]. Older properties are more likely than newer ones to have been upgraded but, as discussed previously, where an assessor does not have evidence of insulation depth/performance (i.e. in most cases) the software falls back on these assumed performance figures, so an older building would fare worse than a more recent one even where upgrades had taken place. As noted earlier, where double glazing is present but window age is unknown, full glazing details can only be entered where the frame is PVCu. For most traditional properties, timber windows are preferred – this means that is the assessor cannot determine their age they will be allocated a relatively poor U-value even if in reality they perform much better.

Recognition/impact of measures – Some improvement measures which are more common in older buildings (e.g. internal window shutters, chimney balloons) are deemed temporary or removable by RdSAP and so cannot be included in the assessment. Some of the least contentious measures for 'historic' buildings (e.g. listed buildings or those within a conservation area) may not result in significant EER improvements – even if they have a significant impact on thermal comfort and heat losses (e.g. draught proofing).

Services – The predominance of open fireplaces is likely to penalise older properties, even if they are not used for heating. Even where they have been replaced with wood stoves which can be highly efficient, as noted previously there is no way to recognise this in the RdSAP software. The same is true of wood boilers, more common in rural areas where achieving a high EER is notoriously difficult. There are few biomass options included in the RdSAP boiler database, and if the exact model cannot be entered again a generic, relatively low-efficiency option must be used. Biomass also achieves a worse EER than, say, oil, as the fuel costs more – although it achieves a far better EIR. As noted previously the EIR is given little prominence on an EPC.

Recommendations – It has already been noted that some recommendations may not be suitable for older properties on aesthetic grounds, although this may be over-simplifying matters as there are often specific types of a given measure that would be acceptable (e.g. timber double glazing rather than PVCu). There are also technical risks, however – often stemming from the application of incompatible, moisture-closed materials on moisture-open structures, particularly where the building fabric is not well

[38] It is not possible to include an exhaustive list in this document, but the work of particular organisations should be referred to including Historic England, Historic Environment Scotland, the Sustainable Traditional Buildings Alliance (STBA) and the Society for the Protection of Ancient Buildings (SPAB), as well as broader bodies such as the BRE, UCL and the UK Centre for Moisture in Buildings (UKCMB).
[39] The Retro Fit-up (CLA, 2017).
[40] Note that RdSAP assumptions for solid brick walls were improved in late 2017, to take some account of this. However, they do not go as far as much of the published *in situ* measurements suggest, and other building elements (e.g. stone walls) remain unchanged.

maintained or is particularly exposed and/or porous, or where there is insufficient ventilation. On this last point, note that ventilation systems are never recommended by an EPC, as they are not included in the list of recommended measures. Note also that some of the recommendations, if implemented properly, will reduce ventilation rates, making a property more airtight – in these circumstances it becomes even more important to ensure there is sufficient ventilation, to avoid problems with fabric or indoor air quality.

This is where the real limitations of an EPC become apparent. At present, it can be said to be at one end of a spectrum, where a holistic, whole-house approach to retrofit is at the other end of the spectrum. EPCs have a narrow and limited function; the risk of problems increases rapidly when they start being used in ways for which they were not designed, i.e. as design tools.

An EPC assessment is not a building survey in any real sense of the term. The starting point of any robust building and/or retrofit survey is condition and maintenance; as the RdSAP guidance notes, *'the assessment does not take into consideration the physical condition of any element'*[41]. Fabric make-up must be properly understood in order to allow compatible upgrade measures to be chosen; in RdSAP assessments, where access to building elements is limited, structural make-up is very often assumed: *''assumed' means that the insulation could not be inspected and an assumption has been made in the methodology based on age and type of construction'*[42]. And so on (see Section 5.3 for more on this).

However, EPCs do have the beginnings of a methodology for addressing technical risk. When a property is assessed as having uninsulated cavity walls, for example, cavity wall insulation (CWI) is always recommended – but if the property has access issues, a narrow cavity or high exposure (all factors that can affect the viability of CWI) the assessor has to note these within the software and this triggers the inclusion of some fixed advisory text at the end of the EPC:

- High exposure: *'This dwelling may be exposed to wind-driven rain and so required further investigation to determine which type of cavity wall insulation is best suited'*
- Access issues: *'This property requires further consideration of how to access the walls for installation of cavity wall insulation'*
- Narrow cavity: *'This dwelling may have narrow cavities and so requires further investigation to determine which type of cavity wall insulation is best suited'*

The inclusion of these notes is both logical and sensible. Unfortunately, in reality they may be of little value when it comes to implementation of the measure. Firstly, the notes are included at the very end of the EPC, where they are least likely to be read. Secondly, 'High exposure' may only be ticked if the property sits within Exposure Zones 3-4 on the UK Exposure Zones map, whereas in reality many properties outside these zones will also be subject to high exposure. And lastly, the recommendation remains in the list of improvement measures without any altered wording. (It should be noted that the inclusion of a stone wall in the RdSAP assessment will also trigger similar text, but only in relation to ascertaining whether there is a cavity in the wall.)

There is a lot that could be done to improve the robustness of this 'flagging' process and extend it to other equally risk-prone measures.

[41] RdSAP 2012 version 9.93 (BRE, 2017).
[42] *Ibid*.

6. Improvement Opportunities & The Whole House Approach

This section sets out how EPCs could be improved, explains the Whole House approach, and then examines how a revised EPC could inform a Whole House assessment. There will inevitably be some barriers to implementation (e.g. improved training & qualifications for assessors, time investment in updating calculation methodologies, the additional costs of improved assessments, etc.) but these are surmountable and Section 7 begins to address them.

6.1 Improvement opportunities

Scrutiny of the ways in which EPCs and RdSAP function reveals a number of opportunities for improvement. Some of these would be relatively simple to implement; others would require more time and thought. With this in mind, the opportunities identified below are split into groups, ranging from those that may be implemented with relative ease (i.e. without any major reworking of the EPC / RdSAP processes) to more significant changes that would allow them to work better with the whole-house approach increasingly championed by Government and industry.

Note that there is a limit to these opportunities. The essential functions of the EPC are likely to remain largely unchanged in the foreseeable future, and this report is not seeking to suggest any major shift in this respect. Rather, it is identifying a range of ways in which EPCs can be made more robust without changing their essential function.

The recommendations shown here are in no particular order, and some echo those previously called for by other organisations[43]. It is likely that further options will be identified during the anticipated second phase of this work (see Section 8).

6.1.1 Re-wording & re-structuring

These are mostly small changes that would have a big beneficial impact for all parties, clarifying to function and boundaries of the EPC document.

- Rename the EER as an Energy Cost Indicator (ECI) or similar. As an interim measure, include a sentence to provide absolute clarity on the fact that this rating is based upon estimated fuel cost and not actual energy efficiency
- Give the assumption caveat ('*The EPC rating shown here is based on standard assumptions about occupancy and energy use and may not reflect how energy is consumed by individual* occupants') more prominence by moving it up the front page, enlarging the font or similar. This text could also be revised to make the indicative nature of EPC ratings clearer to householders
- Reduce the text on page 4 of the EPC document
- Show running costs and savings as annual rather than 3-year figures
- Increase the prominence of the EIR (as was the case on the pre-2012 EPC document, but currently on page 4 and given low visibility) and include clear explanatory text to ensure readers understand how it differs from the EER. This would provide a more rounded, holistic presentation of property characteristics and bring the EPC document more in line with those in other countries and indeed with its EPBD and Kyoto Protocol roots

[43] These include the STBA, the National Trust, Historic England, SPAB and the CLA.

- For low-scoring properties, include a summary of likely reasons for this, to help owner understanding. This would include, for example, reference to a property being off-gas, or having insulation that could not be accessed during the site visit
- Add explicit text to the 'Recommendations' text (currently on page 3) on four key areas:
    - the suitability or otherwise of measures for particular buildings (e.g. traditionally-constructed buildings, buildings with maintenance issues, exposed buildings)
    - the general principle of addressing maintenance first, noting that this will also reduce technical risk of problems associated with certain recommendations
    - the possible need for increased ventilation provision following insulation and airtightness measures – noting that modern ventilation systems incur very low running costs while helping safeguard the indoor air quality and building fabric
    - The benefits of related measures that cannot be included in the formal recommendations due to their temporary nature, e.g. internal shutters and chimney balloons
- Move the Addenda notes (currently at the bottom of page 4) relating to certain measures (e.g. CWI) to sit alongside the particular recommendation, and increase their prominence
- Explain the reasoning behind the ordering of recommendations in Appendix T; review the ordering of recommendations; add explanatory text to Appendix T explaining the function of the last column in Table T ('Rec. Num.')

6.1.2 Advisory notes

These are ways to improve clarity further by increasing the scope for assessors to add further advisory notes, in the manner that they can currently be added in relation to CWI. This essentially comprises adding more tick boxes within the RdSAP software; drafting further set text that would be added automatically to the EPC document; and adding minor additional text to the RdSAP guidance documents.

- Allow assessors to note (tick) where a property is likely to be exposed to high levels of wind-driven rain even though they are not in Zones 3-4; develop standardised Addendum text accordingly to appear on the EPC when this is noted, advising homeowners that certain recommendations (e.g. CWI, IWI) may require further investigation to ensure they are appropriate and that particular systems may be needed
- Allow assessors to note (tick) where a property has evident maintenance issues; develop standardised Addendum text accordingly to appear on the EPC when this is noted, advising homeowners that these issues should be rectified before certain recommendations are implemented
- Allow assessors to note (tick) where a property is of traditional construction and may have significance (formal or otherwise); develop standardised Addendum text accordingly to appear on the EPC when this is noted, advising homeowners that recommendations may be subject to permission, particular care will be needed in design and specification and costs are likely to be higher than for other build types
- Develop standardised Addendum text to appear on the EPC whenever EWI or IWI are recommended on brick or stone buildings, advising homeowners that particular materials and detailing are likely to be needed to ensure the compatibility with existing building fabric

6.1.3 Heating system databases

Some additions to the heating system database within RdSAP would provide a much fairer assessment process for older and rural properties, particularly where they are off the gas network and therefore liable to receive a poor EER.

- Review the boiler database within RdSAP, expanding it to include all boiler models including biomass systems. This will reduce the use of poor default performance assumptions and provide much-needed accuracy particularly to older and rural properties
- Extend the boiler database within RdSAP to include biomass and dual-fuel stoves. This will reduce the use of poor default performance assumptions and provide much-needed accuracy particularly to older and rural properties
- Require manufacturers to enter their model data in all cases, and make entry of the specific boiler model mandatory for assessors

6.1.4 Listed buildings & conservation areas

The position and wording with regard to the requirement or otherwise to produce EPCs for listed buildings and buildings in conservation areas needs to be clarified beyond any doubt, to end the current situation of having a qualified exemption that is meaningless in practice.

- Option A: Make a clear statement to the effect that EPCs are not required for buildings which are listed or which lie in conservation areas (similar to the situation in France). This option has the advantage of clarity but an EPC does help to raise awareness of energy use, which should be at least considered in all buildings irrespective of heritage value.
- Option B: No buildings would be exempt from the requirement to produce an EPC at the relevant trigger point (as is the case in Scotland). This option has the advantage of simplicity as the EPC document itself poses no risk to a building; it is only the application of Minimum Energy Efficiency Standards which poses a threat, so the exemption should be framed in terms of MEES rather than in terms of the requirement to produce an EPC.

It should be noted, however, that many of the concerns around this area are also applicable to the majority of unlisted traditional buildings - i.e. those which lie outside conservation areas. This is an area requiring further more detailed consideration and a special approach developed in SAP for properties in age bands A and B. This would then be consistent with Part L1B of the Building Regulations which makes special provision for all dwellings of traditional construction.

6.1.5 Longer-term proposals

These are improvements which the authors recognise would require more work and correspondingly a longer timescale, but which are felt to be very important in further improving the robustness of EPC and RdSAP processes, and allowing them to work more closely with the whole- house approach to existing building retrofit.

- **Re-name the EPC** as an Energy Cost Certificate (ECC) / Energy & Environmental Cost Certificate (EECC) or similar. This would not require any software changes, but a simple renaming would make the actual function of the document much clearer and help avoid confusion and negative perceptions
- **Develop an insulation database** similar to the current boiler database, but accounting for the ever-increasing number and type of insulation systems. This could be used in two ways: firstly, to allocate more accurate building performance characteristics to the baseline assessment rating; and secondly, to inform the recommendations, allowing filters to recommend certain types of insulation based on property type, exposure, ventilation and so on
- **Develop a ventilation database** drawing on the database contained within full SAP for example. This would allow much more accurate inputting of baseline information, and provide scope for future recommendation of ventilation systems alongside insulation and airtightness measures
- **Review the focus of the EPC** to place more emphasis on the environmental impact of buildings (i.e. the EIR) and less on the EER, in order to provide a more rounded, holistic presentation of property

characteristics and bring the EPC document more in line with its EPBD and Kyoto Protocol roots. Work would be needed to assess the impact on link-ups with energy-related funding schemes

- **Develop an improved assessment process** to allow for greater accuracy both at site assessment and data inputting stages. This may be a separate, enhanced option offered alongside the basic assessment, or (in the future) wholesale replacement. This would be likely to include, for example: assessor access to and scrutiny of all relevant property documentation (e.g. conveyancing documents, building work documentation etc.); the option for assessors to provide or source further documentary evidence (e.g. U-value calculations; professional surveyor views on maintenance and/or applicability of measures); and so on. In some cases assessors would be qualified to provide this evidence themselves; in others this would be provided by a third party
- **Develop enhanced training courses for DEAs** either to facilitate the previous recommendation or as a more general option to expand their understanding of the retrofit process and the importance of a holistic approach; this would include building condition and maintenance as a starting point, in order to make buildings 'retrofit ready'. This could involve the creation of add-on modules to the core DEA course, or link up with existing training courses related to energy modelling and/or retrofit. Note that this recommendation could easily be implemented at a lower level in the short term, by the creation of broader add-on modules to the existing course. At the very least this would give future DEAs a greater basic understanding of where their service sits within the full picture of building retrofit

Note that this last recommendation is consistent with the direction proposed by both Each Home Counts and PAS 2035. It also links in with a new Qualifications Wales report[44] which recognises that the knowledge and skills required to work on traditional buildings needs to be embedded in mainstream qualifications throughout all stages of learning; indeed, Cadw is strongly promoting this through its Strategic Skills Partnership Agreement with CITB, Historic England and Historic Environment Scotland.

6.2 The Whole House approach to retrofit

A "Whole House" approach to retrofit takes into account all aspects of a dwelling's fabric and services but also considers its context and the interaction with the occupants. For example, insulating one wall in a dwelling will make others relatively cooler. Without changes to the ventilation system, the moisture load in the property remains the same, so the risk of condensation on uninsulated walls has increased. This risk of condensation at the junctions between the wall and floor, and the wall and ceiling, or on the windows has also increased. At the same time, adjustments will be needed to the heating controls in order to achieve the intended savings. In traditional buildings, external wall insulation changes the appearance of a property and, if inappropriately applied, can have an impact on an entire streetscape. Any measures which reduce natural ventilation can have a negative impact on indoor air quality and therefore on human health. Context also includes the condition of the dwelling, its exposure and the local weather conditions - a change which might be safe in a well-maintained and sheltered building might lead to serious moisture issues in a more exposed location.

The Whole House approach to retrofit was initially championed by the STBA. The UK Government's 2016 Each Home Counts report acknowledges this and embraces the concept: Recommendation 17 states that *'all retrofit projects will have an appropriate design stage process which takes a holistic approach and adequately considers the home, its local environment, heritage, occupancy, and the*

[44] Building the future: Sector review of qualifications and the qualification system in construction and the built environment (Qualifications Wales, 2018).

householders' improvement objectives when determining suitable measures'[45]. It can immediately be seen that this is at odds with the purpose and structure of the EPC.

The interest in a more holistic approach arose in response to the many unintended consequences of existing retrofit programmes and projects including unhealthy indoor environments, fabric decay, moulds and condensation, building services problems, remedial costs and liabilities, failure to meet reduction targets and even increased carbon emissions and energy use in some cases.

> *'It is generally accepted that, to a large extent, these problems have occurred, directly or indirectly, as a result of single-focus, single-measure or unintegrated approaches to work on existing buildings. Indeed, the concept of retrofit itself could be said to be single focus, often being primarily about energy/carbon in use, rather than a holistic approach with equal concern for issues such as health, comfort, long-term durability of buildings, embodied energy, the wider environment, heritage and community*.
>
> *'Unless we start with the Whole House position, our efforts will lead to unintended consequences and may be counter-productive even in the most narrowly-measured terms. Even if we cannot achieve the Whole House approach for many years, it needs to be the framework within which partial measures and processes are undertaken'*[46].

The implementation of the Each Home Counts (EHC) report is via a series of workstreams. The most advanced of these at the time of writing is the Standards Workstream, which is developing new standards for use in retrofit. PAS 2035, covering assessment of buildings and the design of retrofit measures, is currently being drafted and includes a wider set of objectives than simply energy use; health & wellbeing and heritage are both explicitly mentioned. The EHC report also sets out the need for skills & training to address this, requiring an understanding of building physics, the suitability of measures and the interactions[47] between them (ignored in EPCs).

In Wales, a version of the Whole House approach has been used for some years, though no such developments have occurred in in Scotland which still focuses entirely on carbon emissions from the use of buildings. The Welsh Housing Quality Standard (2008), which is aimed at social housing, covers condition (stability, disrepair and damp), safety and security, thermal comfort, facilities, special needs of the occupants and, in Part 6, states that *'all dwellings should be located in an environment to which residents can relate and in which they can be proud to live'*. This reference to context is completely absent from the EPC assessment process.

The Welsh energy saving scheme for private dwellings (Arbed) also takes a holistic approach. While this does not extend to the full Whole House approach recommended by the STBA, it does include local job creation as part of its aims and metrics, and community benefits were among the gains most strongly identified by residents[48]. This is very important, as retrofit offers a unique opportunity to achieve community regeneration and a wide range of social and economic goals at the same time as improving living conditions and thermal comfort, reducing energy bills and carbon emissions.

[45] Each Home Counts (BEIS & CLG, 2016).
[46] What is whole house retrofit? (STBA, 2016).
[47] For a full explanation of interactions see the STBA's Guidance Wheel .
[48] Arbed Final Report (Ricardo Energy & Environment, 2017)

Buildings are much more than just energy users. They provide shelter, security, and a sense of place, of belonging. Good quality buildings inspire and uplift, whilst poor quality buildings dehumanise people. The assessment of buildings needs to recognise that buildings 'perform' in a variety of ways and that heating and lighting (energy use covered in an EPC) are just two of these many functions.

6.3 The role of EPCs within a Whole House Approach

The suggestions for changes to EPCs set out in Section 6.1 only cover the use of EPCs within their currently defined purpose. While the EPC cannot itself deliver a Whole House assessment, if the changes set out in Section 6.1.5 were implemented, then it could at least be consistent with this approach.

Put simply, the EPC can serve as a useful part of a Whole House assessment, but cannot deliver it. The EPC requires change even to be consistent with a Whole House approach.

The upgraded EPC would feed into the Whole House assessment process, providing base data on the structure (and condition) of the building and setting out a series of (appropriate) measures. It is interesting also that the EU's own report on the EPBD[49] states that *'the detailed energy audit is not regarded as part of the EPC scheme, but as a necessary next step after having completed the EPC. This distinction is necessary for clients' acceptance: an EPC cannot substitute for detailed refurbishment planning, nor has it been designed to do so'*.

What the Whole House approach advocates is not only a much more comprehensive 'energy audit' but a retrofit assessment which includes goals other than energy – i.e. health and heritage. Such an assessment will cost more to carry out and surveyors will need to have a wider skill set, but the alternative is to continue to suffer the negative unintended consequences already associated with numerous retrofit schemes.

To avoid these consequences, PAS 2035 is developing the framework within which such an assessment can be carried out. Aware of the shortcomings of the present system, some major building stock owners are already developing their own approach - the National Trust's Environmental Standards is one such example. This approach could be summarised as: do what is sensible, safe, achievable and cost-effective, then think again. A Whole House Approach is also being followed in a major retrofit programme in London.

A Whole House approach to retrofit is essential. Failures confirm this. The EHC report calls for it; the UKCMB says that it is essential; the developing PAS 2035 can deliver it. Brexit is an opportunity to break the stranglehold of energy as the primary means of assessing and improving buildings. There is no getting away from the fact that survey will be more expensive but, given failures and missed opportunities, the survey cost is a small fraction of the overall cost of retrofit. As a carpenter might put it, measure twice, cut once.

[49] Certification overview & outcomes (CA EPBD, 2015)

7. Recommendations for Further Research

It is clear from this scoping study that there are fundamental problems with EPCs in their current state and, in particular, how they could impact on the way traditional buildings are treated. It is also clear that, with some modification, they could contribute positively towards a whole house assessment, which should always be carried out prior to the development of a retrofit plan for any particular building.

If making an approach to the Ministry of Housing, Communities and Local Government (who have primary responsibility for EPCs) and the Department for Business, Energy and Industrial Strategy (who are increasingly using EPCs as a policy tool) to recommend changes to a system, evidence will be required. Further research is therefore necessary to provide this evidence, and then to determine the optimal course of action.

7.1 Quantitative research

For the changes suggested in this report were to be implemented, we need to understand the effect on EPC scores – however calculated – bearing in mind that the EIR seems a more appropriate measure than the EER. It would be particularly instructive so see how EPC ratings (EER and EIR) for traditional buildings would compare to those for more modern buildings, and to contrast this with the relative 'performance' of traditional buildings under the existing metrics.

This exercise involves data gathering across a wide range of properties; much of this data is likely already to be available where properties already have an EPC. However, there are many variables, so to get a statistically robust result the data sample would need to be large. This can be simplified to a degree by using a limited number of agreed common reference property types as a base.

The quantitative research also needs to establish the types of measures that would be needed to comply with the aspirational target of EPC band C set out in the Clean Growth Strategy, so that we can determine whether the required measures (under the current EPC scoring system) are likely to lead to increased risks to traditional buildings and to human health.

Research on the cost (and difficulty) of improved survey is also necessary, together with research into the acceptability and usefulness of a revised EPC to building owners.

7.2 Legislative research

This scoping study suggests that the legal requirements for the format of EPCs – either in the EPBD or in the Energy Performance of Buildings (England & Wales) Regulations – are not heavily prescriptive. It is also clear that things are done differently in other Member States. This in turn implies that significant change could be achieved without the need to amend UK legislation and while still complying with the EPBD. Research with UK Government is necessary to confirm what changes can be made within existing regulations, and who makes them and whether a cross-departmental approach is feasible, and to determine the scope for further change post Brexit.

7.3 Technical research

Various technical questions about how the RdSAP software works remain to be resolved. For example, we do not at present understand why Appendix T of SAP determines the order in which measures must be presented on an EPC, in the way that it does. We need to know how energy use and savings are calibrated against empirical data. We also need to test assessments under different scenarios, e.g. worst-case assumptions vs best-case evidenced property data; comparing different modelling systems such as SAP and Passive House Planning Package (PHPP).

7.4 Research into training and capacity

PAS 2035, which will apply to ECO funded work, is addressing training at all levels within retrofit and has identified the relevant courses that already exist, but we need to understand the capacity of the industry to deliver the training necessary to carry out improved EPC assessments and whole house assessments.

Further research is also required into the linkages or otherwise between an EPC 'survey' and a building survey. Points requiring clarification include: EPC surveys are likely to be required for both rentals and sales, but building surveys are likely only to be required for sales (i.e. broader condition assessments are not likely to be picked up by EPC assessors during rental assessments); to what extent building surveyors and EPC assessors could complement one another, without threatening the other; where should an EPC survey stop; how a Level 3 building survey might address energy and sustainability and become an approved Whole House assessment; and so on. This is likely to include discussions with RICS / CIOB in the first instance, as well as DEA training bodies.

Lastly, we would recommend that a meeting is arranged with HM Government to discuss both the findings of this report, the improvement options and the recommendations for further development.

7.5 Funding of further research

Two UK government departments have a natural interest in funding this research. BEIS are currently using EPCs as a policy lever intended to deliver against the UK's carbon targets. MHCLG are formally responsible for the implementation of the EPBD and therefore for EPCs.

Property owners also have a natural interest in the outcome of this research. As it stands, owners of large portfolios will be required to invest substantial sums to make changes to the building stock which may or may not be effective, and which might cause damage. For example, the National Trust, the Grosvenor Estate, the Crown and the landlords represented by the Country Land & Business Association all own large portfolios with a high percentage of traditionally-constructed buildings.

A public-private sector partnership is therefore best placed to commission the required research.

Appendix 1: References & Further Reading

All references are listed in the order cited in the main text, followed by further relevant documents and organisations.

- Implementing the EPBD (CA EPBD, 2016)Each Home Counts (BEIS & CLG, 2016)
- The Retro Fit-up (CLA, 2017)
- Energy Performance Certificates across the EU: A mapping of national approaches (BPIE, 2014)
- Energy efficiency and condition standards in private rented housing (Scottish Government, 2017)
- The clean growth strategy: Leading the way to a low carbon future (HM Government, 2017)
- A guide to Energy Performance Certificates for the marketing, sale or let of dwellings (MHCLG 2017)
- Technical assessment of national/regional calculation methodologies for the energy performance of buildings, Table 1 (European Commission, 2015)
- Energy Efficiency in buildings: Update on Standards development and 'Each Home Counts' (BSI, 2017)
- Green Deal Provider Guidance, Step 3, p8 footnote (DECC, 2012)
- The Government response to the ECO: Help to Heat Consultation (BEIS, 2017)
- https://www.ofgem.gov.uk/publications-and-updates/eco2-consultation-deemed-scores
- Technical Paper 8: Energy modelling of the Garden Bothy, Dumfries House (Historic Environment Scotland, 2010)
- Appendices S and T of the SAP 2012 manual (BRE, 2017)
- RdSAP Conventions document (BRE, 2017)
- RdSAP 2012 version 9.93 (BRE, 2017)
- SAP 2012 manual (BRE, 2013)
- Solid wall U-values: heat flux measurements compared with standard assumptions (UCL, 2014)
- BS 7913:2013 Guide to the conservation of historic buildings (BSI, 2013)
- Building the future: Sector review of qualifications and the qualification system in construction and the built environment (Qualifications Wales, 2018)
- Each Home Counts (BEIS & CLG, 2016)
- What is whole house retrofit? (STBA, 2016)
- STBA's Guidance Wheel
- Arbed Final Report (Ricardo Energy & Environment, 2017)
- Certification overview & outcomes (CA EPBD, 2015)

- The domestic Energy Performance Certificate requirements of The Energy Performance of Buildings (England & Wales) Regulations 2012 (SI 2012/3118)
- The Energy Efficiency (Private Rented Property) Regulations 2015 (SI 2015/962)

- The Domestic Private Rented Property Minimum Standard; Guidance for landlords (HM Government, October 2017)
- A guide to EPCs for the marketing, sale and let of dwellings (DCLG, 2012, last updated December 2017)
- BS EN 16883:2017 Conservation of cultural heritage (BSI, 2017)
- Energy efficiency and historic buildings: Energy Performance Certificates (Historic England, 2015)
- Energy efficiency and historic buildings: Advice for Domestic Energy Assessors and Green Deal Advisors (Historic England, 2015)
- Technical Paper 16: Green Deal financial modelling of a traditional cottage and tenement flat (Historic Environment Scotland, 2012)
- Technical Paper 17: Green Deal, Energy Company Obligation and traditional buildings (Historic Environment Scotland, 2013)
- Technical Paper 21: Data sources for energy performance assessments of historic buildings in the United Kingdom (Historic Environment Scotland, 2014)

Relevant organisations & work:

- National Trust
- Historic England
- Historic Environment Scotland
- Society for the Protection of Ancient Buildings (SPAB)
- Sustainable Traditional Buildings Alliance (STBA)
- UK Centre for Moisture in Buildings (UKCMB)

Appendix 2: Sample EPC

Energy Performance Certificate

PREVIEW NOT FOR ISSUE

HM Government

Dwelling type:	Semi-detached house	**Reference number:**	0000-0000-0000-0000-0000
Date of assessment:	20 March 2018	**Type of assessment:**	RdSAP, existing dwelling
Date of certificate:	20 March 2018	**Total floor area:**	82 m²

Use this document to:

- Compare current ratings of properties to see which properties are more energy efficient
- Find out how you can save energy and money by installing improvement measures

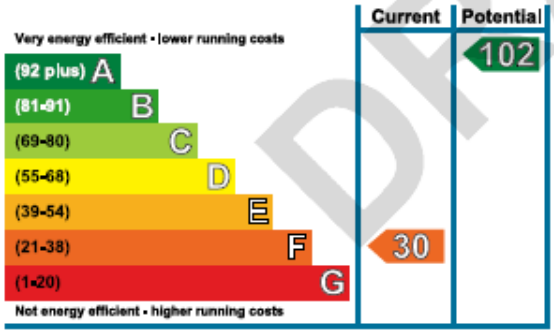
Estimated energy costs of dwelling for 3 years:	**£ 3,501**
Over 3 years you could save	**£ 1,983**

Estimated energy costs of this home

	Current costs	Potential costs	Potential future savings
Lighting	£ 255 over 3 years	£ 171 over 3 years	You could save £ 1,983 over 3 years
Heating	£ 2,898 over 3 years	£ 966 over 3 years	
Hot Water	£ 348 over 3 years	£ 381 over 3 years	
Totals	**£ 3,501**	**£ 1,518**	

These figures show how much the average household would spend in this property for heating, lighting and hot water and is not based on energy used by individual households. This excludes energy use for running appliances like TVs, computers and cookers, and electricity generated by microgeneration.

Energy Efficiency Rating



The graph shows the current energy efficiency of your home.

The higher the rating the lower your fuel bills are likely to be.

The potential rating shows the effect of undertaking the recommendations on page 3.

The average energy efficiency rating for a dwelling in England and Wales is band D (rating 60).

The EPC rating shown here is based on standard assumptions about occupancy and energy use and may not reflect how energy is consumed by individual occupants.

Top actions you can take to save money and make your home more efficient

Recommended measures	Indicative cost	Typical savings over 3 years
1 Internal or external wall insulation	£4,000 - £14,000	£ 1,170
2 Floor insulation (solid floor)	£4,000 - £6,000	£ 117
3 Draught proofing	£80 - £120	£ 57

See page 3 for a full list of recommendations for this property.

To find out more about the recommended measures and other actions you could take today to save money, visit www.gov.uk/energy-grants-calculator or call **0300 123 1234** (standard national rate). The Green Deal may enable you to make your home warmer and cheaper to run.

Page 1 of 4

20 March 2018 RRN: 0000-0000-0000-0000-0000

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Energy Performance Certificate

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Granite or whinstone, as built, no insulation (assumed)	★☆☆☆☆
Roof	Pitched, 300 mm loft insulation	★★★★★
Floor	Solid, no insulation (assumed)	—
Windows	Partial double glazing	★★☆☆☆
Main heating	Boiler and radiators, oil	★★☆☆☆
Main heating controls	TRVs and bypass	★★★☆☆
Secondary heating	Room heaters, coal	—
Hot water	From main system	★★☆☆☆
Lighting	Low energy lighting in 50% of fixed outlets	★★★★☆

Current primary energy use per square metre of floor area: 396 kWh/m² per year

The assessment does not take into consideration the physical condition of any element. 'Assumed' means that the insulation could not be inspected and an assumption has been made in the methodology based on age and type of construction.

See addendum on the last page relating to items in the table above.

Low and zero carbon energy sources

Low and zero carbon energy sources are sources of energy that release either very little or no carbon dioxide into the atmosphere when they are used. Installing these sources may help reduce energy bills as well as cutting carbon. There are none provided for this home.

Your home's heat demand

For most homes, the vast majority of energy costs derive from heating the home. Where applicable, this table shows the energy that could be saved in this property by insulating the loft and walls, based on typical energy use (shown within brackets as it is a reduction in energy use).

Heat demand	Existing dwelling	Impact of loft insulation	Impact of cavity wall insulation	Impact of solid wall insulation
Space heating (kWh per year)	14,631	N/A	N/A	(6,221)
Water heating (kWh per year)	2,128			

You could receive Renewable Heat Incentive (RHI) payments and help reduce carbon emissions by replacing your existing heating system with one that generates renewable heat, subject to meeting minimum energy efficiency requirements. The estimated energy required for space and water heating will form the basis of the payments. For more information, search for the domestic RHI on the www.gov.uk website.

20 March 2018 RRN: 0000-0000-0000-0000-0000

PREVIEW - NOT FOR ISSUE

Energy Performance Certificate

Recommendations

The measures below will improve the energy performance of your dwelling. The performance ratings after improvements listed below are cumulative; that is, they assume the improvements have been installed in the order that they appear in the table. Further information about the recommended measures and other simple actions you could take today to save money is available at www.gov.uk/energy-grants-calculator. Before installing measures, you should make sure you have secured the appropriate permissions, where necessary. Such permissions might include permission from your landlord (if you are a tenant) or approval under Building Regulations for certain types of work.

Recommended measures	Indicative cost	Typical savings per year	Rating after improvement
Internal or external wall insulation	£4,000 - £14,000	£ 390	E53
Floor insulation (solid floor)	£4,000 - £6,000	£ 39	D55
Draught proofing	£80 - £120	£ 19	D56
Low energy lighting for all fixed outlets	£25	£ 23	D57
Heating controls (room thermostat)	£350 - £450	£ 37	D59
Replace boiler with new condensing boiler	£2,200 - £3,000	£ 68	D64
Solar water heating	£4,000 - £6,000	£ 28	D66
Replace single glazed windows with low-E double glazed windows	£3,300 - £6,500	£ 56	C70
Solar photovoltaic panels, 2.5 kWp	£5,000 - £8,000	£ 278	C80
Wind turbine	£15,000 - £25,000	£ 576	A102

Opportunity to benefit from a Green Deal on this property

Green Deal Finance allows you to pay for some of the cost of your improvements in instalments under a Green Deal Plan (note that this is a credit agreement, but with instalments being added to the electricity bill for the property). The availability of a Green Deal Plan will depend upon your financial circumstances. There is a limit to how much Green Deal Finance can be used, which is determined by how much energy the improvements are estimated to **save** for a 'typical household'.

You may be able to obtain support towards repairs or replacements of heating systems and/or basic insulation measures, if you are in receipt of qualifying benefits or tax credits. To learn more about this scheme and the rules about eligibility, call the Energy Saving Advice Service on **0300 123 1234** for England and Wales.

20 March 2018 RRN: 0000-0000-0000-0000-0000

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Energy Performance Certificate

About this document and the data in it

This document has been produced following an energy assessment undertaken by a qualified Energy Assessor, accredited by Stroma Certification. You can obtain contact details of the Accreditation Scheme at www.stroma.com.

A copy of this certificate has been lodged on a national register as a requirement under the Energy Performance of Buildings Regulations 2012 as amended. It will be made available via the online search function at www.epcregister.com. The certificate (including the building address) and other data about the building collected during the energy assessment but not shown on the certificate, for instance heating system data, will be made publicly available at www.opendatacommunities.org.

This certificate and other data about the building may be shared with other bodies (including government departments and enforcement agencies) for research, statistical and enforcement purposes. For further information about how data about the property are used, please visit www.epcregister.com. To opt out of having information about your building made publicly available, please visit www.epcregister.com/optout.

Assessor's accreditation number:
Assessor's name:
Phone number:
E-mail address:
Related party disclosure:

There is more information in the guidance document *Energy Performance Certificates for the marketing, sale and let of dwellings* available on the Government website at:
www.gov.uk/government/collections/energy-performance-certificates. It explains the content and use of this document, advises on how to identify the authenticity of a certificate and how to make a complaint.

About the impact of buildings on the environment

One of the biggest contributors to global warming is carbon dioxide. The energy we use for heating, lighting and power in homes produces over a quarter of the UK's carbon dioxide emissions.

The average household causes about 6 tonnes of carbon dioxide every year. Based on this assessment, your home currently produces approximately 9.1 tonnes of carbon dioxide every year. Adopting the recommendations in this report can reduce emissions and protect the environment. If you were to install these recommendations you could reduce this amount by 8.1 tonnes per year. You could reduce emissions even more by switching to renewable energy sources.

The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO_2) emissions based on standardised assumptions about occupancy and energy use. The higher the rating the less impact it has on the environment.

Addendum

This dwelling has stone walls and so requires further investigation to establish whether these walls are of cavity construction and to determine which type of cavity wall insulation is best suited.

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Page 4 of 4

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