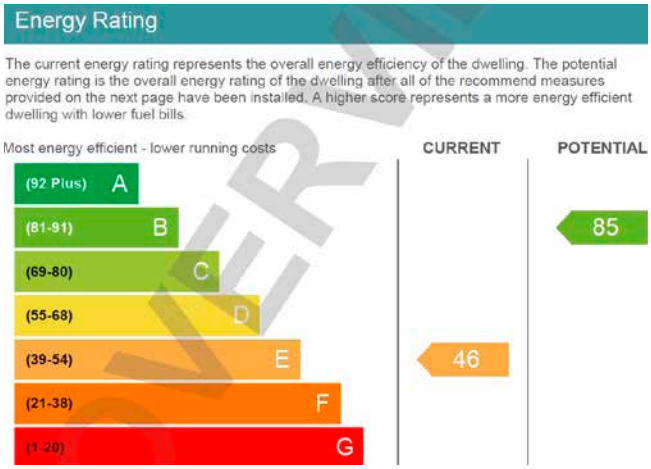
Historic England

Energy Efficiency and Historic Buildings

Energy Performance Certificates (EPCs) Case Studies

Recommended measures	Indicative cost	Typical savings per year	Rating after improvement
Increase loft insulation to 270 mm	£100 - £350	£ 34	F33
Floor insulation (suspended floor)	£800 - £1,200	£ 142	F38
Add additional 80 mm jacket to hot water cylinder	£15 - £30	£ 27	F38
Draught proofing	£80 - £120	£ 53	E40
Low energy lighting for all fixed outlets	£20	£ 20	E40
High heat retention storage heaters and dual immersion cylinder	£2,000 - £3,000	£ 660	D67
Solar water heating	£4,000 - £6,000	£ 69	C69
Replace single glazed windows with low-E double glazed windows	£3,300 - £6,500	£ 40	C71
Solar photovoltaic panels, 2.5 kWp	£3,500 - £5,500	£ 376	B81
Wind turbine	£15,000 - £25,000	£ 675	A104



Summary

Energy Performance Certificates (EPCs) are the Government's legislated rating scheme to summarise and report energy performance of buildings. The domestic and non-domestic sectors use different methods in order to assess the energy efficiency of buildings. The case studies focus on the domestic rented sector.

In 2020 the Government consulted on increasing the Minimum Energy Efficiency Standards (MEES) for privately rented domestic properties from EPC Band E to EPC Band C for new tenancies from 2025 and all tenancies from 2028.

Historic England in conjunction with the MEES working group (National Trust (chair), Historic England, Country Land and Business Association, The Central Association for Agricultural Valuers, The Landmark Trust and other stakeholders) undertook case studies to provide evidence of the issues surrounding EPC assessments for traditionally constructed buildings and identify the barriers to successful improvements to energy efficiency.

The key issues identified were:

- EPC assessment procedure
- Fuel types
- Overall costs
- Impact on traditional construction

The case studies review the EPCs of a broad range of buildings of different construction typologies across the country, and both on- and off-gas grid. Some properties are listed or in conservation areas but not all.

As traditionally constructed buildings account for around 35 per cent of England's building stock, it is vital that EPCs provide an accurate and reliable assessment of a building's energy performance irrespective of their construction.

Front cover: The draft EPC recommendations for Martins Hill Lane from October 2019 [Rich Shirley] (top); Church View, Bucknell [© Mr Bryan Green / Source: Historic England Archive] (bottom left); the Energy Efficiency Rating for Park View, Shenton [Charles Wollaston] (bottom right).

The case studies show the need to:

- Incorporate an understanding of traditional building performance with appropriate data and models in the EPC software
- Provide a system for planning works that will achieve compliance ahead of any future methodology updates
- Provide clear guidance to Domestic Energy Assessors (DEAs) and landlords on acceptable evidence of hidden measures such as insulation
- Update Standard Assessment Procedure (SAP) and the reduced assessment (RdSAP) methodology to take into account carbon emissions of heating systems
- Ensure all databases (for example heating systems) are kept up to date with current models available to ensure accurate energy efficiency can be reflected in the EPC
- Review impact of fuel cost changes on EPC assessments
- Improve the recommendation section on the EPC to include a much wider range of measures, more accurate costs and more realistic estimated outcomes

These case studies are published as part of Historic England's suite of guidance on energy efficiency and adaptation of traditionally constructed buildings. The guidance is intended for architects, surveyors, conservators, other conservation professionals and anyone who is interested in or responsible for the care of buildings.

This publication has been prepared by Camilla Rooney (consultant), Morwenna Slade and Joanne Williams, Historic England. This edition published by Historic England April 2022.

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HistoricEngland.org.uk/energyefficiency

Contents

1 Introduction

In June 2019, the UK Government set targets to bring all greenhouse gas emissions to net zero by 2050, with ambitious interim targets requiring a 57 per cent reduction in emissions across the UK economy by 2032. To achieve these figures, serious action in all sectors of the economy is required, including tackling emissions generated by our homes, which are responsible for 15 per cent of UK greenhouse gas emissions.

The private rented sector is among the least energy efficient in the domestic housing stock, costing more than £6 billion in energy bills in 2018 and producing greenhouse gas emissions of around 11 megatonnes of carbon dioxide equivalent ($MtCO^2e$) per annum (Department for Business, Energy & Industrial Strategy, 2020). In an attempt to drive energy efficiency improvements in the sector, MEES came into effect on 1 April 2018, deeming it unlawful for landlords to grant a tenancy to new tenants for properties with an EPC rating below Band E (unless a registered exemption is in place). From 1 April 2020, the restrictions applied to all tenancies (with a valid EPC) and the cost cap for improvements was set at £3,500. The current changes under consultation suggest that compliance will be raised to EPC band C with a cost cap of £10,000.

It is broadly recognised that there are issues with the current EPC and it's ability to be used as a tool for delivery policy objectives. In the Department for Business, Energy & Industrial Strategy and Ministry of Housing, Communities & Local Government's Call for Evidence (July 2018), only three per cent of the 229 respondents thought EPCs were reliable, and only six per cent thought they were effective at encouraging action. In response, the EPC action plan progress report was published November 2021. It outlines the actions required to improve the quality, the methodology and outcomes of the EPC process.

According to the English Housing Survey (2020), around 35 per cent of the private rented sector in England was built before 1919 and is of traditional solid wall construction. EPCs encourage a 'fabric first' approach. This approach involves maximising the performance of the components and materials that make up the building fabric before considering mechanical or electrical building services systems. This can damage a traditional building's performance and impact its significance. Additionally, fabric first interventions are largely high in embodied carbon with short lifespans.

Energy Performance Certificate (EPCs)

An EPC is a report that informs you of the energy efficiency of a particular property and provides an indication of how much it will cost to heat and power. It also includes recommendations on energy efficient improvements, the cost of carrying them out, and the potential potential cost savings. The EPC is rated using the Standard Assessment Procedure (SAP) (*see* page 3) on a scale of 1 to 100 split across seven bands A-G

EPC rating	SAP points
A	92-100 (most efficient)
B	81-91
C	69-80
D	55-68
E	39-54
F	21-38
G	1-20 (least efficient)

An EPC is required when a property is built, sold or rented. If you are selling or renting a property, an EPC must be ordered before the property is marketed. The EPC is valid for a period of 10 years. Listed buildings are exempt from EPCs however other consents and permissions for works are likely to be required.

For more guidance see Historic England, 2015 *Energy Efficiency and Historic Buildings. Energy Performance Certificates*.

To provide evidence to support the improvements of the EPC methodology, Historic England and partners (National Trust, Country Land and Business Association, The Central Association for Agricultural Valuers, The Landmark Trust) and other stakeholders reviewed a number of traditional buildings that had undergone retrofit to comply with the MEES regulations. This qualitative review focused on the EPC assessment procedure, the different fuel options, the overall cost and the impact retrofit had on the building. The issues, problems and potential solutions are explored through 18 case studies and the review included interviews with landlords and estate managers.

The Standard Assessment Procedure (SAP) and Reduced Data SAP (RdSAP)

The energy efficiency of homes is calculated using a Standard Assessment Procedure (SAP) system developed by the Building Research Establishment. The assessment is based on standardised assumptions for occupancy and behaviour. A new SAP 10.2 was published December 2021 and will come into force Summer 2022. Until then, the current version is SAP2012.

A simplified methodology, the Reduced Data SAP (RdSAP) was introduced in 2005 and the latest version dates from April 2012. The RdSAP assessment uses a set of assumptions about the building based on conventions and requirements at the time the building was constructed. The Government is working on an RdSAP update which is expected to be published in Spring 2022.

For more information see the Department for Business, Energy & Industrial Strategy's Standard Assessment Procedure web page.

Note: Some EPC reports in the case studies show a 'DRAFT' watermark.

These draft reports show how landlords use EPCs to ascertain the EPC rating that might be achieved whilst planning future works.

2 Assessment procedure

The problem

Trusted and accurate assessments that provide a reliable measure of a building's energy performance are crucial in supporting effective action to reduce energy use in buildings. However, the 2018 consultation demonstrates low confidence in the reliability of RdSAP to drive effective decision-making.

The case studies look specifically at issues within the assessment procedure, including the input of inaccurate or inconsistent data by DEAs, misleading information as the result of assumptions in RdSAP, skewed data and software changes.

Key issues

SAP is a methodology developed by the Building Research Establishment and it is predominately used to assess and compare the energy and environmental performance of new dwellings. RdSAP is the methodology used to produce EPCs for existing buildings. It reduces the time required to assess a property by making baseline assumptions.

To generate an EPC for an existing dwelling, an accredited DEA visits the property to collect a range of data required to input into RdSAP. The amount of energy a dwelling will consume is calculated based on standardised assumptions for levels of comfort, occupancy and behaviour. RdSAP provides a rating between 1 and 100 for every property, to compare the likely cost of energy required. In practice, these parameters vary considerably between households.

EPC software makes assumptions about U-values (a product's thermal conductivity measure) based on the building's construction, materials and floor area. For example, where double glazing is present, but window age is unknown, full glazing details can only be entered if the frame is PVCu. If the building has timber-frame windows, and assessors cannot determine window age, a relatively poor U-value will be allocated, even though the building may perform much better in reality.

In addition, 'hidden' measures that are not obvious to a DEA, such as floor or wall insulation, will not be included in the assessment unless proof of installation can be provided, thus resulting in a lower score. There is little guidance for DEAs or landlords on what is deemed acceptable proof of installation for new or existing works.

Both SAP and RdSAP have been subject to several version changes to ensure they remain up to date with the latest industry standards and to provide greater accuracy. Although it is essential that SAP and RdSAP are based on updated data, this creates challenges when assessing a property over time , particularly when there are legislative standards to comply with. Each update may potentially affect the EPC score, positively or negatively, regardless of whether energy efficiency measures have been implemented.

RdSAP 2012 v9.94 launched in September 2019, and it is the seventh major update to the methodology. The next version of SAP (10.2) comes into force with the updated Part L Building regulations in Summer 2022, this will include various changes included updated fuel prices, CO2 emissions and primary energy factors. These newest versions should be seen as an opportunity to include up-to-date costs, new technologies and research on a wider range of traditional materials that will work effectively with traditional buildings. However, since the introduction of EPCs in August 2007 (and particularly with the introduction of MEES on the private rental sector), the system has driven property owners' decision-making, often with considerable costs incurred. Any major overhaul of the software will cause challenges and implications for existing certification and work undertaken by owners.

Recommendations

- Reassure landlords that planned works will achieve compliance ahead of any future methodology updates.
- Provide clear guidance to DEAs and landlords on acceptable evidence of hidden measures.
- Provide landlords and home owners with guidance around future SAP and RdSAP upgrades to enable planning ahead of any uplift in legislative requirements (without putting existing energy efficiency works carried out at risk).

Key findings

- Identical renovations of semi-detached cottages, undertaken three months apart, are rated as C72 and D68 due to updates to fuel costs.
- DEAs refuse to include hidden measures.
- Four EPCs carried out at the same property result in a different rating each time due to inconsistent input of data measures.
- EPC software unable to identify measures to improve the property from a Band F.

Case studies

Wardle Cottage and Rose Cottage, York

Identical renovations of semi-detached cottages, undertaken three months apart, are rated as C72 and D68 due to updates to fuel costs.

Wardle Cottage and Rose Cottage in 2021. [George Winn Darley]

Property description

- Adjoining semi-detached three-bedroom farmworkers' cottages, built in the late 1880s. Brick under tiled roof, pair of French windows added into gables of both cottages, no other alterations. Total floor area 78m^2 per cottage.

- Not listed or in a conservation area.
- Wardle Cottage on protected tenancy. Rose Cottage on assured shorthold tenancy.
- Both previously fueled by open-hearth fires and back boilers. Now on air source heat pumps (ASHPs).

EPC assessment summaries for Wardle Cottage (top) and Rose Cottage (bottom). [George Winn Darley]

Wardle Cottage
19 December 2018 RRN: 9358-8940-7222-6228-0950 **Energy Performance Certificate**

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Solid brick, with internal insulation	★★★★☆
Roof	Pitched, 270 mm loft insulation	★★★★☆
Floor	Solid, insulated	—
Windows	Fully double glazed	★★★★☆
Main heating	Air source heat pump, radiators, electric	★★★★☆
Main heating controls	Time and temperature zone control	★★★★★
Secondary heating	Room heaters, dual fuel (mineral and wood)	—
Hot water	From main system	★★☆☆☆
Lighting	Low energy lighting in all fixed outlets	★★★★★

Current primary energy use per square metre of floor area: 178 kWh/m² per year

Rose Cottage
01 April 2019 RRN: 0478-2809-6047-9601-9975 **Energy Performance Certificate**

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Solid brick, with internal insulation	★★★★☆
Roof	Pitched, 250 mm loft insulation	★★★★☆
Floor	Solid, insulated	—
Windows	Fully double glazed	★★★★☆
Main heating	Air source heat pump, underfloor, electric	★★★★☆
Main heating controls	Time and temperature zone control	★★★★★
Secondary heating	Room heaters, dual fuel (mineral and wood)	—
Hot water	From main system	★☆☆☆☆
Lighting	Low energy lighting in all fixed outlets	★★★★★

Current primary energy use per square metre of floor area: 201 kWh/m² per year

The works

In December 2009, Wardle Cottage and Rose Cottage were assessed as part of Buttercrambe estate's residential portfolio, to allow the estate manager to plan for renovations across the estate. Baseline EPCs were carried out so they could be compared with post-renovation assessments. Wardle Cottage was rated as G18 and Rose Cottage was rated as G16.

Both properties were unmodernised prior to renovation. They were both heated by open-hearth fires and back boilers, with no wall or floor insulation and single glazing throughout. They had outdated kitchens and bathrooms.

EPC assessment recommendations for Wardle Cottage (top) and Rose Cottage (bottom). [George Winn Darley]

Wardle Cottage
19 December 2018 RRN: 9358-8940-7222-6228-0950

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
Solar water heating	£4,000 - £6,000	£ 82	C75
Solar photovoltaic panels, 2.5 kWp	£5,000 - £8,000	£ 288	B86

Rose Cottage
01 April 2019 RRN: 0478-2809-6047-9601-9975

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
Solar water heating	£4,000 - £6,000	£ 135	C73
Heat recovery system for mixer showers	£585 - £725	£ 29	C74
Solar photovoltaic panels, 2.5 kWp	£5,000 - £8,000	£ 295	B85

Wardle Cottage and Rose Cottage were both fully renovated using identical work specifications. This included floor insulation and underfloor heating, full internal dry lining with a Kingspan product, loft insulation, replacement double-glazed windows and insulated doors. Both properties were fitted with a Mitsubishi Ecodan ASHP.

The two renovation projects were completed roughly three months apart, starting with Wardle Cottage. Although it would have been more efficient to do the work simultaneously, staggering the renovations allowed a long-term tenant in Wardle Cottage to move into Rose Cottage during the works. The cost for the energy efficiency measures and associated 'making good' came to £63,734 for Wardle Cottage and £60,784 for Rose Cottage. The difference in cost was due to works carried out on the exterior and shared areas and achieving improved productivity while renovating the second property.

Wardle Cottage's EPC assessment took place on 19 December 2018 and the property received a rating of C72. Rose Cottage's took place on 1 April 2019 and a rating of D68 was given. The same DEA carried out both assessments.

The estimated energy costs for Wardle Cottage were £2,220 and for Rose Cottage they were £2,601. The biggest difference was the energy cost of hot water. Although both properties provide hot water from the main system, Wardle Cottage was awarded two stars for energy efficiency and Rose Cottage only one. Both properties received an environmental impact rating of Band C (Wardle Cottage C74 and Rose Cottage C71.)

The DEA investigated the difference and concluded that an update in fuel prices used to calculate costs in the EPC software had been carried out between the two dates of assessment. Details of fuel price changes within the EPC software are not available beyond January 2018, but previous records indicate these figures are historically updated in January and July each year.

The recommended measures to bring Rose Cottage to a Band C included a solar water heating system (£4,000–£6,000) and a heat recovery system for mixer showers (£585–£725.) The landlord said that the former measure was not practicable for the property, and the latter would only move the EPC up one point.

The cottages' orientation is west, with Wardle Cottage's French windows facing north and Rose Cottage's south. The landlord commented that Rose Cottage benefits from considerable solar gain via the French doors, making the environment within Rose Cottage much warmer than that of Wardle Cottage, despite its lower EPC rating.

2 Manor Farm Cottages and Buick House, Wincanton

DEAs refuse to include hidden measures, thereby resulting in a lower rating. Poor product information in software gives inaccurate results.

Above: Manor Farm Cottages. [Susie Dowding]

Right: Buick House. [© Mr Steve Ehrlicher. Source: Historic England Archive]

Property descriptions

- 2 Manor Farm Cottages, in the curtilage of Buick House, is a semi-detached three-bedroom cottage, built in about 1900 for farmworkers. Total floor area 103m^2.
- Buick House is a mid-terraced 18th-century Grade II listed townhouse. Constructed of stone rubble with clay tile roof. Total floor area 141m^2.
- Both properties are on assured short hold tenancies.
- Both previously fuelled by solid fuel Rayburns, with wood-burning stoves and back boilers. Now on ASHPs.

Page 11: EPC assessment summary and recommendations for 2 Manor Farm Cottages. [Susie Dowding]

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Granite or whinstone, as built, no insulation (assumed)	★☆☆☆☆
	Cavity wall, as built, no insulation (assumed)	★★☆☆☆
Roof	Pitched, no insulation (assumed)	★☆☆☆☆
	Roof room(s), no insulation (assumed)	★☆☆☆☆
Floor	Solid, no insulation (assumed)	—
Windows	Some double glazing	★☆☆☆☆
Main heating	Boiler and radiators, lpg	★★☆☆☆
Main heating controls	Programmer, room thermostat and trvs	★★★★☆
Secondary heating	Room heaters, dual fuel (mineral and wood)	—
Hot water	From main system	★★☆☆☆
Lighting	Low energy lighting in 31% of fixed outlets	★★★☆☆

Current primary energy use per square metre of floor area: 353 kWh/m² per year

2 Manor Farm Cottages
28 October 2014 RRN: 9220-2893-7008-9424-2135 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.

Measures with a green tick may be supported through the Green Deal finance. If you want to take up measures with an orange tick through Green Deal finance, be aware you may need to contribute some payment up-front.

Recommended measures	Indicative cost	Typical savings per year	Rating after improvement	Green Deal finance
Internal or external wall insulation	£4,000 - £14,000	£ 511	F31	✓
Floor Insulation	£800 - £1,200	£ 83	F33	✓
Low energy lighting for all fixed outlets	£45	£ 29	F34	
Solar water heating	£4,000 - £6,000	£ 83	F36	✓
Replace single glazed windows with low-E double glazed windows	£3,300 - £6,500	£ 120	E40	✓
Solar photovoltaic panels, 2.5 kWp	£9,000 - £14,000	£ 266	E48	✓
Wind turbine	£1,500 - £4,000	£ 88	E51	✓

The works – 2 Manor Farm Cottages

The property was bought in the 1950s, alongside a Grade II listed farmhouse, a Grade II listed townhouse and four farm cottages. The landlord has been renovating the properties over the past seven years as they become vacant. A loft conversion carried out 15 years ago included installing insulation under plasterboard.

The landlord undertook the following renovations to 2 Manor Farm Cottages: installing a new upstairs bathroom and upgrading the existing solid fuel Rayburn and wood-burning stove with back boiler to an LPG (liquefied petroleum gas) system. On the advice of the letting agent, the rent was increased from £500 pcm to £925 pcm.

In October 2014, an EPC assessment was carried out. The DEA assumed there was no insulation present and informed the landlord there was not sufficient evidence for the insulation to be included. 2 Manor Farm Cottages was subsequently rated as G20, at which point the landlord applied for an exemption.

Note: In March 2021, 1 Manor Farm Cottages received an EPC rating of Band D. The property had been renovated to the same specification and at the same time as 2 Manor Farm Cottages. The landlord used a different DEA and produced old invoices and building regulation certificates that mentioned insulation. Although the invoices were not very specific, the DEA deemed them adequate. However, if the EPC were assessed by the accreditation body, further evidence may be required.

Researchers reviewed the EPC and noted that 1 Manor Farm Cottages had been identified as being on mains gas. The landlord was notified and confirmed that it was on an LPG system. The DEA was alerted and subsequently spoke to the EPC accreditation body. The mistake was attributed to EPC software: the boiler type (Ideal Vogue c32) can be used on a gas or an LPG supply. The software's database used the 'GC number' (identification number for gas appliances) and presumed it was connected to mains gas, even though the DEA specified LPG.

An updated EPC was produced, and 1 Manor Farm Cottages received a rating of F25. Had the mistake not been identified, the landlord would have continued to rent the property confident that it had a D rating.

The works – Buick House

The landlord later renovated Buick House, by insulating the cellar ceiling with Earthwool R 3.40 150mm and Rockwool 170mm. Due to his previous experience with 2 Manor Farm Cottages, the landlord asked the builder to sign a statement of installation and to give details of the insulation used. He also took photographs of the insulation packaging. The cellar ceiling was then boarded with plasterboard and painted.

In September 2019, an EPC was undertaken by a different DEA and company. The DEA would not accept the landlord's evidence as sufficient and needed visual proof. Buick House was rated D65.

Below: EPC assessment summary and recommendations for Buick House. [Susie Dowding]

Buick House,
11 September 2019 RRN: 0266-2869-7317-9691-7075 **Energy Performance Certificate**

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Sandstone or limestone, as built, no insulation (assumed)	★☆☆☆☆
Roof	Pitched, 250 mm loft insulation	★★★★☆
Floor	To unheated space, insulated	—
	Solid, no insulation (assumed)	—
Windows	Some secondary glazing	★★☆☆☆
Main heating	Boiler and radiators, mains gas	★★★★☆
Main heating controls	Programmer, room thermostat and TRVs	★★★★☆
Secondary heating	None	—
Hot water	From main system	★★★★☆
Lighting	Low energy lighting in 75% of fixed outlets	★★★★★

Current primary energy use per square metre of floor area: 226 kWh/m² per year

Buick House
11 September 2019 RRN: 0266-2869-7317-9691-7075 **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. To receive advice on what measures you can take to reduce your energy bills, visit www.simpleenergyadvice.org.uk or call freephone 0800 444202. 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	£ 289	C73
Solar water heating	£4,000 - £6,000	£ 42	C74
Replace single glazed windows with low-E double glazed windows	£3,300 - £6,500	£ 68	C76
Solar photovoltaic panels, 2.5 kWp	£3,500 - £5,500	£ 334	B84

Rose Cottage, Chesterfield

Four EPCs done for the same property resulted in a different rating each time due to inconsistent input of data, including changes in floor area and building construction.

Rose Cottage
[Sarah Brownridge]

Property description

- 18th-century semi-detached three-bedroom cottage, constructed of coursed Hardwick stone with brick lean-to and chimneystacks. Numerous historic alterations, possibly part of a former row of cottages. Total floor area 78m^2.
- Not listed, but within a conservation area.
- Assured shorthold tenancy.
- Previously on oil central heating. Now on ASHP.

The works

In October 2012, a baseline EPC was undertaken, and the property received a rating of F36, with a potential rating of C75. Renovation works carried out over four to five days, with the tenant in situ, included upgrading nine single-glazed windows to secondary glazing with extensive draught-proofing. An ASHP was installed to replace the oil central heating. The works cost a total of £20,682.

A post-project EPC was undertaken by a DEA contracted by the ASHP company in June 2015. The EPC gave Rose Cottage an energy efficiency rating of E39, a score that was lower than expected. The estate manager noticed that the EPC had recorded Rose Cottage as being fully single glazed and that no roof insulation had been

assumed. This was queried with the DEA. As both the loft insulation and the windows would have been visible during the site visit, the DEA suggested that the software may have defaulted to single glazing and no insulation.

In January 2016, a third EPC was commissioned. This EPC resulted in an energy efficiency rating of F22, 14 points lower than the original baseline EPC. The assessment included full double glazing, but again no roof insulation, and there were also differences in the total floor area, wall fabric, roof type and heating controls.

EPC assessment summaries for Rose Cottage from October 2012 (below) and June 2015 (bottom). [Sarah Brownridge]

Rose Cottage
14 October 2012 RRN: 9578-4921-6240-7272-5920 **Energy Performance Certificate**

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Sandstone, as built, no insulation (assumed)	★☆☆☆☆
	Solid brick, as built, no insulation (assumed)	★☆☆☆☆
	Timber frame, as built, no insulation (assumed)	★☆☆☆☆
Roof	Pitched, no insulation (assumed)	★☆☆☆☆
	Pitched, 150 mm loft insulation	★★★★☆
Floor	Suspended, no insulation (assumed)	—
	Solid, no insulation (assumed)	—
Windows	Single glazed	★☆☆☆☆
Main heating	Boiler and radiators, oil	★★★☆☆
Main heating controls	Programmer, TRVs and bypass	★★★☆☆
Secondary heating	Room heaters, dual fuel (mineral and wood)	—
Hot water	From main system	★★★☆☆
Lighting	Low energy lighting in 86% of fixed outlets	★★★★★

Current primary energy use per square metre of floor area: 384 kWh/m² per year

Rose Cottage
20 June 2015 RRN: 9318-4021-6246-7075-5924 **Energy Performance Certificate**

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Sandstone or limestone, as built, no insulation (assumed)	★☆☆☆☆
	Solid brick, as built, no insulation (assumed)	★☆☆☆☆
Roof	Pitched, no insulation (assumed)	★☆☆☆☆
Floor	Solid, no insulation (assumed)	—
Windows	Single glazed	★☆☆☆☆
Main heating	Air source heat pump, radiators, electric	★★★★☆
Main heating controls	Programmer, TRVs and bypass	★★★☆☆
Secondary heating	Room heaters, dual fuel (mineral and wood)	—
Hot water	From main system	★☆☆☆☆
Lighting	Low energy lighting in 89% of fixed outlets	★★★★★

Current primary energy use per square metre of floor area: 338 kWh/m² per year

In April 2019, a further EPC was carried out. No additional works had taken place between 2016 and 2019. On this occasion, the property received an energy efficiency rating of E44. The assessment recognised that the property had full secondary glazing and 150mm loft insulation.

Below: EPC assessment summary for Rose Cottage from January 2016. [Sarah Brownridge]

Bottom: A comparison of the 4 EPC assessment summaries. [Information from Sarah Brownridge]

Rose Cottage
22 January 2016 RRN: 9458-4021-6249-7576-5924 **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	Roof room(s), no insulation (assumed)	★☆☆☆☆
Floor	Solid, no insulation (assumed)	—
Windows	Full secondary glazing	★★★★☆
Main heating	Air source heat pump, radiators, electric	★★★★☆
Main heating controls	Programmer and room thermostat	★★★☆☆
Secondary heating	Room heaters, dual fuel (mineral and wood)	—
Hot water	From main system	★☆☆☆☆
Lighting	Low energy lighting in 38% of fixed outlets	★★★☆☆

Current primary energy use per square metre of floor area: 496 kWh/m² per year

EPC Date	October 2012	June 2015	January 2016	April 2019
Rating	F36	E39	F22	E44
Floor area	90m²	137m²	104m²	124m²
Walls	Sandstone, solid brick, timber frame	Sandstone/ limestone, solid brick	Granite/whinstone	Sandstone/ limestone, timber frame
Roof	Partial roof insulation	No roof insulation	No roof insulation	Partial roof insulation
Windows	Single glazed	Single glazed	Full secondary glazing	Full secondary glazing
Main heating	Oil	ASHP	ASHP	ASHP
Main heating controls	Programmer, TVRs and bypass	Programmer, TVRs and bypass	Programmer and room thermostat	Programmer and at least two room thermostats
Lighting	86% low energy lighting	89% low energy lighting	38% low energy lighting	83% low energy lighting

Feature	Description	Rating
Wall	Sandstone or limestone, as built, no insulation (assumed)	Very poor
Wall	Timber frame, as built, partial insulation (assumed)	Average
Roof	Pitched, 150mm loft insulation	Good
Roof	Pitched, no insulation (assumed)	Very poor
Roof	Flat, no insulation (assumed)	Very poor
Window	Full secondary glazing	Good
Main heating	Air source heat pump, radiators, electric	Good
Main heating control	Programmer and at least two room thermostats	Good
Hot water	From main system	Very poor
Lighting	Low energy lighting in 83% of fixed outlets	Very good
Floor	Solid, no insulation (assumed)	N/A
Secondary heating	Room heaters, dual fuel (mineral and wood)	N/A

Above: EPC assessment summary for Rose Cottage from April 2019. [Information from Sarah Brownridge]

Park House, Leominster

EPC software unable to identify measures to improve the property from an F rating.

Park House. [Kate Hazzard-Smith]

Property description

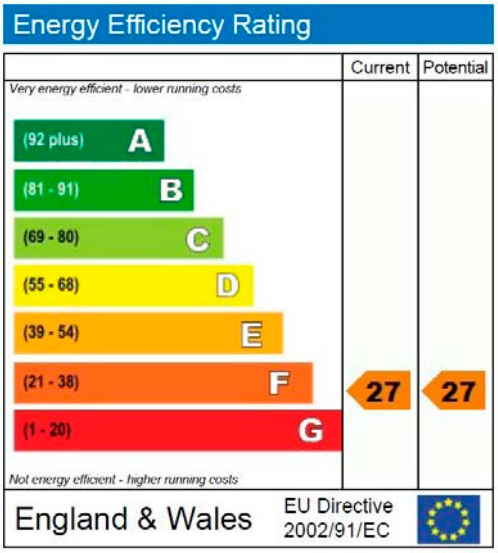
- Semi-detached four-bedroom Arts and Crafts house. Total floor area 281m^2.
- Not listed or within a conservation area, but sits within a Grade II* registered parkland.
- Assured shorthold tenancy.
- LPG heating.

The works

In December 2011, an EPC assessment for Park House was undertaken. It gave the property an energy efficiency rating of F27, with a potential rating of F27. Even though the recommended measures noted the property could improve its rating by four points to F31, by installing solar water heating, solar photovoltaic panels and a wind turbine. It was predicted in the EPC that such works would cost around £23,250.

Planning consent would be required for the work, which would likely be considered inappropriate for the setting. In addition, the property is situated on a steep north-facing slope, surrounded by trees, thereby making solar photovoltaic panels unsuitable.

Using CROHM software (Parity Projects), it was possible to hypothetically model the impact of a full range of measures. Three scenarios were identified that increased the rating to a Band E. These options were all significantly cheaper than the EPC recommendations that kept the property in Band F.



The energy efficiency rating for Park House.
[Kate Hazzard-Smith]

Recommendations

None

Further measures to achieve even higher standards

The measures listed below should be considered if aiming for the highest possible standards for this home. However you should check the conditions in any covenants, planning conditions, warranties or sale contracts. The indicative costs are representative for most properties but may not apply in a particular case.

	Indicative cost	Typical savings per year	Ratings after improvements	
			Energy efficiency	Environmental impact
1 Solar water heating	£4,000 - £6,000	£86	F 28	F 38
2 Solar photovoltaic panels, 2.5 kWp	£11,000 - £20,000	£214	F 30	E 40
3 Wind turbine	£1,500 - £4,000	£76	F 31	E 41
Enhanced energy efficiency rating			**F 31**	
Enhanced environmental impact (CO_2) rating				**E 41**

Improvements to the energy efficiency and environmental impact ratings will usually be in step with each other. However, they can sometimes diverge because reduced energy costs are not always accompanied by a reduction in carbon dioxide (CO_2) emissions.

Suggested measures	Estimated cost	Energy efficiency rating	Environmental impact rating
Installing an A-rated oil combi boiler with full multi-zone controls	£5,200	E53	E49
Draught-proofing doors and windows, low energy lighting, full multi-zone controls	£2,270	E38	D58
Insulating the hot water tank, draught-proofing, low energy lighting, full multi-zone heating controls	£3,975	E39	D58

Above: The EPC assessment recommendations for Park House (top) and the alternative measures modelled by alternative software (bottom). [Kate Hazzard-Smith]

3 Fuel type

The problem

The EPC has previously included two scores:

- Energy efficiency rating, largely based on energy operating costs
- Environmental impact rating, which measures a home's impact on the environment via carbon dioxide (CO^2) emissions

The current EPC format uses the energy efficiency rating as a headline score. The environmental impact rating score was downgraded and then removed entirely in September 2020 (the EPC Action Plans states that this is to be reintroduced in 2022). The emphasis on energy cost as a proxy for energy consumption results in perverse incentives to switch to cheaper, high-carbon fuel types. This puts properties not connected to the gas grid at a significant disadvantage.

Key issues

The cost of running a property's heating system is calculated using SAP and RdSAP software. 'The current EPC format only informs the occupier about the heating system from a cost perspective, without accounting for CO^2 emissions. In April 2021, Government pledged to reduce the UK's carbon emissions by 78 per cent by 2035, but EPC assessments do not provide information or recommendations for house owners on how to lower their emissions. In fact, EPCs give recommendations that focus on fabric first alterations, which are energy hungry. A 'whole house' approach is needed to support both the Government's pledge and property owners' decision-making (Historic England 2018).

Scoring is based on a three-year rolling average price of the fuel used and the efficiency of the heating system. For example, a gas condensing boiler will receive four or five stars, an oil boiler of the same efficiency three stars and an LPG boiler of the same efficiency two stars.

The current methodology means that an off-grid property will receive a much lower energy efficiency rating than a property on mains gas, even if it is of the same or similar construction. As a result, off-grid property owners have to spend more money on building improvements to reach the same energy efficiency rating as those on mains gas. This may lead to an increase in rents in off-grid homes or may force landlords to leave the private rented sector.

In addition, property owners are incentivised to switch to or stay on higher carbon, cheaper fuels in order to meet MEES. For example, although LPG is a lower carbon fuel source, a property on LPG would receive a lower energy efficiency rating than an identical property on oil, due to higher running costs.

The presence of an open fireplace penalises older properties, even if it is not used for heating. Although many fireplaces have been replaced with wood-burning stoves (often in rural areas) or boilers, which can be highly efficient, RdSAP software does not recognise this.

In fact, there are few biomass options included in the RdSAP boiler database. If the exact model cannot be entered, a generic relatively low-efficiency option must be used. As a result, biomass can achieve a worse energy efficiency rating than more carbon-intensive fuels such as oil.

For traditional buildings without mains gas there are a range of low carbon options, however, these need to be considered carefully to ensure they operate efficiently.

Recommendations

- Change SAP and RdSAP scoring to take into account carbon emissions of heating systems.
- Update the heating system database to include more options, so accurate energy efficiency can be calculated.
- Review the impact of fuel cost changes on EPC assessments.

Fuel	Fuel price (pence per unit)	Unit	Pence per kWh (after boiler efficiency)	Energy content (kWh per unit)	KgCO²e per kWh
Electricity Standard Rate	19.88	kWh	19.88 (100%)	1	0.288
Electricity Online Rate	19.43	kWh	19.43 (100%)	1	0.288
Mains Gas Standard Rate	3.74	kWh	4.16 (90%)	1	0.208
Mains Gas Online Rate	3.63	kWh	4.04 (90%)	1	0.208
Kerosene	40.48	Litre	4.59 (90%)	9.8	0.298
Gas oil	53.64	Litre	5.73 (90%)	10.4	0.316
LPG	45.25	Litre	7.55 (90%)	6.66	0.241
Butane	167.99	Litre	23.42 (90%)	7.97	0.241
Propane	74.24	Litre	11.67 (90%)	7.07	0.241
Seasoned wood	24.73	Kg	6.93 (85%)	4.20	0.028
Pellets	29.33	Kg	6.90 (90%)	4.72	0.053
Smokeless fuel	44.70	Kg	8.90 (75%)	8.51	0.396
Coal	35.30	Kg	6.88 (75%)	6.20	0.396
GSHP	19.88	kWh	5.68 (350%)	1	0.082
ASHP	19.43	kWh	7.19 (270%)	1	0.107

Above: $C0^2$ emissions based on UK Government greenhouse gas conversion factors for company reporting Scope 3 (Greenhouse Gas Protocol accounting tool), which includes emissions from transmission and distribution.

Key findings

- Landlord switches from LPG to oil to make property comply with MEES at an affordable cost.
- Landlord switches from LPG to oil to make property comply with MEES, but reduces the environmental impact rating from E42 to F37.
- Two otherwise identical cottages score a rating of E41 on oil and G20 on LPG.
- Identical properties on terraced row receive Band B on electricity and Band B and Band D on mains gas.
- Landlord decides against installing ASHP as the measure does not improve rating band.

Case studies

Hollybrooks, Bucknall

Landlord switches from LPG to oil to make property comply with MEES at an affordable cost.

Hollybrooks.
[Andrew Liddiment]

Property description

- Three-bedroom dormer bungalow in brick with tiled roof, constructed in 1960. Total floor area 124m^2.
- Not listed or within a conservation area.
- Assured shorthold tenancy.
- Previously on LPG. Now on oil.

The works

Hollybrooks was built in the 1960s at the edge of Bucknall village to accommodate a groundskeeper. The property was renovated in 2014 after it became vacant. A bulk tank LPG heating system was installed, replacing an existing back boiler heated by an open fire. The landlord chose LPG over oil as a more affordable option. Other improvements to the property at the time included full double glazing, additional insulation to ceilings and limited sloping ceiling insulation.

In July 2020, Hollybrooks was assessed as F21. The DEA who carried out the draft EPC recommended that insulating the 'room in the roof' (the entire first floor) would improve the rating to E40.

Hollybrooks
30 July 2020 RRN: 0000-0000-0000-0000-0000

PREVIEW - NOT FOR ISSUE
Energy Performance Certificate

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Cavity wall, filled cavity	★★★☆☆
Roof	Pitched, no insulation (assumed)	★☆☆☆☆
	Roof room(s), no insulation (assumed)	★☆☆☆☆
Floor	Suspended, no insulation (assumed)	—
Windows	Fully double glazed	★★★☆☆
Main heating	Boiler and radiators, LPG	★★☆☆☆
Main heating controls	Programmer, room thermostat and TRVs	★★★★☆
Secondary heating	Room heaters, dual fuel (mineral and wood)	—
Hot water	From main system	★★☆☆☆
Lighting	Low energy lighting in 60% of fixed outlets	★★★★☆

Current primary energy use per square metre of floor area: 317 kWh/m² per year

Above: The draft EPC assessment summary for Hollybrooks. [Andrew Liddiment]

Below: The draft EPC recommendations. {Andrew Liddiment]

This was based on insulating the flat ceiling with 200mm mineral wool and the sloped ceilings with 50mm Kingspan and installing 50mm PIR insulation within a stud wall along the vertical walls. The estimated cost for insulation and making good was around £10,000 to £15,000.

Due to the cost estimate for installing room-in-roof insulation, the EPC DEA was asked to model with a modern oil boiler (such as a Worcester Greenstar Danesmoor 18/25 ErP+), thermostatic radiator valves, programmer and room thermostat. The DEA confirmed this would increase the score to D56, based on 100 per cent low energy lighting, 100 per cent draught-proofing and a log burner. These measures were estimated to cost around £6,500 + VAT. However, the DEA advised that achieving a Band C at the property was not possible if an oil boiler was installed.

Recommended measures	Indicative cost	Typical savings per year	Rating after improvement
Room-in-roof insulation	£1,500 - £2,700	£ 702	E40
Floor insulation (suspended floor)	£800 - £1,200	£ 150	E44
Low energy lighting for all fixed outlets	£20	£ 28	E45
Solar water heating	£4,000 - £6,000	£ 87	E48
Solar photovoltaic panels, 2.5 kWp	£3,500 - £5,500	£ 335	D57
Wind turbine	£15,000 - £25,000	£ 669	C73

Consequently, the property was modelled with an ASHP (Viessmann Vitocal 222A 10kw), with programmer and room thermostat controls, which increased the score to D66. If the controls were improved to include a zoned time and temperature control, the score would have been C70.

To ensure the property could be heated effectively by an ASHP, heat loss through the walls, roof and floors would need to be minimised. To ensure the U-values were at an acceptable tolerance of around 0.20 maximum, extensive roof and floor insulation would be required, as well as full internal dry lining. These measures would significantly improve the efficiency of the property. However, the contractor advised that the work would be costly, especially in terms of related 'knock on' expenses and disruption to tenants. From experience of installing ASHPs in other properties, the landlord estimated the improvements would amount to £20,000 to £25,000, including associated costs.

After considering all the advice, the landlord intends to switch to an oil boiler to reach a Band D. The property would then comply with MEES in the short term at an affordable cost.

Beech House Lodge, Christchurch

Landlord switches from LPG to oil to comply with MEES but reduces the environmental impact score from E42 to F37.

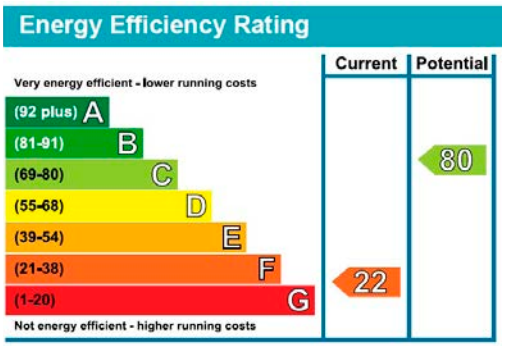
Beech House Lodge.
[Rich Shirley]

Property description

- Former gatehouse with heritage interest, set in 2,023ha historic estate. Total floor area 55m^2.
- Not listed or within a conservation area. Located in national park.
- Assured short hold tenancy.
- Previously on LPG. Now on ASHP.

The works

In 2013, a baseline EPC was carried out at Beech House Lodge to identify measures for making it comply with MEES. It was given an energy efficiency rating of F22 and an environmental impact rating of E42. The recommended measures to achieve an E40 rating included internal and external wall insulation, floor insulation, draught-proofing, room thermostats, solar water heating and the replacement of single-glazed windows with low-E double-glazed windows. The indicative cost in the EPC of these measures was around £24,400.



The EPC rating for Beech House Lodge from 2013. [Rich Shirley]

Due to the restricted floor space of the property, internal wall and floor insulation would not be possible. Furthermore, the property is not suitable for solar heating because it is surrounded by woodland. Installing full double glazing would make a difference of only three points at a potentially high cost. To reach a Band C rating on the existing LPG fuel source, it was predicted to cost around £50,900 and required a wind turbine.

The property agents looked at different options using CROHM software (Parity Projects). Installing an ASHP was considered as a route to secure a higher rating. However, the contractor advised that the heat loss from the property would be too great: as wall insulation for the property is not feasible, it would be necessary to install two ASHPs at a cost of around £28,000.

The most affordable route to securing a Band E was to switch from LPG to oil, with smart heating controls. The conversion was carried out at a cost of £8,000, in which the existing LPG system, which was roughly five years old, was replaced.

Beech House Lodge

25 April 2019 RRN: 9458-0083-6244-5711-8944 **Energy Performance Certificate**

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Solid brick, as built, no insulation (assumed)	★☆☆☆☆
	Cavity wall, as built, no insulation (assumed)	★★☆☆☆
Roof	Pitched, no insulation (assumed)	★☆☆☆☆
	Flat, no insulation (assumed)	★☆☆☆☆
Floor	Solid, no insulation (assumed)	—
Windows	Some double glazing	★★☆☆☆
Main heating	Boiler and radiators, LPG	★★☆☆☆
Main heating controls	Programmer, TRVs and bypass	★★★☆☆
Secondary heating	Room heaters, dual fuel (mineral and wood)	—
Hot water	From main system	★★☆☆☆
Lighting	Low energy lighting in all fixed outlets	★★★★★

Current primary energy use per square metre of floor area: 346 kWh/m² per year

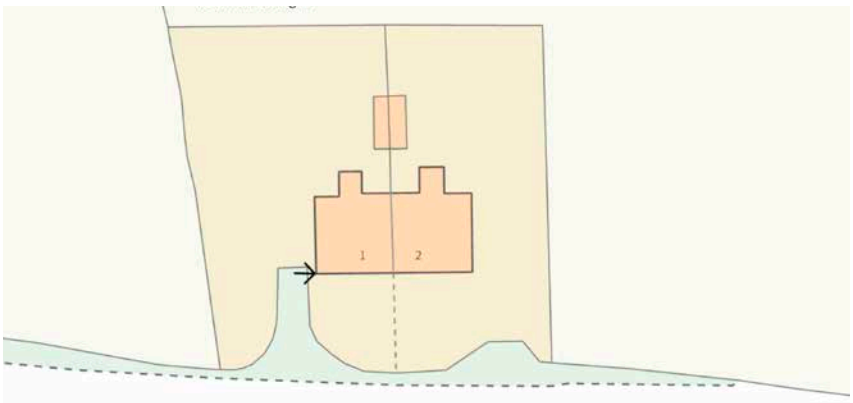
Above: The EPC assessment summary for Beech House Lodge from April 2019.. [Rich Shirley]

Below: 1 and 2 New Weir Cottages. [© Crown Copyright and database right 2022. All rights reserved. Ordnance Survey Licence number 100024900]

A second EPC was conducted by the same DEA in March 2020 and resulted in an energy efficiency rating of E43, an improvement of 21 points. The energy use per square metre was roughly the same (346 kWh/m² to 334 kWh/m²), but the estimated cost over three years dropped by £3,438 to £2,121. However, the environmental impact rating dropped five points, from E42 to F37.

1 and 2 New Weir Cottages, Hereford

Two otherwise identical cottages score a rating of E41 on oil and G20 on LPG.



Beech House Lodge

24 March 2020 RRN: 0054-2810-6874-9891-8365 **Energy Performance Certificate**

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Solid brick, as built, no insulation (assumed)	★☆☆☆☆
	Cavity wall, as built, no insulation (assumed)	★★☆☆☆
Roof	Pitched, no insulation (assumed)	★☆☆☆☆
	Flat, no insulation (assumed)	★☆☆☆☆
Floor	Solid, no insulation (assumed)	—
Windows	Some double glazing	★★☆☆☆
Main heating	Boiler and radiators, oil	★★★☆☆
Main heating controls	Time and temperature zone control	★★★★★
Secondary heating	Room heaters, dual fuel (mineral and wood)	—
Hot water	From main system	★★★☆☆
Lighting	Low energy lighting in all fixed outlets	★★★★★

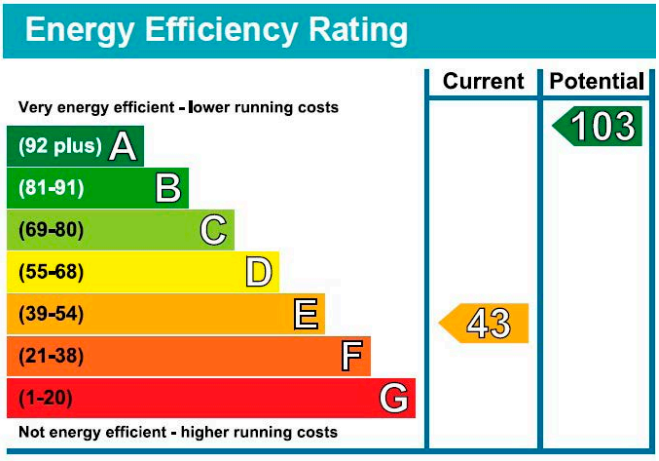
Current primary energy use per square metre of floor area: 334 kWh/m² per year

Above: The EPC assessment summary for Beech House Lodge from March 2020. [Rich Shirley]

Below: The EPC rating from March 2020. [Rich Shirley].

Property description

- Two identical semi-detached cottages, built as farmworkers' cottages in the 1920s. Solid brick walls in English garden wall bond, with pitched, semi-hipped roof and gable to the front elevation. Total floor area 105m^2 per cottage.
- Possible curtilage structure to listed buildings within the estate.
- Assured short hold tenancies.
- Previously, both properties were fed by open fires and back boilers. Now, 1 New Weir Cottages has an oil boiler and wood burner. 2 New Weir Cottages is on LPG.



The works

1 and 2 New Weir Cottages are almost identical semi-detached properties owned by the National Trust. The windows are mainly fitted with secondary glazing and timber-framed sash windows on the rear extensions. The floors throughout are timber suspended, except for the kitchen floors and storeroom floors, which are solid.

The only major difference between the properties is the fuel type.

1 New Weir has an oil boiler and a wood burner, whereas 2 New Weir has an LPG combi boiler, providing heating and hot water.

Originally, both properties would have been heated by open fires and back boilers, and conversion would have taken place when the properties were vacated by tenants. The difference in fuel type can be attributed to a change in National Trust policy in 2019, which advised against oil installations and prioritised LPG as a greener fuel type. The oil-fired boiler in 1 New Weir was an older system and the LPG in 2 New Weir was more recent, in line with this policy.

Below: A comparison of the EPC assessment summaries for 1 and 2 New Weir Cottages. [Anna Watts]

Feature	1 New Weir Cottages		2 New Weir Cottages	
	Description	Rating	Description	Rating
Wall	Solid brick, as built, no insulation (assumed)	Very poor	Solid brick, as built, no insulation (assumed)	Very poor
Roof	Pitched, no insulation (assumed)	Very poor	Pitched, no insulation (assumed)	Very poor
Window	Mostly secondary glazing	Average	Mostly secondary glazing	Average
Main heating	Boiler and radiators, oil	Average	Boiler and radiators, LPG	Poor
Main heating control	Programmer, room thermostat and TRVs	Good	Programmer, room thermostat and TRVs	Good
Hot Water	From main system	Average	From main system	Poor
Lighting	Low energy lighting in 93% of fixed outlets	Very good	Low energy lighting in 85% of fixed outlets	Very good
Floor	Suspended, no insulation(assumed)	N/A	Suspended, no insulation(assumed)	N/A
Floor	Solid, no insulation (assumed)	N/A		
Secondary heating	Room heaters, wood logs	N/A	Room heaters, electric	N/A

The same person assessed both properties in September 2020. 1 New Weir scored an energy efficiency rating of E41, whereas 2 New Weir scored an energy efficiency rating of G20. Both properties had a similar environmental impact score: E39 for 1 New Weir and E41 for 2 New Weir.

For 1 New Weir to reach a potential energy efficiency rating of C69, the following measures were recommended in the EPC:

- Internal or external wall insulation, £4,000–£14,000 +15 points
- Floor insulation to suspended floor, £800–£1,200 +3 points
- Solar water heating, £4,000–£6,000 +2 points
- Solar photovoltaic panels, 2.5kWp5, £3,500–£5,500 +9 points

For 2 New Weir to reach a potential energy efficiency rating of C69, the above measures plus the installation of a wind turbine (£15,000–£25,000: +20 points) were recommended in the EPC. The above measures would cost between £27,300 and £51,700 in total.

A report commissioned by the National Trust on the environmental performance of 2 New Weir in December 2020 found that insulating the walls and floor would not be cost effective or appropriate. Potential issues included:

- Risk of cold bridging leading to condensation and damp
- Reduction in room size rendering rooms unusable
- Complexity in detailing around internal and external features
- Loss of rental income during extensive works required
- Aesthetic impact of external works, especially if carried out on one half of a semi-detached property
- Planning restrictions

A separate report produced by another DEA found that switching from LPG to oil would raise the energy efficiency rating score by 14 points (F34). Adding loft insulation to a minimum of 100mm would increase the score by a further eight points (E42).

A quote to convert 2 New Weir from LPG to oil (Titan Ecosafe oil tank and Worcester Greenstar Heatslave oil boiler) was £6,998.00 + VAT. Installing an ASHP or high heat retention storage heaters was not considered because of the costs associated with overhauling the wet system and making good.

Route	Benefit
Change heating fuel to Oil	
Replace existing LPG boiler with an oil fired Worcester Greenstar Heatslave II 25/32 or PCDF equivalent	+14 points
Raise/add loft insulation to 100mm min	+8 points
Change heating to Air-Water Air Source Heat Pump	
Remove LPG and install an Air-Water Air Source Heat Pump and a 50mm factory insulated hot water cylinder with dual immersion heaters & thermostat and remove fixed electric heaters & maintain blockage of fireplaces	+14 points
Raise/add loft insulation to 100mm min	+8 points
Have a dual heating system retaining LPG for ground floor and hot water	
Remove the existing radiators from the first floor bedrooms and replace with High Heat Retention Storage Heaters eg Dimplex Quantum 050/070 etc or PCDF equivalent units and remove any fixed electric heaters and maintain blockage of fireplaces	+13 points
Raise/add loft insulation to 100mm min	+8 points

Above: Potential improvement routes for 1 and 2 New Weir Cottages. [Anna Watts]

58 Martins Hill Lane, Christchurch

Identical properties on terraced row receive an EPC Band F on electricity and Band D on mains gas.

Property description

- Three-bedroom brick house in a row of three, built in the mid-1800s. Total floor area 84m^2.
- Not listed, but within a conservation area and likely the curtilage of Grade II listed granary building.
- Rent Act tenancy.
- Electric heating.

Terraced row of cottages on Martins Hill Lane. [Rich Shirley]

The works

In March 2013, the property was assessed, and it received an energy efficiency rating of D57, with a potential rating of B87. The whole estate was assessed again in 2019, following concerns with the reliability of the information in the original EPC assessments: for example, an 18th-century farmhouse was recorded as having cavity wall insulation.

A subsequent draft EPC, completed in October 2019, rated 58 Martins Hill Lane as F32. This assessment was carried out by an energy assessor who was known to the property agent to be meticulous. There had been no material changes to the property in the intervening period, apart from some general maintenance such as replacing broken light fittings.

The difference in scores can be attributed to a difference in data input, including inconsistent information about the levels of wall and roof insulation, main heating type and heating controls. The 2013 EPC categorises the main heating as electric storage heaters on an off-peak tariff. However, the property contains on-demand electric heaters on a standard tariff.

Below: The EPC assessment summaries from March 2013 (top) and draft from 2019 (bottom). [Rich Shirley]

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Cavity wall, filled cavity	★★★★☆
Roof	Pitched, 200 mm loft insulation	★★★★☆
Floor	Suspended, no insulation (assumed)	—
Windows	Partial double glazing	★★☆☆☆
Main heating	Electric storage heaters	★★★☆☆
Main heating controls	Manual charge control	★★☆☆☆
Secondary heating	Room heaters, electric	—
Hot water	Electric immersion, off-peak	★☆☆☆☆
Lighting	Low energy lighting in 67% of fixed outlets	★★★★☆

Current primary energy use per square metre of floor area: 376 kWh/m² per year

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Solid brick, as built, no insulation (assumed)	★☆☆☆☆
	Cavity wall, filled cavity	★★★☆☆
Roof	Pitched, 150 mm loft insulation	★★★★☆
Floor	Suspended, no insulation (assumed)	—
Windows	Partial double glazing	★★☆☆☆
Main heating	Room heaters, electric	★☆☆☆☆
Main heating controls	Appliance thermostats	★★★★☆
Secondary heating	Room heaters, electric	—
Hot water	Electric immersion, standard tariff	★☆☆☆☆
Lighting	Low energy lighting in 50% of fixed outlets	★★★★☆

Current primary energy use per square metre of floor area: 388 kWh/m² per year

Recommended measures	Indicative cost	Typical savings per year	Rating after improvement	Green Deal finance
Floor insulation	£800 - £1,200	£ 59	D60	✓
Add additional 80 mm jacket to hot water cylinder	£15 - £30	£ 19	D61	✓
Low energy lighting for all fixed outlets	£15	£ 13	D61	
Fan assisted storage heaters and dual immersion cylinder	£1,500 - £2,000	£ 177	C69	✓
Solar water heating	£4,000 - £6,000	£ 40	C71	✓
Replace single glazed windows with low-E double glazing	£3,300 - £6,500	£ 32	C73	✓
Solar photovoltaic panels, 2.5 kWp	£9,000 - £14,000	£ 260	B83	✓
Wind turbine	£1,500 - £4,000	£ 85	B87	✓

Recommended measures	Indicative cost	Typical savings per year	Rating after improvement
Increase loft insulation to 270 mm	£100 - £350	£ 34	F33
Floor insulation (suspended floor)	£800 - £1,200	£ 142	F38
Add additional 80 mm jacket to hot water cylinder	£15 - £30	£ 27	F38
Draught proofing	£80 - £120	£ 53	E40
Low energy lighting for all fixed outlets	£20	£ 20	E40
High heat retention storage heaters and dual immersion cylinder	£2,000 - £3,000	£ 660	D67
Solar water heating	£4,000 - £6,000	£ 69	C69
Replace single glazed windows with low-E double glazed windows	£3,300 - £6,500	£ 40	C71
Solar photovoltaic panels, 2.5 kWp	£3,500 - £5,500	£ 376	B81
Wind turbine	£15,000 - £25,000	£ 675	A104

Above: The EPC recommendations from March 2013 (top) and draft from October 2019 (above). [Rich Shirley]

The predicted energy use for the property in the 2013 EPC is 376 kWh/m^2 per year, which is consistent with the 2019 EPC prediction of 388 kWh/m^2 per year. Both EPCs give the property an identical environmental impact rating of E41. However, the estimated energy costs on the two EPCs show a much wider discrepancy: £2,694 in 2013 up to £5,562 in 2019. This suggests that updates to SAP on increasing fuel costs may also have contributed to the difference between the energy efficiency ratings, which are based on assumed running costs for the building.

The 2019 EPC suggests a spend of around £4,720 to secure the property a rating of D67, whereas the 2013 EPC had identified a spend

of only £1,245. According to the 2019 EPC, for the property to secure a rating of C71, the owner would need to spend £8,860, rather than the £2,780 suggested in the 2013 EPC.

The village of Burton in Christchurch benefits from mains gas, which extends to the property adjacent to 58 Martins Hill Lane. As part of a terraced row, this property is identical to 58 Martins Hill Lane in its key features and has a rating of D68. The decision was made to extend gas to 58 Martins Hill Lane at a cost of £1,000, with an additional £7,000 to install an A-rated Worcester Bosch gas boiler. This measure was not identified on either the 2013 or 2019 EPC assessments. The decision to install gas was made because the tenants preferred gas and electric heating was expensive.

1 Park View, Shenton

Landlord decides against installing an ASHP because the measure does not improve the EPC Band.

Property description

- Two-bedroom brick and tile house, built in about 1860, typical of estate workers' cottages. Total floor area 70m^2.
- Not listed, but within a conservation area.
- Rent act tenancy.
- Oil heating.

Semi-detached cottages at Park View.
[Charles Wollaston]

The works

1 Park View was assessed in December 2020 and was given an energy efficiency rating of E39 and a potential score of B85. The recommended measures included:

- Internal or external wall insulation, £4000–£14,000 +19 points
- Floor insulation (solid floor), £4,000–£6,000 +3 points
- New condensing boiler, £2,200–£3,000 +9 points
- Solar water heating, £4,000–£6,000 +3 points
- Solar photovoltaic panels, £3,500-£5,500 +12 points

The landlord has personal experience with ASHPs and was interested in the potential improvement to the rating for 1 Park View. An EPC assessor modelled the installation of an ASHP in 1 Park View, which showed that, with no other measures, it would be an improvement of seven points (E46).

As the measure would not improve the EPC Band, the landlord decided against installing an ASHP. No other modelling was done. When the property next becomes vacant, the landlord will install internal wall insulation to achieve a predicted rating of D58. The landlord anticipates this will be at the higher end of the EPC's predicted costs, excluding associated redecoration costs.

The landlord estimates that to reach a predicted rating of C70 by also installing floor insulation and a new condensing boiler, the cost would be in the region of £35,000. The rent would likely remain the same as present, at £935 pcm, which is in line with properties of the same size in the area. Solar water heating and solar panels would not be appropriate for this property because the roof does not provide sufficient area and it is shaded by trees. Also, the house is in a conservation area.

4 High costs

The problem

The Government has invested a total of £1.3 billion in supporting green home upgrades, including in March 2021 an additional £300 million to be distributed through local authorities in England to low-income households. However, overall policy is fragmented and not delivering at the scale or pace required. Some of the problem can be attributed to the high costs of delivering effective energy efficiency measures. The Government predicts that home upgrades can help households save more than £300 a year on their energy bills. However, landlords are finding that energy efficiency measures are costing far more than anticipated, based on EPC predictions. This is because the EPC does not consider the associated costs incurred when renovating.

Key issues

An EPC is a tool designed to give a property an energy efficiency rating and provide recommendations to improve energy efficiency and reduce costs. It provides estimated costs for implementing recommended changes and potential savings. This allows homeowners to compare the cost of installation against lower energy bills.

However, the estimated costs recommended by the EPC are often inaccurate and misleading because they do not include wider project costs, such as in-depth surveys, making good and applications for planning consents. There is also a disconnect between the predicted and actual energy performance of a building, known as the 'performance gap'. The performance gap can be impacted by occupant behaviour, weather conditions, workmanship/installation errors, systems' control settings and modelling issues.

The private rented sector faces significant barriers to the adoption of energy performance improvement measures: 67 per cent of private rented sector properties in England and Wales are below EPC Band C for energy efficiency (Department for Business, Energy & Industrial Strategy, 2020). Due to an uneven playing field, in which the landlord covers the investment cost and the tenant typically benefits from reduced fuel bills, there is little incentive for landlords to carry out energy improvements beyond MEES requirements.

The role of maintenance in an energy-efficient household is often underestimated and is not mentioned anywhere on the current EPC. Keeping a home well maintained and in good repair is an essential first step in the whole house approach to ensure energy efficiency. Maintenance should be completed prior to, or in conjunction with, the installation of fabric measures, such as insulation.

The condition and performance of the existing fabric, as well as its mechanical and electrical services such as heating controls, ventilation, windows and guttering, directly impacts the ability of the building to be warm and dry. Furthermore, if the basics are neglected, the performance of any additional energy efficiency improvement measures is likely to be affected.

Recommendations

Overhaul the recommendation section of the EPC to include a much wider range of measures, more accurate costs and more realistic estimated outcomes.

Key findings

- Real-life costs of renovations found to be far in excess of indicative costs on EPC.
- CROHM software identifies measures to achieve a Band D or Band C at a fraction of the costs set out in EPC.
- Two properties could not reach Band E following renovation works that totalled £17,109.
- Landlord carries out all possible energy efficiency measures on property to achieve a Band E at a cost of £30,000 to £40,000.

Case studies

1 and 2 Model Cottages, Wrexham

Real-life costs of renovations found to be far in excess of indicative costs on EPC.

One of the semi-detached Model Cottages. [Iain Hill-Trevor]

Property description

- Two semi-detached two-bedroom cottages of brick and slate, built in the early 20th century with modest extensions in the 1970s.
- 1 Model Cottages total floor area 69m^2; 2 Model Cottages total floor area 82m^2.
- Not listed or in a conservation area.
- Both assured shorthold tenancies.
- Both on electric heating.

The works

1 Model Cottages was overhauled and renovated in late 2016 to early 2017. The walls were dry lined, the solid floor was insulated and the roof received 300mm of loft insulation. All windows except one were double glazed. An electric central heating system was installed with a thermostatically controlled heater on a 100 per cent renewable electricity tariff. The landlord chose electricity over oil or LPG as a more environmentally friendly option.

1 Model Cottages
22 May 2017 RRN: 8823-7825-5000-5192-3992

Energy Performance Certificate

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Solid brick, with internal insulation	★★★★☆
Roof	Pitched, 300 mm loft insulation	★★★★★
Floor	Solid, insulated	—
Windows	Mostly double glazing	★★★☆☆
Main heating	Room heaters, electric	★☆☆☆☆
Main heating controls	Programmer and room thermostats	★★★★☆
Secondary heating	Room heaters, dual fuel (mineral and wood)	—
Hot water	Electric immersion, standard tariff	★☆☆☆☆
Lighting	Low energy lighting in all fixed outlets	★★★★★

Current primary energy use per square metre of floor area: 376 kWh/m² per year

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.

Measures with a green tick may be supported through the Green Deal finance. If you want to take up measures with an orange tick through Green Deal finance, be aware you may need to contribute some payment up-front.

Recommended measures	Indicative cost	Typical savings per year	Rating after improvement	Green Deal finance
High heat retention storage heaters and dual immersion cylinder	£1,600 - £2,400	£ 590	C70	✓
Solar water heating	£4,000 - £6,000	£ 53	C72	✓
Solar photovoltaic panels, 2.5 kWp	£5,000 - £8,000	£ 282	B84	✓

Above: The EPC assessment (top) and recommendations (bottom) for 1 Model Cottages. [Iain Hill-Trevor]

An EPC for 1 Model Cottages was carried out in May 2017 and gave the property an energy efficiency rating of E44. The cottage did not have a baseline EPC, but the neighbouring cottage was assessed in November 2012 and was given an energy efficiency rating of F32. As the condition of the two properties before renovation was identical, this suggests that 1 Model Cottages achieved an improvement of only 12 points after the extensive works detailed above. The total cost of renovating 1 Model Cottages was £54,000 before redecoration.

The EPC for 1 Model Cottages recommends installing high heat retention storage heaters and a dual immersion cylinder, which

The EPC assessment (below) and recommendations (bottom) for 2 Model Cottages. [Iain Hill-Trevor]

would improve the rating of the property to C70. It estimates a cost between £1,600 and £2,400. The landlord had a quote for the identical neighbouring property and found it would cost in excess of £7,000.

The 2012 EPC for 2 Model Cottages recommends cavity wall insulation, internal or external wall insulation and floor insulation. The EPC suggests these combined measures would improve the rating of 2 Model Cottages to D55.

2 Model Cottages
05 November 2012 RRN: 9605-2825-7293-9902-7591

Energy Performance Certificate

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Solid brick, as built, no insulation (assumed)	★☆☆☆☆
	Cavity wall, as built, no insulation (assumed)	★★☆☆☆
Roof	Pitched, 100 mm loft insulation	★★★☆☆
	Pitched, limited insulation (assumed)	★☆☆☆☆
Floor	Solid, no insulation (assumed)	—
Windows	Partial double glazing	★★☆☆☆
Main heating	Room heaters, electric	★★☆☆☆
Main heating controls	Programmer and room thermostats	★★★★☆
Secondary heating	Room heaters, dual fuel (mineral and wood)	—
Hot water	Electric immersion, off-peak	★★☆☆☆
Lighting	Low energy lighting in 50% of fixed outlets	★★★★☆

Current primary energy use per square metre of floor area: 562 kWh/m² per year

Recommended measures	Indicative cost	Typical savings per year	Rating after improvement
Cavity wall insulation	£500 - £1,500	£ 92	F35
Internal or external wall insulation	£4,000 - £14,000	£ 416	E51
Floor Insulation	£800 - £1,200	£ 97	D55
Draught proofing	£80 - £120	£ 24	D56
Low energy lighting for all fixed outlets	£25	£ 15	D57
Fan assisted storage heaters and dual immersion cylinder	£1500 - £2000	£ 304	C69
Solar water heating	£4,000 - £6,000	£ 33	C71
Replace single glazed windows with low-E double glazed windows	£3,300 - £6,500	£ 67	C74
Solar photovoltaic panels, 2.5 kWp	£9,000 - £14,000	£ 217	B84
Wind turbine	£1,500 - £4,000	£ 84	B88

The EPC estimates floor insulation would cost in the region of £800 to £1,200. When carrying out floor insulation at 1 Model Cottages, the landlord recorded the expenditure as follows (not including redecoration costs or estate labour):

Digging out floors	£1,560
Screed	£550
Concrete	£5,250
Skirting	£390
Flooring	£840
Insulation	£650
New kitchen	£850
Total	£10,090

The landlord reports that several other properties on the estate have also been upgraded, mostly including floor insulation, wall and roof insulation (where possible and appropriate to the type of construction), new heating systems and double glazing. The landlord notes that the estate has not managed to get any property beyond a Band D and has found that refurbishments generally cost between £30,000 and £70,000 depending on property size.

Polesden Farm Cottage, Dorking

CROHM software identifies measures to achieve a Band D or C at a fraction of the costs set out in EPC.

Polesden Farm Cottage, Dorking.
[Vicky Flanders]

Property description

- Two-bedroom brick and tile cottage. Total floor area 74m^2.
- Not listed or in a conservation area, possibly in curtilage of wider estate.
- Assured shorthold tenancy.
- Oil heating.

The works

The National Trust invited a group of Department for Business, Energy & Industrial Strategy policy advisors to the Polesden Lacey estate to look at several private rented sector properties under National Trust management. The purpose of the exercise was to compare recommendations from EPCs with hypothetical measures generated by CROHM software (Parity Projects).

CROHM is a licensed tool where you can upload information from an EPC. This data can then be manipulated and investigated to drive investment scenarios. Whereas the EPC software has only 46 measures to choose from, CROHM has hundreds, thus allowing for more tailored options. The cost of measures is input and updated by Parity Projects to give more realistic indications, with the potential to vary results between geographical areas.

The group members was shown a mix of listed and unlisted properties by a National Trust building surveyor and estate manager. They were shown the EPC recommendations and discussed measures considered to be appropriate to the properties.

Below: EPC recommendations for Polesden Farm Cottage, Dorking. [Vicky Flanders]

Polesden Farm Cottage had been given an energy efficiency rating of F28 in August 2009. To reach a Band D, the EPC recommended roof and internal/external wall insulation, at an estimated cost of around

Recommended measures	Indicative cost	Typical savings per year	Rating after improvement	£/SAP
Flat roof or sloping ceiling insulation	£850 - £1,500	£ 26	E40	£1,175
Internal or external wall insulation	£4,000 - £14,000	£ 289	D59	£473
Floor insulation (solid floor)	£4,000 - £6,000	£ 51	D63	£1,250
Draught proofing	£80 - £120	£ 11	D64	£100
Replace boiler with new condensing boiler	£2,200 - £3,000	£ 32	D66	£1,300
Solar water heating	£4,000 - £6,000	£ 43	C69	£1,667
Replace single glazed windows with Low-Emissivity double glazed windows	£3,300 - £6,500	£ 69	C74	£980
Solar photovoltaic panels, 2.5 kWp	£5,000 - £8,000	£ 312	B85	£590

£10,750. To reach a Band C, floor insulation, draught-proofing, a new condensing boiler and solar water heating would be required, at an estimated cost of £23,450.

Using the CROHM software, it was possible to achieve a Band D for around £1,305 and a Band C rating for £7,449. The recommended measures were checked to ensure they were appropriate for the property. They included:

- Hot water cylinder thermostat
- 300mm loft insulation
- Full multi-zone controls
- Draught-proofing for doors and windows
- 2.5kWp photovoltaic array
- Secondary glazing

Below: CROHM recommendations for Polesden Farm Cottage, Dorking. [Vicky Flanders]

Name	Cost (+increase)	SAP Score	Confidence
PCDF boiler reference from generic SAP boiler information	£0 (£0)	43.42 E	1
+ Hot water cylinder thermostat	£300 (£+300)	47.31 E	1
+ 300mm loft insulation from unknown insulation - no access to loft	£705 (£+405)	50.99 E	1
+ Full multi zone controls from full normal control set	£1305 (£+600)	54.61 D	1
+ Draughtproof doors and windows	£1605 (£+300)	55.56 D	1
+ 300mm loft insulation from 100mm	£1905 (£+300)	56.35 D	1
+ 2.5kWp PV array south east and 30 degree pitch with moderate shading	£6255 (£+4350)	67.04 D	1
+ Secondary glazing from single glazing	£7449 (£+1194)	69.02 C	1

Below: The Old Forge (left) and Dove Cottage (right). [Thomas Jennerfust]

The Old Forge and Dove Cottage, Berkeley

Two properties could not reach Band E following renovation works that totalled £17,109.

Property description

- Old Forge is a three-bedroom house, built in the early 1900s. Total floor area 85m².
- Dove Cottage is a two-bedroom cottage, built in the 1900s. Total floor area 73m².
- Old Forge is not listed or in a conservation area.
- Dove Cottage is Grade II listed.
- Both assured shorthold tenancies.
- Old Forge is on dual fuel; Dove Cottage is on electricity.

The works

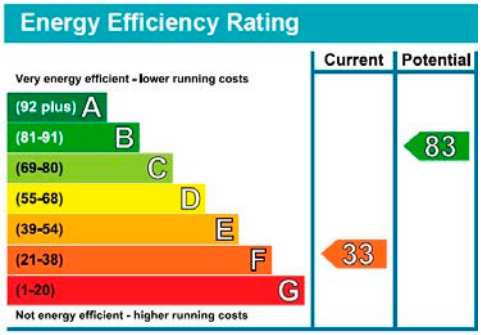
The landlord manages four rural properties, three of which are let to local long-term tenants, on average at 28 per cent below market rent. Ahead of the 2018 MEES regulations, the landlord decided to invest in both properties, with the aim of improving energy efficiency. Larger scale works were carried out when the properties were vacated, with smaller measures carried out with tenants in situ.

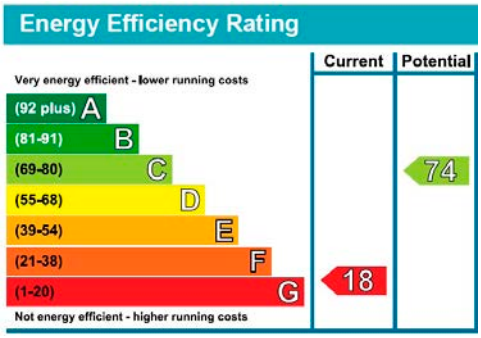
The Old Forge was assessed in March 2013 and given an energy efficiency rating of F29. £10,005 was spent renovating the house, including increasing loft insulation and installing a high-efficiency dual fuel Ecoboiler stove. In February 2020, the property was assessed again and has only improved by four points, to an energy efficiency rating of F33.

Dove Cottage was vacated during the first coronavirus lockdown. The property had been assessed in March 2020 and received an energy efficiency rating of F22. The landlord spent £7,104 on renovation works, including replacing an old coal back boiler with an electric heating system. An electric boiler was installed alongside the existing hot water cylinder, a fully pumped control pack was supplied, and two new radiators were installed. The decision was based on recommendations from two contractors, who were asked to quote for the works. Both advised electricity would be most efficient for a small cottage.

The property was assessed again in June 2020 and received an energy efficiency rating of G18, a drop of four points and one SAP band. The landlord has applied for an exemption based on the expenditure on the property to date.

Energy Efficiency Ratings for the Old Forge (left) and Dove Cottage (right). [Thomas Jennerfust]





Recommended measures	Indicative cost	Typical savings per year	Rating after improvement
Internal or external wall insulation	£4,000 - £14,000	£ 500	E52
Floor insulation (solid floor)	£4,000 - £6,000	£ 87	D56
Draught proofing	£80 - £120	£ 18	D57
Low energy lighting for all fixed outlets	£30	£ 32	D58
Heating controls (programmer, room thermostat and TRVs)	£350 - £450	£ 93	D62
Solar water heating	£4,000 - £6,000	£ 139	D67
Replace single glazed windows with low-E double glazed windows	£3,300 - £6,500	£ 126	C72
Solar photovoltaic panels, 2.5 kWp	£3,500 - £5,500	£ 340	B83

EPC recommendations for the Old Forge (above) and Dove Cottage (below). Thomas Jennerfust.

Note: The landlord has invested a total of £37,502 upgrading the four properties. Of the other two properties, one moved from F26 to E45 at a spend of £14,166 and the other moved from G17 to F35 at a spend of £6,227. If the minimum rating was increased to Band C, the landlord stated the properties would be sold or the rents increased, which would price out the existing tenants.

Recommended measures	Indicative cost	Typical savings per year	Rating after improvement
Room-in-roof insulation	£1,500 - £2,700	£ 601	F33
Internal or external wall insulation	£4,000 - £14,000	£ 286	E43
Floor insulation (solid floor)	£4,000 - £6,000	£ 135	E48
Draught proofing	£80 - £120	£ 17	E49
Solar water heating	£4,000 - £6,000	£ 84	E51
Replace single glazed windows with low-E double glazed windows	£3,300 - £6,500	£ 214	D60
High performance external doors	£1,500	£ 57	D62
Solar photovoltaic panels, 2.5 kWp	£3,500 - £5,500	£ 340	C74

The Lodge, Shenton

Landlord carries out all possible energy efficiency measures on property to achieve Band E at a cost of £30,000 to 40,000.

The Lodge, Shenton.
[Charles Wollaston]

Property description

- Victorian two-bedroom detached house, constructed from bricks with blue clay tiles, situated in historic parkland. Total floor area 101m^2.
- Not listed or in a conservation area, adjacent to registered battlefield.
- Assured shorthold tenancy.
- LPG heating.

The works

The landlord has an estate of 32 private rental properties, seven farms and some commercial properties in the village of Shenton. The landlord is renovating the properties to improve their energy efficiency ratings in line with MEES regulations. Each property was assessed before renovation to gain a baseline score and the DEA produced several draft EPCs based on different hypothetical renovation works to help guide decision-making. After renovations were completed, a final EPC was produced and lodged.

Recommended measures	Indicative cost	Typical savings per year	Rating after improvement
Internal or external wall insulation	£4,000 - £14,000	£ 605	F34
Floor insulation (solid floor)	£4,000 - £6,000	£ 96	F37
Low energy lighting for all fixed outlets	£35	£ 47	F38
Solar water heating	£4,000 - £6,000	£ 57	E40
Replace single glazed windows with low-E double glazed windows	£3,300 - £6,500	£ 78	E43
Solar photovoltaic panels, 2.5 kWp	£5,000 - £8,000	£ 314	E52
Wind turbine	£15,000 - £25,000	£ 652	C71

EPC recommendations for The Lodge.
[Charles Wollaston]

The Lodge was assessed in March 2019 after longstanding Rent Act tenants vacated it. It was given a baseline energy efficiency rating of G17. The recommended measures included internal or external wall insulation, floor insulation and low energy lighting. This would improve the rating to F38. Solar water heating would be needed to reach a Band E and a Band C would involve installing double glazing, solar photovoltaic panels and a wind turbine.

The Lodge is located in historic parkland adjacent to the registered Bosworth Battlefield. Planning consent for solar panels and a wind turbine would likely be turned down. Furthermore, these measures were considered by the landlord to be inappropriate in terms of the setting and aesthetics of the building.

Three draft EPC assessments were produced for The Lodge to model the following hypothetical scenarios:

- Install electric boiler and hot water cylinder E41
- Install electric heaters and hot water cylinder E47
- Upgrade LPG boiler E45

The assessments also included installing full double glazing, 250mm loft insulation, solid floor insulation across most of the ground floor and internal wall insulation throughout.

The landlord decided to go with the third option: upgrading a five-year-old LPG boiler. The landlord estimated the total cost of the energy improvement measures to be between £30,000 and £40,000. Of this sum, £17,000 was spent on installing double glazing, using heritage wooden frames to preserve the character of the place. Other renovation works included complete rewiring and new plumbing, upgrading the kitchen and bathroom, relocating the boiler and tank,

laying new carpets and floor tiles, repointing, installing a wood-burning stove and flue, and general redecoration. The total amount spent on renovation works was around £140,000.

The Lodge was reassessed in November 2020 and was given an energy efficiency rating of E45, with a potential rating of C79. The measures to reach a Band C included:

- Floor insulation (remaining ground floor), £4,000–6,000 +1 point
- Solar water heating, £4,000–£6,000 +4 points
- Heat recovery system for mixer showers, £585–£725 +1 point
- Solar photovoltaic panels, 2.5kWp, £3,500–£5,500 +9 points
- Wind turbine, £15,000–£25,000 +19 points

These remaining measures would be costly, disruptive to tenants and inappropriate to the property and setting. Unless a wind turbine was installed, they would also make little difference to the energy efficiency rating. The landlord does not think it is possible to achieve a Band C for this property, or any of the others on the estate. If the minimum requirement were increased to a Band C, the landlord would be forced to evict the tenants and sell the property.

5 Traditional construction

The problem

Different traditional designs and construction mean that a 'one size fits all' energy improvement solution is rarely appropriate for traditional homes. Improvements require an approach that considers a building in its context in order to find a balanced solution that saves energy, sustains heritage significance and maintains a comfortable, healthy indoor environment: a whole house approach.

Key issues

Traditionally constructed buildings are formally defined in regulations as having 'permeable fabric that both absorbs and readily allows the evaporation of moisture'. In practice, traditional buildings are more often characterised by their year of construction. In England, buildings constructed before 1919 are considered to be traditional. The English Housing Survey estimates that around 35 per cent of the private rented sector in England was built before 1919, rising significantly in rural areas.

Traditionally constructed buildings differ from other building stock. The EPC methodology needs to take account of their physical characteristics, conservation principles, and appropriate energy saving measures.

Physical characteristics

These buildings may have complex and irregular geometry, including:

- Envelope construction lacking insulation or vapour barriers.
- Vernacular construction methods and natural non-standardised materials that are heterogeneous in their composition.
- Passive, non-mechanical, indoor climate management strategies, such as thermal mass, moisture buffering and natural ventilation through wall or window openings.

Conservation principles

The treatment of historic buildings is governed by established conservation principles and practices that require the protection of a building's historic fabric and distinguishing character.

Energy efficiency measures

Energy efficiency improvements need to consider the impact on the work on the building, and short- and long-term goals. A whole-house approach needs to be taken (Historic England, 2018). This involves understanding the building in its context to find balanced solutions that save energy, sustain heritage signficance, and maintain a comfortable and healthy indoor environment. Planning ahead in this way can minimise risks, facilitate any consenting processes and help ensure that design, installation and 'occupant in-use' phases turn out as planned.

The types of energy retrofit that are appropriate in newer/modern buildings may damage traditionally constructed buildings because the materials used for modern buildings are generally vapour barriers, which would prevent the natural permeability of a traditional building. Furthermore, modern retrofit recommendations could result in loss of aesethetic character and/or historic signficance or perverse outcomes relating to the economics, fabric and indoor environment of the building.

Another consideration is the desire to identify and retain a building's inherent energy-efficient features. Traditional buildings were often designed to respond to local climatic conditions and to take advantage of natural sources of heat, light and ventilation. These buildings are commonly described as having inherent features – for example, shutters, awnings, porches, skylights, transoms and vents – that contribute to better energy performance. Often, these measures are low cost and involve minimal alterations to building fabric.

Existing studies evaluating whole building energy consumption have examined a wide range of retrofit strategies, including measures affecting the building envelope, measures affecting HVAC systems (heating, ventilation and air cooling) and those affecting both. Retrofit studies that additionally examined changes in occupant behaviour in traditional buildings found that they can affect energy savings from physical retrofits in both positive and negative ways. It is thought that behavioural changes alone can, in fact, exceed savings made from physical retrofits, but also that the behavioural 'rebound effect' (increase in environmental damage by the occupant) can significantly reduce savings from physical retrofits.

Recommendations

Incorporate an understanding of traditional building performance with appropriate data and models in EPC software.

Key findings

- No appropriate fabric first measures identified in the EPC, putting emphasis on less sustainable systems change.
- Most recommended measures found to be inappropriate or harmful to Band F property.
- Recommendations for Grade II listed property are not appropriate as they do not provide contextual guidance for decision-making.
- Listed timber-framed building achieves Band C at a cost of around £50,000.

Case studies

1 Littlewood Cottages, Chichester

No appropriate fabric first measures identified on the EPC, putting emphasis on less sustainable systems change.

1 Littlewood Cottages. [Jo Lugg]

Property description

- Typical local estate semi-detached Sussex farm cottage, late 19th century. Flint and brick property, with 'torching' to roof tiles. Mid-20th-century ground-floor extension and later room-in-roof extension. Total floor area 103m².
- In curtilage of Grade II listed farmhouse.
- Tenancy type unknown.
- LPG heating.

The works

1 Littlewood Cottages is a traditionally constructed flint and brick semi-detached cottage. The property has tiles hung on chestnut laths, with the upper part of each tile bedded into a lime and hair mortar, known as 'torching'. The property is adjacent to a Grade II listed farmhouse and a range of farm buildings from the same development, located on the edge of the South Downs Way.

In March 2013, the property was assessed and it received an energy efficiency rating of F25, with a potential rating of D61. In 2013, existing energy efficiency measures included an LPG boiler with programmer, room thermostats and thermostatic radiator valves – providing heating and hot water to the property – and secondary glazing to all windows. After the EPC assessment, the owner carried out the following additional measures:

- Room-in-roof loft insulation to a depth of 250mm (horizontal) and 100mm (angled and skeilings) and a 50mm ventilation gap.
- Low energy lighting to all fixed outlets.
- Flat roof insulation to a depth of 100mm, Celotex material.

Below: National Trust's draft EPC recommendations for 1 Littlewood Cottages. [Jo Lugg]

Recommended measures	Indicative cost	Typical savings per year	Rating after improvement
Room-in-roof insulation	£1,500 - £2,700	£ 344	E43
Cavity wall insulation	£500 - £1,500	£ 26	E44
Internal or external wall insulation	£4,000 - £14,000	£ 167	E52
Floor insulation (solid floor)	£4,000 - £6,000	£ 52	D55
Solar water heating	£4,000 - £6,000	£ 84	D59
High performance external doors	£1,000	£ 20	D60
Solar photovoltaic panels, 2.5 kWp	£3,500 - £5,500	£ 358	C69

National Trust's draft EPC assessment for 1 Littlewood Cottages. [Jo Lugg]

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Solid brick, as built, no insulation (assumed)	★☆☆☆☆
	Cavity wall, as built, insulated (assumed)	★★★★☆
	Cavity wall, as built, no insulation (assumed)	★★☆☆☆
Roof	Pitched, 100 mm loft insulation	★★★☆☆
	Roof room(s), no insulation (assumed)	★☆☆☆☆
	Flat, insulated (assumed)	★★★☆☆
Floor	Solid, no insulation (assumed)	—
	Solid, limited insulation (assumed)	—
Windows	Full secondary glazing	★★★★☆
Main heating	Boiler and radiators, LPG	★★☆☆☆
Main heating controls	Programmer, room thermostat and TRVs	★★★★☆
Secondary heating	None	—
Hot water	From main system	★★☆☆☆
Lighting	Low energy lighting in all fixed outlets	★★★★★

Current primary energy use per square metre of floor area: 241 kWh/m² per year

In August 2019, a draft EPC was produced for 1 Littlewood Cottages, which gave the property an F28 rating. The following measures were recommended:

- Room-in roof insulation
- Cavity wall insulation
- Internal or external wall insulation
- Floor insulation
- Solar water heating
- High performance external doors
- Solar photovoltaic panels

The EPC recommended measures were assessed by a National Trust building surveyor in March 2020, who provided the following comments.

The property's structure does not allow for further insulation than that installed in 2013. Most of the external walls at 1 Littlewood Cottages are solid flint and brickwork, with a section of cavity wall to the post-1930s extension and 2012 extension only. The depth of the 1930s cavity is unknown, which means that insulation may collect in pockets and leave gaps, thereby providing insufficient coverage. Leaving gaps could also cause dampness in the future, via potential bridging of the cavity, the porous nature of the brickwork and interstitial condensation. The kitchen extension is constructed of cavity brickwork with cavity insulation. Although it was not seen during the visual inspection, the insulation was included as part of the

original specification in 2012 when the kitchen was built. This section of cavity wall makes up less than 20 per cent of the brickwork area of the building. Additional cavity insulation filling the void would lead to bridging and damp internally.

The adjoining property is similar in its major features to 1 Littlewood Cottages, but its fuel type is oil. This property received an E rating. As no appropriate fabric-based measures were identified for 1 Littlewood Cottages via the EPC, one way for the property to comply with MEES regulations would be to switch from LPG to oil.

Fullers Farm, Guildford

Most recommended measures found to be inappropriate or harmful to Band F property.

Fullers Farm.
[Jo Lugg]

Property description

- Detached brick two-storey house, constructed between 1870 and 1888. Unique split-level design in the domestic Revival style, with additional early and post-1935 extensions. Total floor area 111m².
- In curtilage of a listed building, set within Grade II registered parkland.
- Tenancy type unknown.
- LPG heating.

The works

In October 2017, an EPC assessment was undertaken of Fullers Farm. The property had a modern LPG boiler with programmer, room thermostats and thermostatic radiator valves – providing heating and hot water – loft insulation to a depth of 250mm, secondary glazing to all windows (except the dining room) and low energy lighting to all fixed outlets.

After the 2017 assessment, several improvement measures were carried out between 2017 and 2019. These included:

- Installing secondary glazing to the dining room windows
- Draught-proofing the front door
- Fitting an 80mm jacket to the hot water cylinder

In 2019, a new EPC assessment was carried out and the property was given a rating of F26. The EPC suggested that Fullers Farm has a potential rating of D64. The recommended measures to achieve this rating included:

- Cavity wall insulation
- Internal or external wall insulation
- Floor insulation (solid floor)
- Additional 80mm jacket to hot water cylinder
- Solar water heating
- Solar photovoltaic panels, 2.5 kWp

In February 2020, the National Trust commissioned a building surveyor to review the 2019 energy efficiency recommendations. The report sought to ascertain whether the recommendations were deemed reasonable and whether any other improvements should be considered.

It found that all reasonable measures for a building of this age and construction had already been undertaken in relation to cost payback. The report also highlighted that the recommendations in the 2019 EPC, excluding installing a hot water cylinder jacket, would be inappropriate and detrimental to the building and its inhabitants in the long term.

Potential problems included:

- Inconsistent filling of the cavity wall could result in pockets and gaps, thereby providing minimal thickness of insulation and potentially causing a thermal bridge.
- External insulation would require significant detailing around opening elements and substantial alteration to the building's roofline. Furthermore, it could prevent the building envelope from breathing, and likely lead to damp and condensation issues.
- Internal insulation could potentially cause cold bridging around irregular floor levels and openings, and may lead to damp and condensation issues.
- Floor insulation may require the existing original tiled floor to be lifted and replaced, thus necessitating the alteration of all doorways and fitted furniture and incurring the loss of original features.
- Installing solar heating and photovoltaic panels may potentially damage the roof tiles and result in loss of detailing and character. The usable roof area is relatively small.

An additional 80mm hot water cylinder jacket was fitted, which improved the score of the property by one point. In addition, an inner door off the porch was added to prevent further heat loss from the hallway via the porch. Rugs or carpets with underlay were recommended to enhance the occupants' feeling of warmth. However, neither of these last measures provided any improvement to the property's energy efficiency score.

33 East Street, Corfe Castle

Recommendations for Grade II listed cottage are not appropriate as they do not provide contextual guidance for decision-making.

33 East Street.
[© Michael Dibb]

Property description

- 17th-century two-bedroom mid-terraced cottage, built from Purbeck stone with stone slate roof. Row of three cottages, probably originally one house. Total floor area 58m².
- Grade II listed and in conservation area.
- Assured short hold tenancy.
- Electric heating.

The works

33 East Street is part of a family-run estate of 16 let properties in ownership since 1720. All but two of the properties are Grade II listed, dating from the 16th and 17th centuries. 33 East Street is heated with individual electric room heaters, controlled by individual thermostats, and a wood burner. Hot water is provided by an electric immersion heater on a standard tariff.

In October 2020, the landlord assessed 33 East Street after it was vacated by longstanding tenants. The property had been updated aesthetically before the assessment, but no energy efficiency measures had been carried out. The property was given an energy efficiency rating of F24, with a potential rating of A95.

The EPC made the following recommendations to achieve an A rating:

Room-in-roof insulation, £1,500–£2,700	+19 points
Internal or external wall insulation, £4,000–£14,000	+4 points
Floor insulation (solid floor), £4,000–£6,000	+2 points
Hot water cylinder insulation, £15–£30	+1 point
Draught-proofing, £80–£120	+1 point
Low energy lighting, £25	+1 point
High heat retention storage heaters, £1,200–£1,800	+22 points
Solar water heating, £4,000–£6,000	+2 points
Double-glazed windows, £3,300–£6,500	+4 points
Solar photovoltaic panels, 2.5 kWp, £3,500–£5,500	+14 points

Feature	Description	Rating
Wall	Sandstone or limestone, as built, no insulation (assumed)	Very poor
Roof	Roof room(s), ceiling insulated	Very poor
Window	Single glazed	Very poor
Main heating	Room heaters, electric	Very poor
Main heating control	Appliance thermostats	Good
Hot water	Electric immersion, standard tariff	Very poor
Lighting	Low energy lighting in 29% of fixed outlets	Average
Floor	Solid, no insulation (assumed)	N/A
Secondary heating	Room heaters, dual fuel (mineral and wood)	N/A

Above: EPC assessment summary for 33 East Street, Corfe Castle.

The room-in-roof insulation was installed during a major renovation in 1985, but no evidence was available to demonstrate this to the assessor. Installing additional roof insulation would make the space unusable due to reduced head height.

External wall insulation would not be acceptable for a listed property of this type. The rooms are generally small with uneven walls, and internal wall insulation would further reduce the size of the two bedrooms and living area. In addition, the landlord experienced damp and mould in another property that received wall insulation.

The ground floor of the property is flagstones laid on bare earth with no foundations, which makes underfloor insulation unviable. The landlord had laid carpets with thick underlay to improve the warmth of the property. Solar water heating and solar photovoltaic panels would not be suitable for a listed building of this type in a conservation area.

Of the remaining recommendations, hot water cylinder insulation, draught-proofing and low energy lighting are affordable and simple measures that do not pose any risk to the building. However, they only improve the rating by one point each, to F27. Double-glazed windows would provide a further four points (F31). However, replacing historic windows with standard double glazing in a listed building in a conservation area may not be acceptable; an understanding of the signficance and condition of the windows would be required to determine a decision. Alternatives would need to be carefully planned, and permission would be required in advance. This would likely result in a higher cost, which may not be justifiable considering the relatively low impact to the rating.

Alternatively, installing a high heat retention storage heater would improve the rating by 22 points (E49), at a lower cost and with less impact to historic significance. In addition, mains gas is available in the street and the cost of connecting the house to the grid and

installing a gas boiler would be approximately £8,000. The house has not been modelled on a gas fuel type, but it is likely that this measure alone would increase the rating of the property to at least Band E.

Note: The inappropriate measures recommended in the EPC made the landlord distrustful of following the guidance and unsure about the correct approach for the property. This meant that the smaller scale and more appropriate measures contained in the EPC were 'lost' or overlooked. The landlord did not receive useful advice from the DEA during the visit and was unclear about where to seek help. The software was not able to consider the sensitive considerations required for a listed building and was also not able to pick up on contextual opportunities, such as the nearby availability of mains gas.

Church View, Bucknell

Listed timber-framed building achieves C rating at a cost of around £50,000.

Church View, Bucknell. [© Mr Bryan Green / Source: Historic England Archive]

Property description

- Three-bedroom timber-framed house, with lime-rendered infill on rubblestone plinth and reed thatch roof, built in mid-17th century. Total floor area 120m^2.
- Grade II listed.
- Assured shorthold tenancy.
- Oil heating.

The works

Church View is a black and white, half-timbered, thatched cottage with lime panelling. Historically, it had been separated into two small cottages and it was extensively renovated and converted back into one cottage in 2014. The cottage did not receive a baseline EPC assessment, but it would likely have achieved a low rating due to its poor condition at the time.

Renovation works included installing an oil boiler, replacing open fires and back boilers, full double glazing, solid floor insulation and low energy lighting. The walls were insulated with breathable internal wall insulation, made from reconstituted wood fibre panels, plastered in lime and painted with a natural mineral paint.

The total cost of renovation was £118,000 plus fees. Of this, £27,926.53 relates to direct energy performance works and £21,286.50 associated making good: a total of £49,213.03.

In September 2018, the property was assessed and achieved an energy efficiency rating of C72. The property would achieve a rating of B89 if a wind turbine were installed.

The property manager stated that installing natural wall insulation was more expensive than conventional non-breathable products and that lime plastering took longer to apply and cure. Otherwise, the installation was straightforward. The main concern would be if current or future tenants were to paint the wall with a vinyl, acrylic or oil-based paint, which would inhibit the breathability of the insulation.

Below: EPC assessment summary for Church View. [Andrew Liddiment]

Church View
18 September 2018 RRN: 8128-7628-5300-1955-9996 **Energy Performance Certificate**

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Timber frame, with additional insulation	★★★★☆
	Sandstone or limestone, with internal insulation	★★★★☆
Roof	Roof room(s), insulated	★★★★★
Floor	Solid, insulated	—
Windows	Fully double glazed	★★★★☆
Main heating	Boiler and radiators, oil	★★★☆☆
Main heating controls	Programmer, room thermostat and TRVs	★★★★☆
Secondary heating	Room heaters, dual fuel (mineral and wood)	—
Hot water	From main system	★★★☆☆
Lighting	Low energy lighting in all fixed outlets	★★★★★

Current primary energy use per square metre of floor area: 143 kWh/m² per year

6 Conclusion

Traditional buildings have proven themselves to be reliable and durable. They were constructed of hard-wearing materials that require little energy or carbon to maintain them. Built before the Industrial Revolution, their occupants produced little carbon, yet EPC assessments deem them to now be fuel and energy hungry.

The opportunity to lower carbon emissions and improve energy efficiency measures via EPC assessments is currently limited. As the Government is looking to decarbonise the national grid by 2035 and grants for ASHPs are being offered to homeowners from April 2022, it is important that EPC scores are recalibrated to consider carbon emissions of heating systems. Alterations to EPCs could also offer valuable support to property owners and construction specialists to meet the UK's pledge to reduce carbon. In addition, it is critical that the EPC methodology reflects the full range of heating systems and products available.

Work is required to improve EPC recommendations and costings. As identified in this report, other software such as Parity Projects' CROHM are able to identify cheaper recommendations than those proposed by the EPC assessment. The way in which EPC recommendations are costed needs to be reviewed to include installation, survey and maintenance expenses.

Finally, the EPC database needs to be updated to include more material ranges and its understanding of traditional building construction. At present, the standard calculation for traditional buildings relies on default values for materials made after 1965. These default values perceive traditional buildings to perform poorly, even though this is largely not the case. With traditional buildings accounting for around 30 per cent of England's building stock, EPCs should provide appropriate decision making to support the Government and owners to meet net zero targets.

7 Glossary

ASHPs – air source heat pumps
BEIS – Department for Business, Energy and Industrial Strategy
CAAV – The Central Association of Agricultural Valuers
CLA – The Country Land and Business Association
CROHM – Carbon Reduction Options for Housing Managers retrofit stock assessment service provided by Parity Projects https://parityprojects.com/
DEA(s) – Domestic Energy Assessor(s)
DLUHC – Department for Levelling Up, Housing and Communities
EPC – Energy Performance Certificate
HVAC – heating, ventilation and air conditioning
kWh/m² – energy consumption measured in kilowatts per m^2
kWp – peak power measured in kilowatts
LPG – liquefied petroleum gas
MEES – Minimum Energy Efficiency Standard
MHCLG – Ministry of Housing. Communities and Local Government (now DLUHC)
NT – National Trust
PCDF – product characteristics database
pcm – per calendar month
PIR – polyisocyanurate insulation
PVCu – Polyvinyl chloride un-plasticised
RdSAP – Reduced Data Standard Assessment Procedure
SAP – Standard Assessment Procedure
TRVs – thermostatic radiator valves
U-values – measure of the rate of heat transfer

8 References

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https://www.gov.uk/government/publications/improving-energy-performance-certificates-action-plan-progress-report/improving-energy-performance-certificates-action-plan-progress-report

Department for Levelling Up, Housing and Communities Energy Performance Certificates guidance web page https://www.gov.uk/government/collections/energy-performance-certificates

Department for Levelling Up, Housing and Communities English Housing Survey web page https://www.gov.uk/government/collections/english-housing-survey

Greenhouse Gas Protocol web site with standardised frameworks to measure and manage greenhouse gas (GHG) emissions https://ghgprotocol.org/

Historic England guidance

Historic England Climate Change: Mitigation, Adaptation and Energy Measures web page https://historicengland.org.uk/whats-new/features/climate-change/

Historic England Energy Efficiency and Historic Buildings web page https://historicengland.org.uk/advice/technical-advice/energy-efficiency-and-historic-buildings/

Historic England 2015 *Energy Efficiency and Historic Buildings: Energy Performance Certificates* https://historicengland.org.uk/images-books/publications/eehb-energy-performance-certificates/

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Historic England Conservation Principles, Policies and Guidance web page https://historicengland.org.uk/advice/constructive-conservation/conservation-principles

Historic England's Technical Tuesday Webinars

https://historicengland.org.uk/services-skills/training-skills/online-training/webinars/technical-tuesdays/

Free webinars, presented by Historic England's Technical Conservation Team, provide delegates with an in-depth look at a range of technical conservation topics including energy efficiency in historic buildings.

Recordings of previous webinars include:

Energy Performance: Achieving an EPC B Rating and the Implications for Traditional Buildings https://historicengland.org.uk/services-skills/training-skills/online-training/webinars/recordings/previous-webinar-on-energy-performance-achieving-an-epc-b-rating/

Conservation Retrofit: Energy Performance Certificates in the Private Rental Sector Case Studies https://historicengland.org.uk/services-skills/training-skills/online-training/webinars/recordings/webinar-on-conservation-retrofit-energy-performance-certificates-in-the-private-rental-sector/

9 Where to get advice

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< < Contents