CREDS

CENTRE FOR RESEARCH INTO ENERGY DEMAND SOLUTIONS

Environmental Change Institute, University of Oxford, OUCE,
South Parks Road, Oxford OX1 3QY, UK

www.creds.ac.uk

Energy Performance Certificates (EPCs)

19 October 2018

CREDS responds to consultations and calls for evidence from government, agencies and businesses, providing insight and expertise to decision-makers.

This response was created for the UK's Department for Business, Energy & Industrial Strategy (BEIS)'s call for evidence on the performance of Energy Performance Certificates (EPCs). BEIS sought evidence on how EPCs perform against three attributes: quality, availability and encouraging action to improve energy efficiency. The consultation ran from July-October 2018.

The consultation response written on behalf of CREDS by the UCL Energy Institute (Bennett G, Hamilton I, Liddiard R, Love, J, Lowe R, Mallaburn P, McKenna E, Oreszczyn T, Ruyssevelt P, Wingfield J) with comments by the Environmental Change Institute, University of Oxford (Eyre N and Fawcett T).

There were 26 consultation questions divided into nine sections and CREDS responded to 12 questions in five sections (list below).

1. Aims, uses and key attributes of EPCs (Qs 1–3)
2. EPC data quality: Reliability (Qs 4–5)
3. EPC data quality: Accuracy (Qs 6–8)
4. EPC data quality: Up to date (Q 10)
5. EPC availability: Access to data (Qs 18–20)

The full consultation response, as submitted, is below.

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Energy Performance Certificates in buildings: call for evidence

Centre for Research in Energy Demand Solutions (CREDS)
Response written by the
UCL Energy Institute: Bennett G, Hamilton I, Liddiard R, Love, J, Lowe R, Mallaburn P, McKenna E, Oreszczyn T, Ruyssevelt P, Wingfield J
with comments by the Environmental Change Institute, University of Oxford: Eyre and Fawcett T

SUMMARY

EPCs will grow in importance as the policy environment moves to a more performance-based approach, as is happening with MEES and the aspiration to move the housing stock to EPC Grade C. Linking EPC performance to the provision of finance, debt and subsidy will put EPCs in the spotlight and increase the legal exposure of the process generating them.

However there is clear and compelling evidence of significant and widespread issues around the reliability, accuracy and precision of EPCs. We have seen major discrepancies operating on a number of levels in the EPC data: between different assessors, between different classes of property, between assessments on the same property, between different EPC assessment regimes.

There is also clear real-world evidence that EPCs may not reflect the actual performance of the building even when occupant behaviour is discounted. This is most clear in non-domestic buildings where average in-use performance bears little relation to EPC rating. This observation is less marked in household ratings, but it is still a major concern.

Making the EPC process more transparent will go a long way to addressing these problems by allowing energy users and researchers to question discrepancies and help improve the process. Cloning is a case in point: this is a perfectly sensible approach for similar properties but the process needs to be opened up to scrutiny. Gaming of the system is another area that needs to be addressed.

Two areas of research show how EPC accuracy could be significantly improved:

- UCL research shows that smart meter data and IoT technology can be used to "ground" EPC calculations in reality just as weather stations are used for forecasts. This lack of grounding has caused serious errors in the EPC system such as using the wrong U-value for solid wall properties until 2016.
- Improving regulatory compliance and quality control in the construction sector in the aftermath of Grenfell should make a significant impact on the "performance gap" because it will be easier to be sure that what is actually constructed was what was originally designed.

Note, as part of our evidence we have referenced non-public documents such as papers in preparation, or papers under peer review as personal communications. We would happily discuss the detail of these publications with BEIS.

Aims, uses and key attributes of EPCs

1. Have we captured all of the current uses of EPCs?

Yes	
No	**X**

Are there any existing or emerging uses we should be aware of?

The table of uses has identified many uses related to its application in specific policies. However, we believe the table should more explicitly cover other more general uses where EPCs have become one of the key indicators/currency of the efficiency of the built stock which includes the following:

1. **General informing of Government policy**, for example we suspect that almost every government energy efficiency policy is assessed by its impact on the distribution of SAP ratings.
2. EPCs are also **used by academic researchers** as a measure of energy efficiency. Numerous academic papers refer to SAP. It has become a currency for energy efficiency discourse.
3. **Fuel cost estimation:** There is increased interest in being able to predict the likely fuel expenditure of a particular occupant in a particular building. Either for estimating direct debits by utilities, or as represented in the table as "green tagging" for mortgages etc. SAP could play a key role in the building element of the assessment. NEED is used by Estate Agent platforms in part because SAP is less trusted as a predictor.
4. **Stock efficiency reporting:** Many large stock holding agencies are required to report the efficiency of their stock, e.g. local authorities, housing associations. EPCs are often used to undertake this type of reporting.
5. **To provide value for energy efficient properties –** this probably was one of the "original purposes of the EPC".

We do not believe "data source" is a use, but a method of facilitating a use.

2. Do you agree that we have identified the key attributes for EPCs?

Have we correctly identified the key attributes?

Yes	
No	**X**

Are there other important attributes we have not listed?

We believe that an important attribute is **what an EPC actually represents/measures**? In summary: peak kW or annual kWh? Performance of building fabric only or of systems too, and if so which ones?

As our energy system evolves to meet different requirements we believe that an

energy label should reflect these changes. This has happened historically as the EPC evolved from focusing on fuel cost to CO_2 emissions. As we decarbonise our energy system, moving from fossil fuels to renewables and nuclear, fuel costs will reduce but capital costs increase. This is likely to result in a change to how energy is costed, which will in turn impact on ratings such as SAP with time of energy use and peak power becoming more important compared to total annual energy. Therefore should what we label be re-examined? Will there be increased interest in labelling **peak power** in the future?

Also, if the UK is wanting to quickly decarbonise, emissions associated with embodied energy become more important, should a label include embodied energy. Also should non-regulated energy use be accounted for? Should the label reflect the life-time of measures? At present boilers only last for decades while the fabric lasts centuries.

All labels have limitations, the key is that EPCs should incentivise building owners to move a complex system to a desirable new state and this desirable new state is changing rapidly as we introduce more renewables to the system.

It is important to recognise that there may have to be trade-offs between some attributes, for example lowering costs might reduce quality and vice versa. With this in mind we are interested on views as to which attributes respondents consider to be the most important for EPCs to work well.

Please indicate below how important you consider each attribute

	Very important	Important	Somewhat important	Not important	Unsure/no opinion
Reliability					
Accuracy					
Up to date					
Improves energy performance					
Influences property decisions					
Access to data					
Coverage					
Simple and low cost					

Please provide any details to explain your answer

3. Which attributes are important for which uses?

Some attributes may be more important for particular uses. We would be interested in views on which attributes are most important for the different uses.

	Reliability	Accuracy	Up to date	Improves energy performance	Influences property decisions	Access to data	Coverage	Simple and low cost
Providing information to consumers								
Minimum standards for rental properties								
Eligibility criteria for FiTs/RHI								
Eligibility criteria for ECO funding								
Use by 3rd parties for research etc								
Green mortgages and green finance								
Target setting for government policies								

Please provide any details to explain your answer

Reliability, Accuracy and Cost are related, and **important for almost all uses**. We anticipate the use for policy, e.g. setting of minimum standards, will make EPCs more valued. In turn, as they become more valued it becomes more important for them to be reliable and accurate.

In the past homes were regulated to have a label but there was limited value in what that label actually said. This is now changing as EPCs have the potential to be part of the big data revolution, being used for all sorts of applications than may have never been intended when they were first conceived. Also more policies may be introduced to incentivise people to achieve a desired rating of C (for example). There will therefore be real value, and indeed responsibility, in having an EPC of a certain level. This means we must improve the reliability and accuracy, which will probably lead to a cost increase.

It may be possible to find ways of accessing much of the data required to provide a more accurate EPC from existing data sets, smart meters, etc., which could reduce the cost of physical surveying. However, due to the current voluntary nature of access to smart meter data, the use of these data is not guaranteed in the way that there is a statutory obligation for the generation of EPCs.

Therefore, **Access to data** is also important, for a range of uses. By 'access to data' we mean:

1. Access to raw survey data (subject to appropriate security measures). Access to raw survey data can help householders and researchers detect mistakes and drive improvement in reliability.
2. Access to additional data, e.g. smart meter data, as highlighted above.

We emphasise that we do not anticipate that simply increasing the reliability and accuracy will help drive the market for EPCs. Increase in reliability and accuracy is expected as an outcome of an increase in their value, which will in turn by driven by energy efficiency policy.

EPC data quality: Reliability

4. What evidence do you have relating to the reliability of EPC assessments?

Please provide evidence where applicable. It would be helpful to indicate how recent this is.

There is an increasing body of empirical evidence that the reliability of EPCs could be significantly improved, the challenge is doing this using the existing surveyor system at minimal cost.

Examples of this evidence include:

1. We have estimated the error in EPC reliability to be equivalent to 10 EPC points on average[1]. This work compared values from the national data base of all registered EPCs for properties that have had more than one EPC. Figure 1 shows how, for 1.6 million dwellings that have had two EPC assessments, the EPC ratings are likely to decrease as well as increase. For example, thirty percent of C rated buildings were issued a D rating for their second assessment. Normally one would expect a later EPC to improve - not get worse - suggesting that there is considerable random error in the EPC rating system.

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[1]Personal communication from J Love et al, "Quantifying the uncertainty of England and Wales EPC ratings using 1.6 million certificates", UCL Energy Institute.
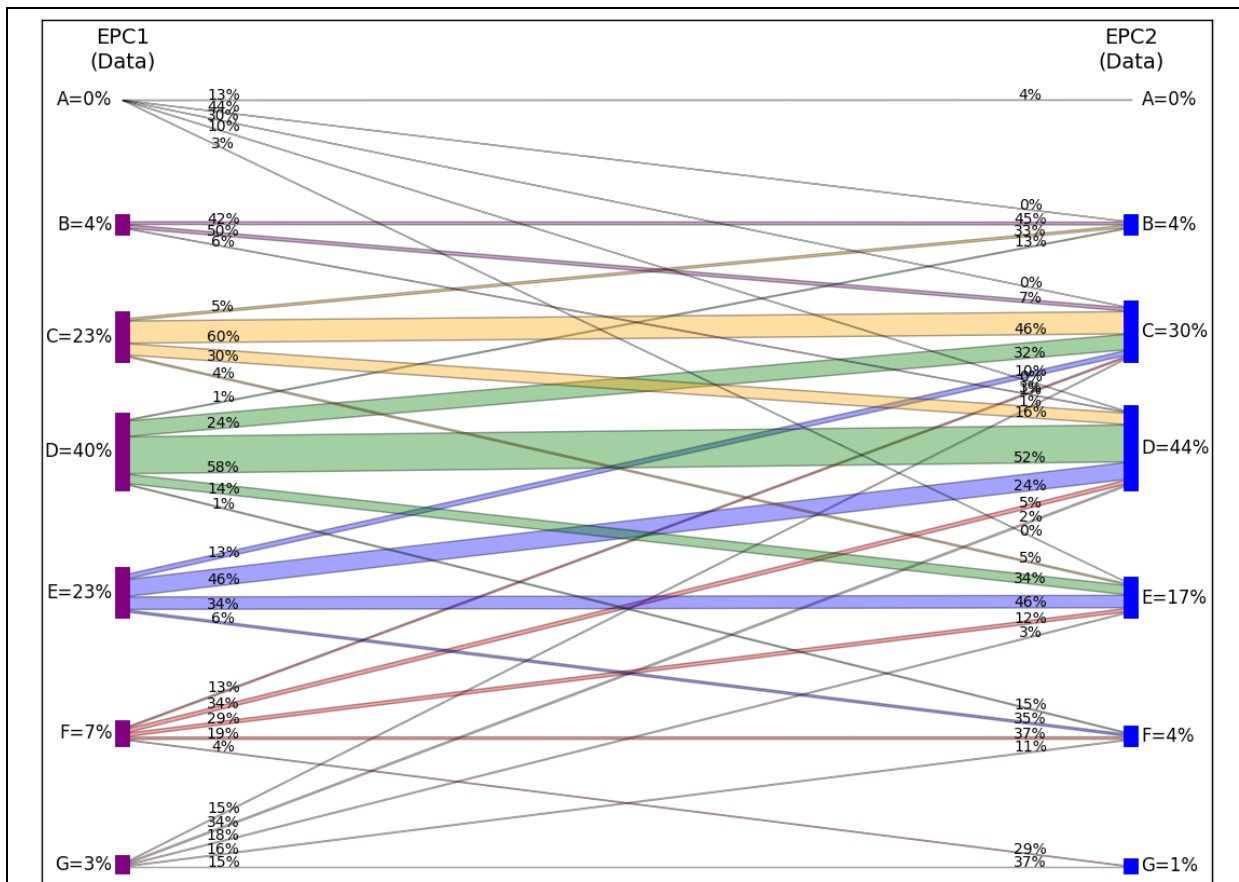
Figure 1.Visualisation of extent of change of second EPC from first EPC for individual dwellings.. Transitions with less than 1% are omitted for clarity. Reproduced from Figure 3 of Reference 1.

2. Perhaps most worrying is the fact that over half of highly energy efficient buildings (A or B rated) get a worse rating the second time around. It appears that most assessors cannot identify highly energy efficient properties which is exactly what the EPC rating is supposed to encourage, instead we suspect they default to using U-values associated with the age of construction. This is worrying because if these were buildings that people had purchased at a premium cost (because they had a high rating) then at the point of sale home owners would **not be able to recoup this premium**. A specific example of this is one of the first zero carbon developments in the UK, BedZED (Beddington Zero Energy Development). The properties have fabric U-values for wall, roof and floor of 0.1 W/m^{2}K, plus triple glazed argon filled glazing. The SAP/EPC design energy use was 75kWh/m^2, with a measured energy use of 125kWh/m^2 [2]. However, when the properties were sold the mean EPC energy rating was 175 kWh/m^2, i.e. more than twice the design value, see Figure 2 and Table 1 below. We may have expected the properties to get an A or B, EPC rating, whereas 30 of the 43 properties (70%) were given a C or worse rating! In addition, 33 of 43 assessors (77%) had failed to even notice triple glazing. Also, 41 out of 43 assessors had rated the U-value of the wall as 0.3 to 0.6 W/m^{2}K when it was in fact 0.1 W/m^{2}K. The 300 mm of insulation - which would have made the walls very thick - should have been an indicator of this. Furthermore, 9 out of 43 rated the roof insulation at 0.31 to 0.5 W/m^{2}K when the design heat loss was a third of

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[2]Janet Young, Towards Zero Energy Buildings: Lessons Learned From The BedZED Development , UCL PhD Thesis, September 2015

http://discovery.ucl.ac.uk/1472436/7/Janet%20Young%20UCL%20Thesis.pdf.REDACTED.pdf
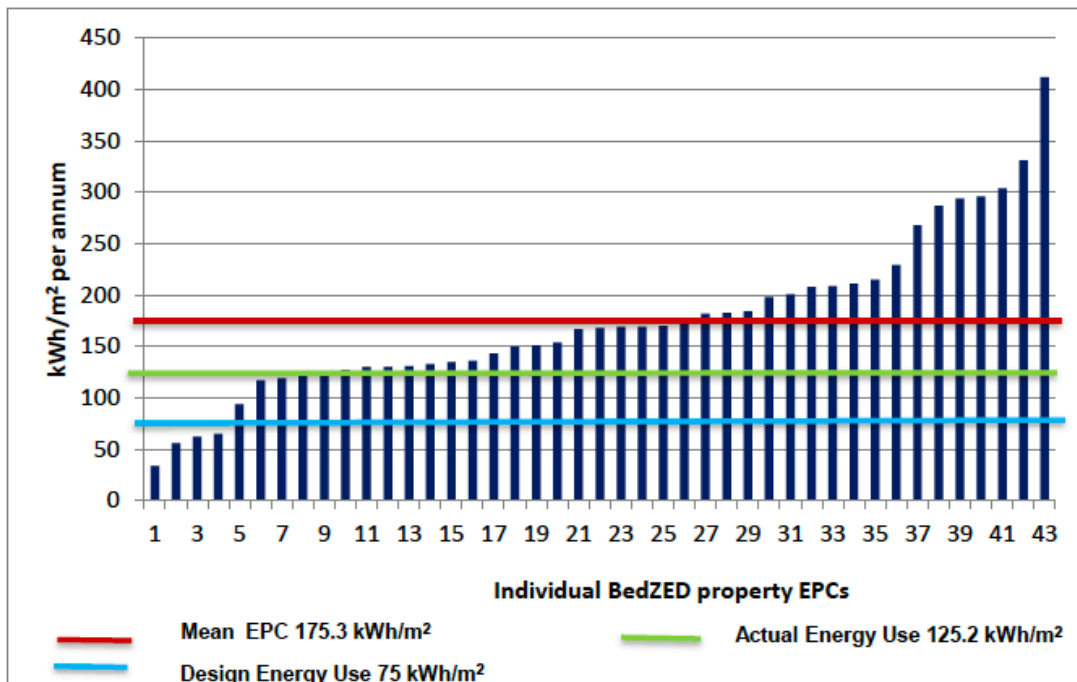.

this 0.1 W/m²K.

Figure 2. Estimated Annual Energy Use from BedZED EPCs. Reproduced from Figure 7.8 in Reference 2.

Table 1. BedZED EPC Ratings Summary. Reproduced from Table 7.14 in Reference 2.

Energy Efficiency rating	A 92+	B 81-91	C 69-80	D 55-68	E 39-54	F 21-38	G 1-20	Total
Number	4	9	24	5	0	1	0	43
Environmental Impact rating	A 92+	B 81-91	C 69-80	D 55-68	E 39-54	F 21-38	G 1-20	
Number	9	7	22	3	2	0	0	43

3. Historic studies have indicated that some assessors make considerable errors on basic measurements. For example, trained EPC assessors were used to measure the perimeter area of the same building before and after the installation of Warm Front measures which did not change the perimeter area[3], see graph below. A few reports suggested homes have doubled the perimeter length when they are resurveyed, with many showing a change of 10 m for what is one of the most basic measurements that can be done. This is old data and hopefully standards have improved, we hope to obtain new data for the whole of London via a new project with the GLA. If there are still appreciable errors in the physical characteristics of the stock it may be that administrative data from the Ordinance Survey and other sources can be used to provide an automatic check of the data to see if appears to be wrongly input. It is important that buildings have an accurate measurement of its key parameters once, and that this is used for many different purposes, rather than multiple less accurate measurements used for different purposes. This provides evidence to have a long-term

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[3]Sung-Hyon Hong, UCL PhD Thesis, "Changes in Space Heating Energy Consumption Following Energy Efficient Refurbishment in Low-Income Dwellings in England", September 2010

repository of data via Building log books, with an obligation to report changes such as extensions and these should automatically result in new EPCs.
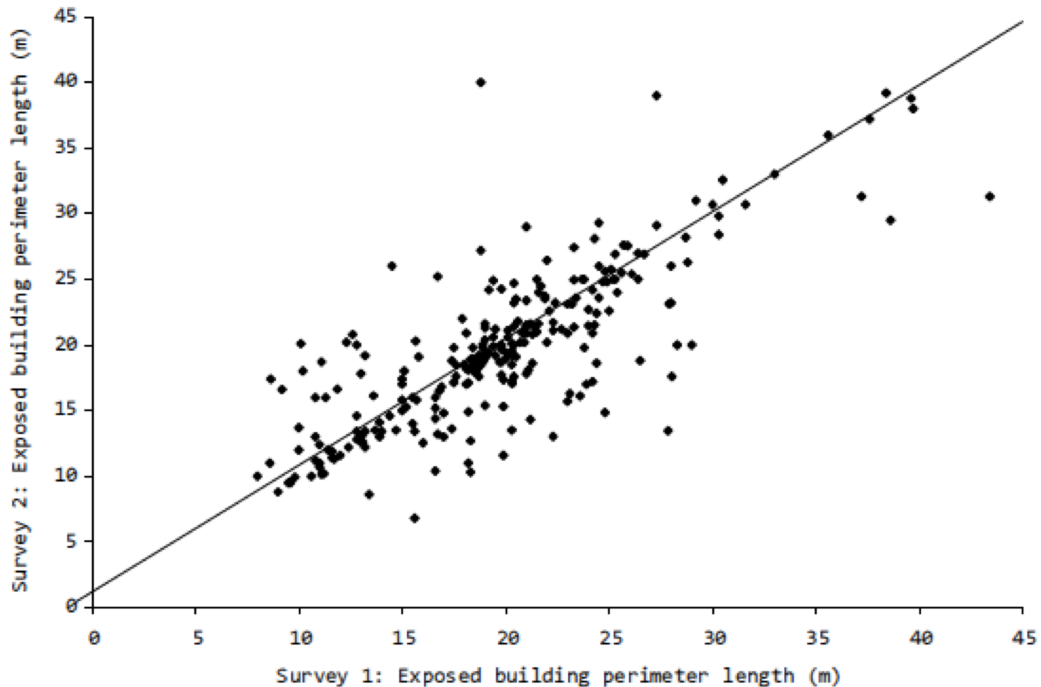

Figure 3. A comparison of two surveys of exposed building perimeter length. Reproduced from Figure 3.4 in Reference 3.

4. Further evidence of issues surrounding accuracy can be demonstrated through a quick study of floor areas and floor heights in domestic EPCs. Within the EPC bulk data release of October 2017, there are 6,884 instances of floor heights of less than one metre. There are also 331,900 instances of total floor areas of less than 5m^2. Some degree of reality-checking either within the EPC software, or within the lodgement process ought to eliminate such fundamental errors. If such checks were in place before lodgement, this may create a time/cost saving for the surveyor.

Whilst we have set out above some evidence that there is variability in EPC results, the sources of this variation are not clear. Much variation is likely to be due to unintentional discrepancies, but deliberate manipulation of the results may also occur.

Discrepancies could be occurring as a result of different levels of training and experience amongst EPC assessors, because of different auditing processes and software employed by different accreditation bodies, or because competition on price between different assessors pushes them to spend less time in a building which means they make more errors.

Do you have any information on how reliability varies across different properties, and/or the likely sources of variation in assessments?

We have evidence that the reliability is worse for less efficient dwellings. While the average reliability error is 10 EPC points, we estimate that the error on a dwelling at the E-F band boundary is about 24 points, and the error on a dwelling at the C-B band boundary is about 4 points[4].

When considering an EPC it is also important to realise that not all EPCs are the same, they have a vintage associated with the particular calculation method in force at the time of the assessment. The method of calculation has for example changed assumptions about fuel costs and carbon emission factors. These methodology changes do not appear to affect the overall distribution of EPC ratings over time, see Figure 4. However, for a particular property they may increase the uncertainty when comparing the rating of one home over time or comparing the rating of two homes whose ratings were calculated at different times.
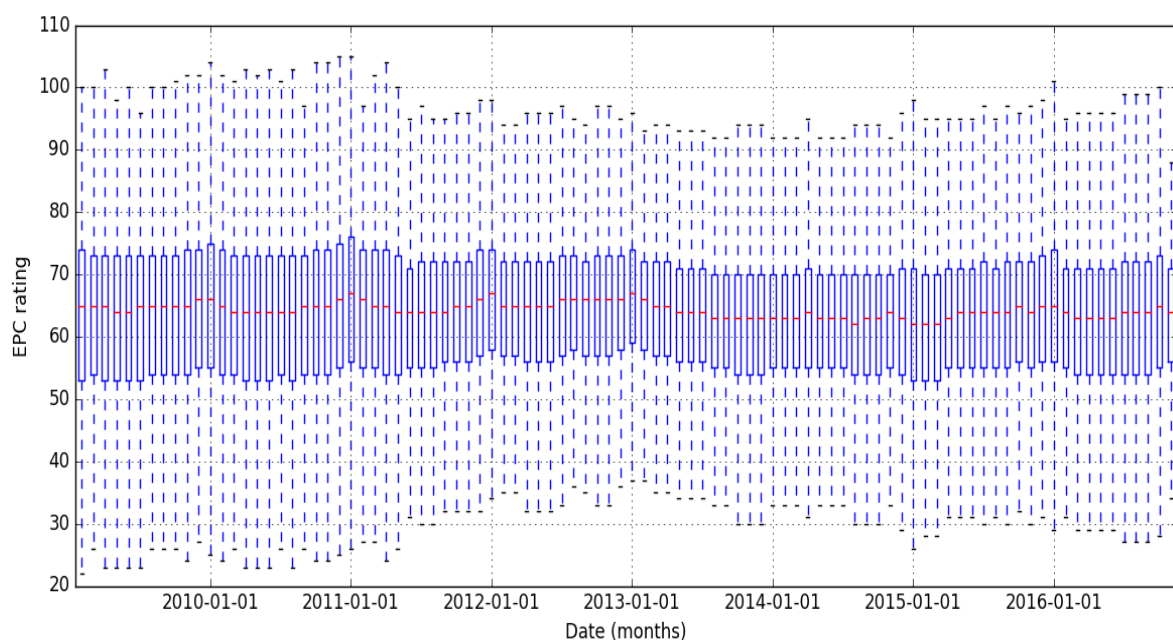

Figure 4. Monthly distributions of EPC ratings from 2009 to 2016. Showing median (red), interquartile range (edges of each box) and 1.5 interquartile ranges above and below the box (edges of whiskers). Reproduced from Figure 1 in Reference 4.

We also have evidence on how *accuracy* varies across different properties (this specific question is not asked in the call for evidence questions on accuracy so we include it here):

There is considerable evidence that there is a bigger discrepancy between measured and SAP predicted energy use for certain types of buildings and for certain subsectors of the population. This is an area that UCL is actively researching. Preliminary results suggest that bigger, older properties (even after taking account of the solid wall U-values mentioned in the EPC Accuracy section of this report) are less well modelled by SAP when comparing SAP prediction to actual energy use, see Figure 5[5]. This plot compares how predicted energy use from EPC type calculations (labelled as SAP (CHM)) compare with measured energy use from

[4] J Love et al, Quantifying the uncertainty of England and Wales EPC ratings using 1.6 million certificates", UCL Energy Institute.

[5] A. Summerfield et al, personal communication

gas meter data (labelled NEED 2012), for buildings of different vintage of construction, using 1982 as the vintage of comparison. It can be seen that for detached houses (the larger types of properties) measured data suggests little change in energy use with age (less than 50%) whereas modelled calculations suggest at least a doubling of gas use in older properties.

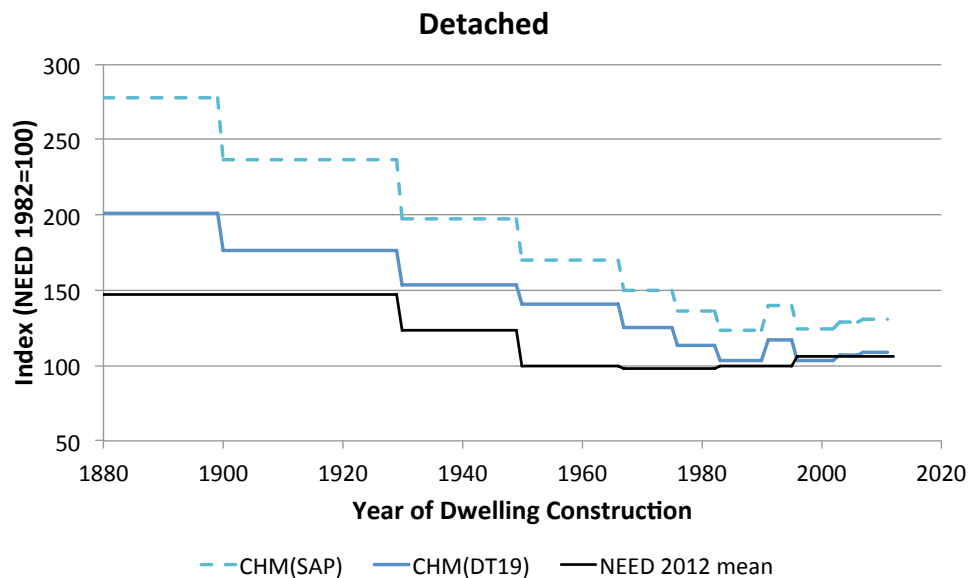## Comparison of gas consumption across age bands

Figure 5. Relative mean gas consumption from NEED data (index = 100 for 1982-95) compared with estimates from CHM (SAP) and CHM (DT19) for detached dwellings by age category. Reproduced from Reference 5. CHM (SAP) stands for the Cambridge Housing Model which uses the EPC software i.e. SAP as its core calculation. NEED data is measured annualised energy data.

Preliminary analysis of energy savings for individual technologies also suggests that there are sub-sectors that can get a bigger percentage of energy saving for packages of technologies than others.

5. Which of the suggestions below do you think would be effective in improving the reliability of EPC ratings?

	Very effective	Effective	Somewhat effective	Not effective	Counterproductive	Unsure/no opinion
Apps and smart defaults						
Better measurement technologies						
Ability to use survey data from previous EPC						

Access to additional sources of data about the building						
Strengthened quality assurance						
Other suggestion (please give details below)						

We would be interested any other suggestions as to how to improve reliability of EPCs, building on the question above about causes of variation. We would be particularly interested in ways that the seller or existing landlord of a property could be encouraged to value an accurate EPC, because currently the benefits of accuracy accrue to the new owner, but it is the seller or letting/ estate agent who commissions the EPC.

Please give details of any other suggestion you may have to improve EPC reliability

We think that making all EPC data public is critical to improving reliability. Currently only a subset of data is made publicly available. Release would enable homeowners and researchers to question inputs into EPCs which in turn could improve the reliability if assessors were aware that their assumptions could be questioned.

We also think that it is important to very clearly label EPCs that have been cloned, i.e. generated from similar properties rather than detailed inspection[6]. Cloning is a legitimate time saving activity to replicate EPCs for similar properties. However, it is important that such cloned labels are clearly logged in the EPC register as such and that the parent is clearly labelled.

As EPCs obtain greater value, for example, from policies that encourage higher scores, it is essential to ensure further checks to prevent gaming of the system. It is therefore critically important that detailed analysis is undertaken of both inputs and outputs of EPCs over time to check for gaming.

We believe that reliability of EPCs could be improved by linking EPC data to smart meter data. This is an area currently researched by UCL as well as other countries such as Sweden, see section of report: "Are you developing any kind of tool for measuring the energy performance of buildings".

A further suggestion is mandating the use of National Land and Property Gazetteer Unique Property Reference Numbers (UPRN) for each address. This will facilitate simpler matching to other datasets that contain a UPRN. The ability to cross reference individual EPCs to indicate where one EPC has replaced another for the same premises, would be very useful for tracking alterations and progress over time. This could be achieved by using UPRNs on all EPCs. Even where properties are under construction, a UPRN is still available from the Gazetteer.

The integration of data from Her Majesty's Land Registry (HMLR) would provide

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[6] Energy performance certificates for dwellings in the social and private rented sectors A guide to generating Energy Performance Certificates for similar dwellings owned by the same landlord, July 2008, Department for Communities and Local Government.

benefits, particularly when applied to non-domestic EPCs and DECs, where there can be multiple buildings for one premises, such as a large factory site or a school. The HMLR data may be used to establish the land boundary within which buildings are located, but where there is only a single addressable point (UPRN). This method has been successfully implemented in the UCL Energy 3DStock model[7]. This process of identification then also becomes useful when linking other data sets, such as records of improvement works to individual buildings within premises. Again, the use of such data and the linking to other datasets would be simplified through the use of UPRNs.

Technical training of Assessors: A review of training of assessors for EPCs in 2008[8], concluded that significant improvements to the technical training of assessors, as occurs in countries like Denmark and Germany, may improve the reliability of EPC's.

Please provide reasoning and any evidence you have to support the responses provided to this question

EPC data quality: Accuracy

6. What evidence do you have of the accuracy of the models used to produce EPCs in comparison to other methods such as the co-heating test?

Please provide evidence where applicable. It would be helpful to indicate how recent this is.

There is no ground truth for an EPC, because EPCs do not predict the energy performance of a real occupied home. There is therefore no simple way of testing EPC accuracy by looking at monitored energy data, but detailed smart meter data might make useful comparisons possible (as argued below). The EPC is a normative calculation (assuming a standard occupancy and weather) utilising expert knowledge representing what is believed to be the key factors that result in an energy efficient home i.e. giving value to energy efficiency measures and their likely impact. Comparing against actual measurements is always going to be problematic as an EPC assumes the building is heated to a standard temperature for a fixed number of hours a day and makes many additional assumptions e.g. homes have at least 0.5 an air change per hour to prevent mould growth except where heat recovery is used, that the heating system is always adequately sized to provide the heat demand, and that the property is heated in two zones and located in the Pennines. Also the EPC only rates the regulated (Building Regulation covered) energy use, whereas

[7] http://discovery.ucl.ac.uk/1517805/

[8] Personal Communication, Lowe R and McCartney K, Report on the Proposed National Occupational Standard for Domestic Energy Assessors, UCL CBES, December 2006.

unregulated uses may be significant in some buildings.

The following will impact the accuracy:

1. **Simplifications and input assumptions** make EPC calculations practical but can introduce significant errors if their validity is not quantified. Probably the best example of an error in the assumptions is historically using the wrong U-value for solid wall properties. This has a major impact on the rating, in theory approximately 30% of solid walled properties may have a worse rating than they actually should, see Figure 6[9]. The solid wall issue has been rectified for future EPCs post SAP 2016, but not all assumptions have been rigorously tested and so until they are SAP will not be accurate. New data collection via a range of different mechanisms such as smart meters and other IoT enabled devices opens up the potential for EPC models such as SAP and SBEM to be continually grounded in new data in the future in an analogous way that weather models are continually grounded with weather data from monitoring stations around the world.
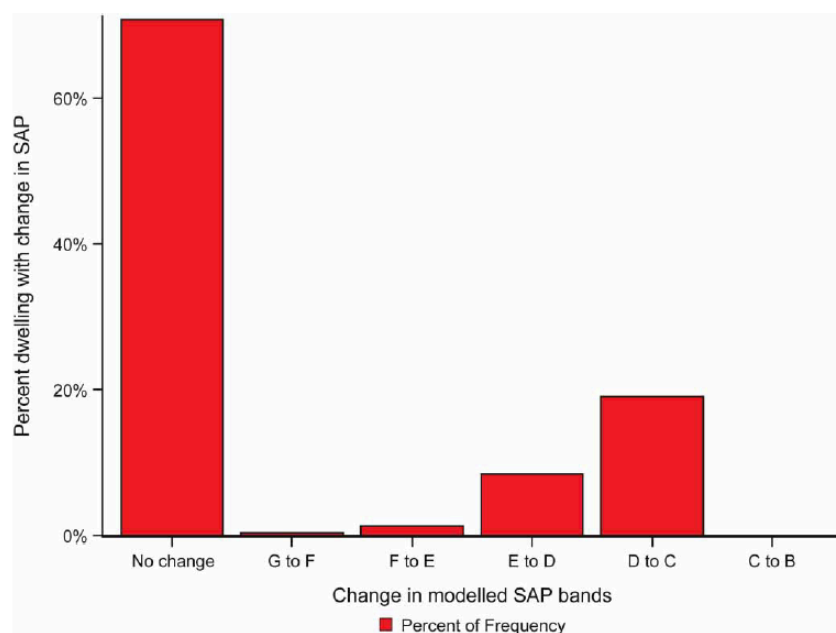

Figure 6. Percentage of solid-wall dwellings that would move up an EPC band if the U-value for the solid wall were changed from 2.1 to 1.3 Wm²/K. Reproduced from Figure 5 of Reference 8.

2. **Identifying what has actually been constructed compared to assumed construction or design intent.** Quality control in construction, particularly in relation to compliance with regulations has not been a priority in the construction sector. Regulatory compliance is now on everybody's agenda following Grenfell. Hopefully this will result in improved standards of compliance, historically compliance has been poor, resulting in what is often referred to as the performance gap. This was highlighted by the Zero Carbon Hub report "Closing the gap between designed and built performance"[10], see Figure 7, which shows that for new build homes the heat loss can be double that designed.

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[9] Francis G. N. Li et al, (2014): Solid-wall U-values: heat flux measurements compared with standard assumptions, Building Research & Information. An earlier and equally egregious example was the assumption of a zero U value for cavity party walls - Lowe, R.J. et al. (2007) Evidence for heat losses via party wall cavities in masonry construction, Building Services Engineering Research & Technology, 28 (2) 161-181. http://bse.sagepub.com/cgi/reprint/28/2/161 .

[10] Zero Carbon Hub, "Closing the gap between designed and built performance.
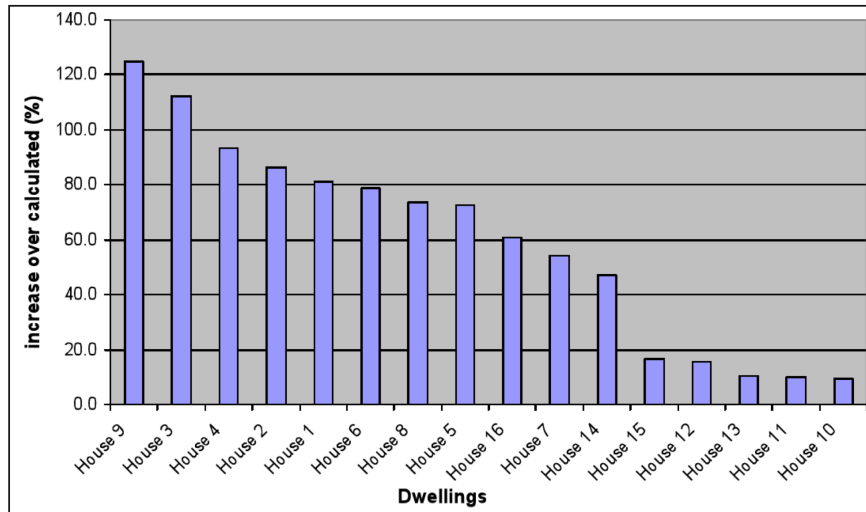
Figure 7. Measured v Predicted whole house heat loss as a percentage of the predicted value. Reproduced from Figure 2 of Reference 9.

With regard to non-domestic EPCs Figure 8 shows the measured energy use for offices compared to their EPC rating[11]. Sample sizes are very small for A, F and G rated properties but there is very little evidence of any difference in energy use between C and E properties.
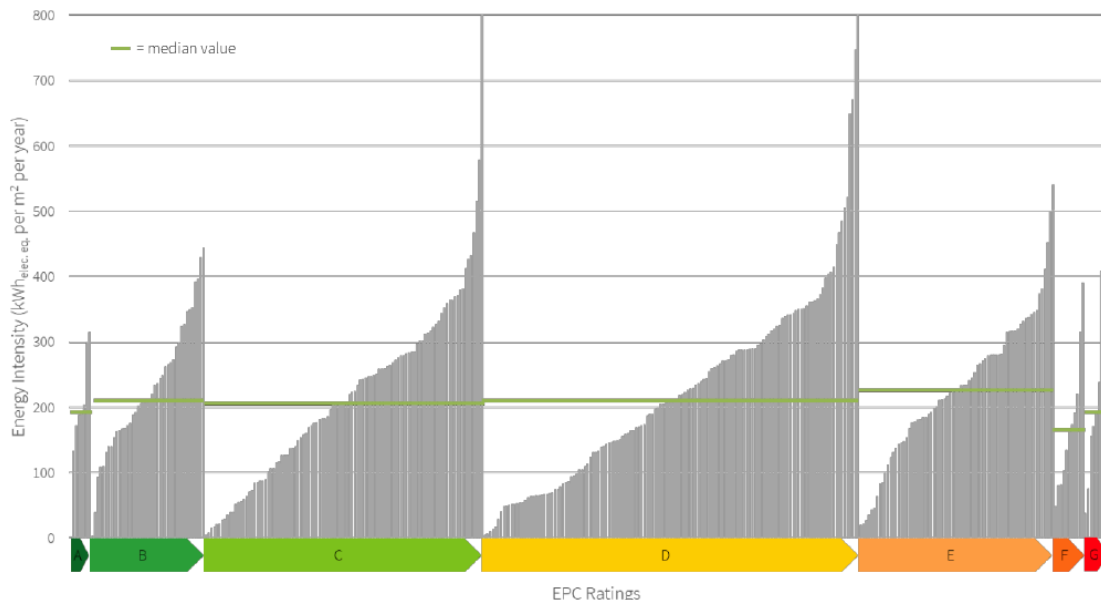
Figure 1 Office energy intensity (kWh$_{elec. eq.}$ per m^2 (NLA) per year) by EPC rating. Each grey bar represents a single office building's energy intensity over the course of a year. (Source Real Estate Environmental Benchmark 2017, Better Buildings Partnership)

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[11] Better Buildings Partnership report September 2018, Helping Businesses To Improve The Way They Use Energy – Call For Evidence.

7. Are you developing any kind of tool for measuring the energy performance of buildings (controlling for the effects of occupant behaviour) using smart meter data or other data, which could be relevant for EPCs?

BEIS has been exploring the technical possibilities for new ways of measuring thermal performance of domestic buildings using smart meter data and other new data sources.

Incorporating such tools into EPCs could offer the potential to reduce the performance gap by allowing 'as built' performance data to be used in an EPC rating, whilst at the same time factoring out the effects of occupant behaviour so that the EPC rating remains reflective of the building itself. This could also simplify the process of generating an EPC and improve the repeatability and accuracy of EPCs. Any use of smart meter data would require the householder's consent, in line with data access and privacy requirements.

Are you developing any such tools?

Yes	**X**
No	

Please provide further details where applicable

UCL has been working on a method that could be complementary to a surveyed EPC to check if there is a problem with a EPC calculation. This method uses smart meter energy data with weather data and allows actual building energy performance (i.e. combination of heat loss and heating system efficiency) to be compared to predicted, without being confounded by the effects of occupancy. The following reports and papers cover various aspects of the research.

1. Summerfield, A. J., Oreszczyn, T., Hamilton, I. G., Shipworth, D., Huebner, G. M., Lowe, R. J., & Ruyssevelt, P. (2015). Empirical variation in 24-h profiles of delivered power for a sample of UK dwellings: Implications for evaluating energy savings. ENERGY AND BUILDINGS, 88, 193-202. doi:10.1016/j.enbuild.2014.11.075
2. Developing a rapid, scalable method of thermal characterisation for UK dwellings using smart meter data, Jonathan David Chambers, UCL PhD Thesis, June 2017.
3. BS2015: Proceedings of the 14th Conference of International Building Performance Simulation Association, Hyderabad, India, Dec. 7-9, 2015. Quantifying Uncertainty In Grey-box Building Models Arising From Smart Meter Energy Data Sampling Frequency, Jonathan Chambers, Tadj Oreszczyn, and David Shipworth.
4. Summerfield, A. J., Lowe, R. J., & Oreszczyn, T. (2010). Two models for benchmarking UK domestic delivered energy. Building Research & Information, 38, 12-24. doi:10.1080/09613210903399025

Research is ongoing at UCL via the following two EPSRC funded projects:

1. Centre for Research in Energy Demand Solutions (CREDS) Buildings theme
2. Smart Meter Research Portal (SMRP)

8. What evidence do you have on how EPC accuracy could be improved using the tools and data sources outlined above, or through any other means?

BEIS currently does not have a clear understanding of how these products work and how robust and reliable they are, therefore if they are suitable for use for policy purposes such as EPCs. We would need to be satisfied that such products could effectively factor out the behaviour of occupants before they could be used in EPCs. Consideration would also need to be given to any data consent issues, and to the interface system between smart meter data and energy performance certificates. We would be interested in views from the wider EPC community on how these approaches for measuring building performance could be incorporated into the current EPC framework

Please provide any evidence you have on how EPC accuracy might be improved using such tools or other methods

Our method allows the actual performance of the building to be compared to the predicted performance of the EPC (through the Power Temperature Gradient metric). If there is a significant discrepancy then this can indicate if the EPC is inaccurate, which can then be flagged up and corrected.

Do you have any views as to how these approaches could best be incorporated into the current EPC framework?

It would be necessary to link smart meter data to EPC data which would require gaining consent from the customer. This could be done by the EPC assessor as part of the process of commissioning the survey.

The measure of actual performance would need to be incorporated into the EPC framework e.g. introducing an operational performance rating to domestic EPCs, or as a separate report that compared actual and predicted performance.

EPC data quality: Up to date

9. What evidence do you have on how frequently people are likely to make updates to their properties which would change the EPC score?

Please provide evidence where applicable

10. Which of the suggestions below do you think would be effective in ensuring that the information on EPCs is up to date?

	Very effective	Effective	Somewhat effective	Not effective	Counterproductive	Unsure/no opinion
Reduce validity period (3 or 5 years)						
New EPC required for extensions and major renovations						
New EPC required for other changes affecting EPC						
Trigger point specific to HMOs						
New EPC required for Green Mortgage						

Do you have any other suggestions for ensuring EPCs remain up to date?

If smart meter data was included in the EPC process, then this could also be used to continuously monitor building energy performance and flag up any significant changes that occur.

Alternatively, rather than producing a new EPC, a trigger point could produce a note that gets added to the EPC data. The note would flag up that a specific measure is no longer valid e.g. boiler has changed, and include detail of the new measure installed.

Please provide reasoning and any evidence you have to support the responses provided to this question

11. Would you support introducing new EPC trigger points at any of the stages listed above (or any other stages)?

	Yes	No	Unsure/no opinion
Extensions and major renovations			
Other works to the building affecting the EPC rating			

Where an HMO doesn't already have an EPC and a room is rented out			
For applying for a 'green mortgage' or green finance			

What evidence do you have on the advantages and disadvantages of any of these trigger points?

Encouraging action: Improving energy performance

12. What evidence do you have on how useful the EPC recommendations are to consumers when they are considering making changes to a property?

Please provide evidence where applicable

How effective are the recommendations at encouraging consumers to take action?

13. Which of the suggestions provided below do you think would be effective in encouraging building owners to make appropriate energy performance improvements to their property?

	Very effective	Effective	Somewhat effective	Not effective	Counterproductive	Unsure/no opinion
Directing people to the digitally led energy advice service						
Changing the way recommendations are presented						
Allowing innovation in EPC formats						
Enhanced role for assessors in						

providing information						
EPC app						
Including operational rating and/or occupancy data						
Make recommendations more tailored						
Additional information relevant to homeowners						
'Nudge points' that prompt people to look at EPC						

Please give details of any other suggestion you may have to improve EPCs' effectiveness in encouraging building owners to improve the energy performance of their property

Please provide reasoning and any evidence you have to support the responses provided to this question

14. What are your views on introducing operational performance ratings for non-domestic buildings, either on the EPC or separately?

Encouraging action: Influencing property decisions

15. What evidence do you have on how useful the EPC rating and cost information are to consumers when purchasing or renting a property?

Please provide evidence where applicable

Are consumers using information on the EPC to negotiate property prices or rents?

16. Do you have any evidence on consumers' understanding of the energy efficiency rating used in EPCs?

Please provide evidence where applicable

Do you think a different rating such as carbon emissions or primary energy would have a better impact for consumers?

Please indicate which you think would be most effective:

Existing rating based on cost	
Rating based on primary energy	
Rating based on carbon emissions	
Unsure/no opinion	

17. Which of the suggestions provided below do you think would enable prospective buyers and tenants to make more effective decisions based on the information on the EPC?

	Very effective	Effective	Somewhat effective	Not effective	Counterproductive	Unsure/no opinion
Providing more of the information on the EPC in adverts						
Requiring a link to the digitally led advice service						
Including EPC rating on mortgage statements						
Better visibility of EPC data on property comparison sites						
Providing EPC cost information on adverts						

Clearer data on ventilation						
Present energy costs as annual costs instead of over 3 years						
Provide better information on heat networks						
Adding information about future direction of government policy						

Please give details of any other suggestion you may have to improve EPCs' effectiveness in influencing property decisions

Please provide reasoning and any evidence you have to support the responses provided to this question

EPC availability: Access to data

18. What evidence do you have on how easy it is to access EPC data, either through the Energy Performance of Buildings registers or Open Data? Is there any additional information that would be valuable? Please explain why.

Please provide evidence where applicable

What additional information would be valuable and why?

For research purposes, it would be beneficial to have access to all of the underlying data of each EPC, as part of the bulk download. There are certain parameters that are crucial to the operation of effective energy analyses that are not currently accessible from the Open Data sources of EPC data. This is especially true for non-domestic EPCs, which have an extremely limited number of fields, which then limits what can be achieved with the data. For example, even the release of property age data would have a potentially significant benefit to modelling energy use in the building stock.
Of particular use would be a time stamp on the lodgement of EPCs. Currently, there is only a date stamp, but there are many instances of the same property

having multiple EPCs lodged on the same day. If a time stamp were recorded at the point of lodgement, it would be possible to identify the 'current' EPC, as it would be the one with the latest date and time stamp.

It would also be useful to know if a new EPC has been created because an extension has been built or a major refurbishment. It is not clear from the guidance if this should trigger a new EPC nor is it labelled as such.

If you are currently a user of the Open Data Communities website, what do you use the information for and how valuable is this website as a source of data?

UCL is using the EPC database for research into the UK building stock, both domestic and non-domestic. It is a valuable source of contextual data for participants that we recruit to our research projects. As mentioned above, the value would be increased if the raw data were made available rather than the current subset of parameters.

19. Which of the suggestions provided below do you think would improve the ability of building owners and other stakeholders to make effective use of EPC data?

	Very effective	Effective	Somewhat effective	Not effective	Counterproductive	Unsure/no opinion
Allowing building owners access to EPC survey data						
Facility for building owners to share survey data with 3rd parties						
Data warehouse and building log book						
Green building passport						

Please give details of any other suggestion you may have to improve access to EPC data

EPCs should include a clear property reference to enable it to be linked to other administrative data sets. The National Land and Property Gazetteer's Unique Property Reference Number (UPRN) could easily serve this purpose. This UPRN spans both domestic and non-domestic properties.

Please provide reasoning and any evidence you have to support the responses provided to this question

20. Do you think a 'data warehouse', 'building log book' and/or 'green building passport' would be useful in increasing take up of energy efficiency improvements or supporting existing initiatives?

The government has worked with the implementation of Each Home Counts to develop a digitally-led energy saving advice service, which has recently been made available to the public. This fulfils some of the recommendations of the 'building log book' and 'green building passport' proposals, including providing tailored recommendations and advice to homeowners.

We would be interested in views and evidence more generally as to how valuable a 'data warehouse', 'building log book', and/or 'green building passport' would be and what contribution they would make to increasing take up of energy performance improvements or supporting other initiatives.

Do you think any of the options suggested for combining EPCs with other data would be useful? Please select one or more options

Data warehouse	**X**
Building log book	
Green building passport	
None of the above	
Unsure/no opinion	

Please providing any supporting details for your answer above

These ideas seem promising, but as yet there is little evidence as to their effectiveness. CREDS will be undertaking research into policy mechanisms which support renovation and deep renovation in particular.

What kinds of data might usefully be included in addition to EPC data and how could these proposals best be implemented?

As mentioned previously, smart meter data could usefully be included in addition to EPC data as it can allow the actual performance of the building plus heating system to be estimated and compared against that predicted by the EPC highlighting any potential inaccuracies in the EPC or indeed the underlying building itself e.g. poor building work.
This could be implemented by gaining consent from the householder to access their smart meter data and for the processor of this data to be a DCC Other User.

How might more comprehensive assessments be encouraged without making them a requirement for homeowners?

EPC availability: Coverage

21. What evidence do you have on levels of compliance with the requirement for providing an EPC when purchasing/letting a property, and/or the requirement to display the EPC rating in property listings?

Please provide evidence on levels of compliance where applicable

[blank box]

Does this differ by tenure type or by any other subset of the building stock?

[blank box]

The existing data given above suggests that levels of compliance are significantly higher for buying than renting in the domestic market. Given the relatively low cost of EPCs, we would be interested in any evidence on the reasons for lack of compliance.

What evidence do you have on the reasons for lack of compliance with the requirement for an EPC?

Please provide evidence where applicable

[blank box]

22. Do you have any evidence on what enforcement work is currently being done to ensure that EPCs are being produced?

Please provide evidence where applicable

[blank box]

23. Which of the suggestions provided below do you think would be effective in improving compliance with the requirement for an EPC, bearing in mind the other changes to EPCs being considered in this Call for Evidence?

	Very effective	Effective	Somewhat effective	Not effective	Counterproductive	Unsure/no opinion

Align enforcement authorities for EPCs and PRS						
Putting greater obligation on estate/letting agents						
More formal role for accreditation schemes in identifying non-compliance						
Providing better information to landlords						
Providing better information to tenants						
Linking EPCs to other requirements on landlords						
Increased role for property comparison sites						

Please give details of any other suggestion you may have to improve EPC coverage

Please provide reasoning and any evidence you have to support the responses provided to this question

EPC availability: Simple and low cost

24. What information do you have on costs of EPCs, how easy it is to procure an EPC or on consumer attitudes about EPC costs?

Please provide evidence where applicable

25. Which of the suggestions provided above do you think would be effective making the process of procuring EPCs easier or more

affordable, bearing in mind the other changes to EPCs being considered in this Call for Evidence?

	Very effective	*Effective*	*Somewhat effective*	*Not effective*	*Counterproductive*	*Unsure/no opinion*
Allowing an EPC assessor to use previous survey data						
Drawing in additional data sets						
EPC assessor apps with smart defaults						

Please give details of any other suggestion you may have to reduce the cost of EPCs or make the process simpler

Please provide reasoning and any evidence you have to support the responses provided to this question

26. This Call for Evidence has outlined a number of options for making improvements to EPCs. Of the suggestions discussed in this document or which you have put forward, is there one or more you think is particularly important, or are there any other suggestions you have or comments you want to make about EPCs?

Please provide any suggestions, views or comments here where applicable