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

Environmental Audit Committee inquiry on energy efficiency of existing homes – submission from CREDS

13 July 2020

The Centre for Research into Energy Demand Solutions (CREDS), was established in 2018 with a vision to make the UK a leader in understanding the changes in energy demand needed for the transition to a secure and affordable zero-carbon energy system. Working with researchers, businesses and policy makers, our work addresses a broad range of issues. CREDS is funded by EPSRC and ESRC.

www.creds.ac.uk

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

This submission was written on behalf of CREDS by:

Tadj Oreszczyn and Peter Mallaburn (UCL Energy Institute), with comments by Cliff Elwell and Robert Lowe (UCL Energy Institute), and Nick Eyre and Tina Fawcett (Environmental Change Institute, University of Oxford).

UK Research and Innovation
Engineering and Physical Sciences Research Council
Economic and Social Research Council

Q: How effective is the EPC rating at measuring energy efficiency? Are there any alternative methodologies that could be used?

Energy Performance Certificates (EPCs) were designed for the 20th century and need to be rapidly made fit for purpose to deliver a net zero carbon target this century. The EPC-generated Standard Assessment Procedure (SAP) label does not rate a building's energy efficiency but its fuel costs, this problem could easily be addressed. The EPC method has many limitations, but we believe that there are several key things that could be done to overcome the current limitations of SAP/EPC, and this would be preferential to developing a completely new EPC scheme. We just do not have the time and resource to develop a completely new scheme when it has taken the UK three decades to establish EPCs and £1 billion to EPC-survey existing homes.

Does an EPC measure energy efficiency?

No. The EPC rating that is displayed consists of a fuel cost rating (SAP) which is called an Energy Efficiency Rating, and a carbon emission rating called an Environmental Impact Rating. Neither of these ratings directly display energy efficiency as defined by energy used to provide a useful service. There are good historic reasons why these ratings were selected, but they no longer support the UK's new net zero carbon emissions target. For example, replacing a gas boiler with an electric heat pump does not improve a SAP2012 energy efficiency rating, yet the heat pump is three times more efficient! Although SAP 10 will alter the carbon factors, the relative price differential between gas and electricity, which is a key driver in the SAP rating, will not change. The key output from SAP therefore needs to change to reflect the current priority of making the UK net zero and the stock ready for decarbonised heat. SAP undertakes much of the necessary calculation, it is just that its output is not what is required to deliver a system which is not dependent on the local burning of fossil fuels.

Are there alternative EPC methods?

The EPC methodology consists of three main elements: data collection, calculation (SAP); and output/label. All three elements have evolved over time and all three could be improved to make the rating more accurate, reliable and useful in delivering a net zero UK. Often the discussion around alternative methods focuses around the SAP calculation. This has evolved from a steady state variable degree-day annual calculation to a semi-transient monthly calculation, and it could change further to a full-transient simulation. However, we do not believe that the main limitation is with the core calculation, which can easily be changed, but the quality of data input and the assumptions that are made in the calculations and output/label. The quality of the data input is in part driven by the value occupants and government put on an EPC. Historically the EPC has had a low value and so the EPC method has defaulted to the cheapest and hence least reliable system.

CREDS believes that there are many ways of improving the accuracy and reliability of data which we reported in detail to a BEIS call for evidence on the performance of Energy Performance Certificates which ran from July to October 2018. This can be accessed at https://www.creds.ac.uk/wp-content/uploads/BEIS-EPCs-Consultation-Call-Oct-2018.pdf. As of the 10 July 2020, the consultation website stated "We are analysing your feedback".

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.

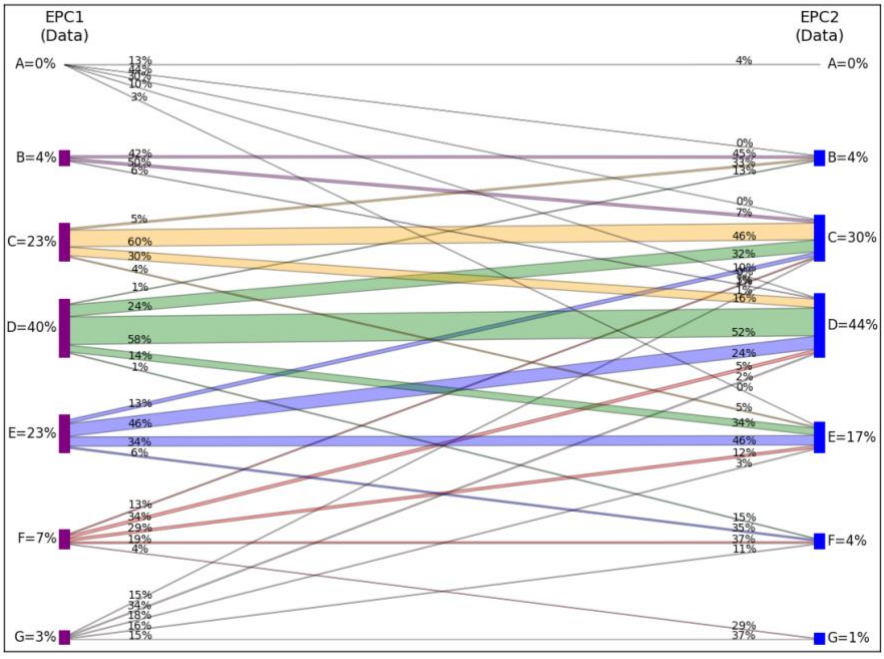

Figure 1.Visualisation of extent of change of second EPC from first EPC for individual dwellings.. Transitions with less than 1% are omitted for clarity. Reproduced from Figure 3 of Reference 1.

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

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.

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 this 0.1 W/m$_2$K.

[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.

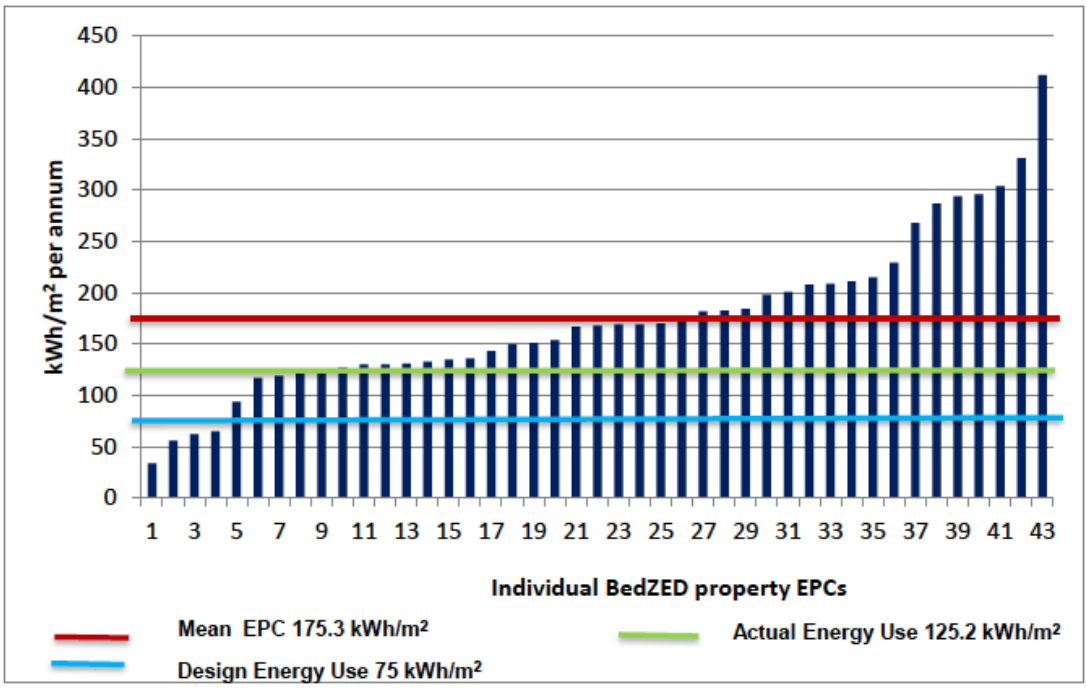

Figure 2. Estimated Annual Energy Use from BedZED EPCs. Reproduced from Figure 7.8 in Reference 2.

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**

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

We feel that it is essential to bring occupants along a net zero journey to improve their home and derive value from this improvement. The EPC, or a calculation of predicted energy use, is critically important in moving along that journey for occupants, businesses and government. Things that should be considered to bring EPCs to the 21st century, mostly at minimal cost, include the following.

1. Systematically improve SAP core algorithms by continuously grounding the SAP model with empirical data. The advent of smart meter data linked to contextual data such as the English Housing Survey and 3DStock[3], UCL's building energy performance

3 3DStock is a digital twin of domestic and non-domestic buildings that links at an individual property EPC data with a wide range of other data sources including metered data for specific BEIS purposes, Steadman, P., et al. (2020). Building stock energy modelling in the UK: the 3DStock method and the London Building Stock Model. Buildings and Cities, 1(1), pp. 100–119. DOI: https://doi.org/10.5334/bc.52

model, should facilitate this at minimal additional cost. There should be a national programme of testing the validity of the National Household Model (NHM) and SAP and developing them as a transparent and open source model. This would allow various model improvements to be tested against metered performance.

2. Minimise programming errors – it is nonsensical that we have several different programmed versions of the core SAP calculation, all with errors. We should have one national open source, core calculation, which is fully documented with all assumptions and properly debugged. This would save costs for every company and improve reliability for all commercial users. Given that government has to programme its own version for NHM (that has SAP at its core) this should not involve any additional cost.
3. Assessors should be fully trained to undertake measurements to an agreed level of accuracy and replicability for all SAP/RdSAP (Reduced data SAP) inputs in order to arrive at a pre-determined accuracy to SAP. If input parameters cannot be measured by assessors accurately enough then the SAP algorithm needs to be changed. Data collected as part of the EPC, plus other data such as smart meter, should be used regularly to improve training and accuracy. The focus of improved training should be on the parameters that most impact accuracy.
4. Where there are already reliable data sources for SAP/RdSAP inputs such as floor area, property age, energy efficiency interventions, etc. from consequential improvements, Valuation Office Agency tax banding, etc., these should be publicly logged and used by assessors in preference to guestimates.
5. The use of default parameters based on property age may be a major limitation to accurate assessment and so should be reviewed.
6. All EPC input data should be publicly logged for a property. This would benefit multiple stakeholders.
    a. The **consumer** as they would know what assumptions had been made when their EPC was calculated and could legitimately challenge it. Also, SAP calculations could be tailored to the occupant's behaviour to better predict cost etc. Detailed measurements have cost the country £1 billion and the full value should be extracted from this data.
    b. **EPC assessors** who are reassessing a property, because it would only require them to identify what has changed.
    c. It would benefit **companies** who wish to use the EPC input data to better help develop improved services to their customers
    d. It would benefit **government** because they could run SAP with a consistent vintage of rating and use this information in policy support. **Local authorities** could create detailed regional stock models with which to plan their net zero refurbishment.

e. Researchers could use this data to help improve the SAP algorithms and EPC processes.

7. Change the EPC output/label to better represent the fitness of a building to deliver a net-zero future, e.g. delivered annual kWh/m_2 of floor area. If 6 above is undertaken, then it is possible to reissue an updated label for homes. If it is not, and a new label is produced, historic labels which have cost £1 billion to produce will be worthless.

Many of the above issues are already under consideration by government (BEIS/MHCLG) and some have challenges in implementation. However, given the core role of EPCs in delivering net zero and the importance of early action we believe strong leadership and appropriate resourcing is needed to rapidly deliver appropriate methodological developments. See also our response to cross-government working below.

Q: Are there examples of where energy efficiency policy has fallen between Government Departments? How could cross-departmental coordination be improved?

EPCs could be significantly improved with better co-ordination between BEIS and MHCLG on EPC data. Currently EPCs only includes the output rating, summary data (e.g. levels of insulation) and general recommendations on action. The input data generated by the assessor are not made public but are still held by MHCLG. Releasing this data in some form will, we believe, significantly improve the accuracy and reliability (and therefore credibility) of EPCs with householders, which should, in turn, make it easier for BEIS to use its programmes to persuade them to take action.

We believe that there are four reasons for this:

1. **It will improve the quality of EPC input data.** At present, homeowners cannot query any of the assumptions a surveyor may have made during a survey. Therefore, there is no incentive for an assessor to get the input data correct. In addition, it makes it more difficult to include data from other sources (for example from Valuation Office surveys) rather than relying on surveyors with limited time to undertake certain measurements. This would enable surveyors to focus on the key data that we do not already have.
2. **It allows innovative approaches e.g. "real-time" EPCs**. Currently, all EPCs have a "vintage" because they are tied to the time when the survey was done and the version of the underlying software used. This makes it difficult to compare one EPC with another. If the input data is available, then the calculation could be simply re-run with the latest version software. This could also apply if the house has some form of regulated or certified improvement, e.g. new windows or boiler, making the overall process cheaper and less intrusive for the householder.

3. **It can provide better advice to homeowners**. At present the recommendations for energy efficient improvements are general and not updated with the latest cost/benefit data or support programmes available. Using the input data allows recommendations to be updated and even tailored for a particular household. It will also enable EPC data to be used with smart meter data thereby giving more confidence in the actual performance of a building.
4. **It could help drive zero carbon refurbishment programmes**. Currently the main government tool for national planning is the National Household Model, which is a national model populated with 5-yearly English Housing Survey data. If EPC input data were available it would be possible to drive the national model using EPC data. This will improve overall accuracy and, could, in theory, allow the same policy model to be used at the household, local authority, regional and national scales.