Original Article

An introduction to UK Energy Performance Certificates (EPCs)

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ABSTRACT **This paper provides an overview of the rationale for engaging in the carbon production debate. It then establishes emission rates and measurements associated with carbon utilisation. The paper provides a useful overview for the application of Energy Performance Certificates (EPCs) related to dwellings and non-dwellings. Furthermore, it explains the application of Display Energy Certificates (DECs) on public buildings. The roles and responsibilities of key personnel are identified in the EPC and DEC processes, and thus the paper provides a succinct summary for practicing building surveyors.**

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INTRODUCTION

The First World Climate Conference took place in 1979, and was followed by the setting up of the Intergovernmental Panel on Climate Change (IPCC) in 1988. The IPCC's first report assisted the formation of the UN Framework Convention in 1992 in Rio.

In 1995, the IPCC's second report was published, and it made note of the 'human influence' on global warming; this report influenced the creation of the Kyoto Protocol of 1997 (which came into force in 2005). The third IPCC report in 2001 presented stronger evidence of the adverse human effects of global warming.

As a result of the Kyoto protocol and IPCC reports, the EU produced a European directive: 2002/91/EC Energy Performance of Buildings. This was followed in the United Kingdom by the White paper: Our Energy Future – Creating a Low Carbon Economy (2003).

The EU directive led to a spate of legislation across Europe, as the main requirement, which was to produce Energy Performance Certificates (EPCs) for dwellings and non-dwellings; and in England and Wales, the creation of Display Energy Certificates (DECs) on public buildings, all of which had no precedent in the majority of EU member states.

CARBON DIOXIDE (CO_2) EMISSIONS AND MEASUREMENTS

There are many claims in relation to the continued release of CO_2 and the subsequent effects. One such claim is that when the world has warmed by 6°, sea levels could rise by as much as 85 metres, with all the catastrophic implications this would bring to the world. This claim presents a worst case scenario with regard to the consequences of continued CO_2 release. The IPCC prediction that there will not be any large-scale ice melt until 2050 has also recently been proven wrong. In 2008, for the first time in 125 000 years, it became possible to circumnavigate the North Pole. This historic event went largely unreported in the global press, yet it is seen by many as clear evidence of global warming and that the speed of change may be faster than currently appreciated.

So, why are EPCs important in trying to address the above critical issue? The rationale for the introduction of EPCs is based upon the fact that buildings account for approximately 40–50 per cent of Europe's total CO_2 emissions.

This figure can be broken down further to reveal that domestic buildings produce approximately 30 per cent and non-domestic (commercial) buildings produce 20 per cent of the total CO_2 emissions of the United Kingdom.

The emissions from an average commercial building can be subdivided as follows:

- space heating – 55 per cent
- space cooling – 5 per cent
- water cooling – 15 per cent
- lighting – 25 per cent

In order to address, and thus try and reduce the levels of CO_2 produced, the Energy Performance of Buildings Directive (EPBD, 2003) became law in January 2006; however, there was a 3-year 'extension' for those countries that needed to train the new profession of energy assessors. Therefore, across the majority of Europe the 'real' implementation date was 4 January 2009, and at the time of writing, approximately half of the European nations have not as yet managed to achieve full compliance with the EU directive.

The EPBD has three main aspects:

- To provide a valid methodology for calculating the energy performance of buildings.
- To provide application of minimum requirements on the energy performance of new buildings and large existing buildings that are subject to major renovation.
- To inform purchasers and tenants of the energy efficiency of a property when set against a national benchmark value (EPC).

Figure 1 shows example EPCs for England and Wales appertaining to domestic and commercial properties.

It is worth noting that although the two EPCs (depicted in Figure 1) appear similar, a closer inspection (shown in Figure 2) reveals that the main A–G scale is numbered differently on each graph. A domestic EPC 'rating' of 1 produces a band G (the worst rating possible), whereas a score of 1 on a commercial EPC produces a band A at the opposite end of the scale.

WHEN ARE EPC'S REQUIRED?

EPCs, which are an asset rating, are required when a building is constructed, sold or let. Existing occupiers and tenants do not require an EPC unless they sell, assign or sublet

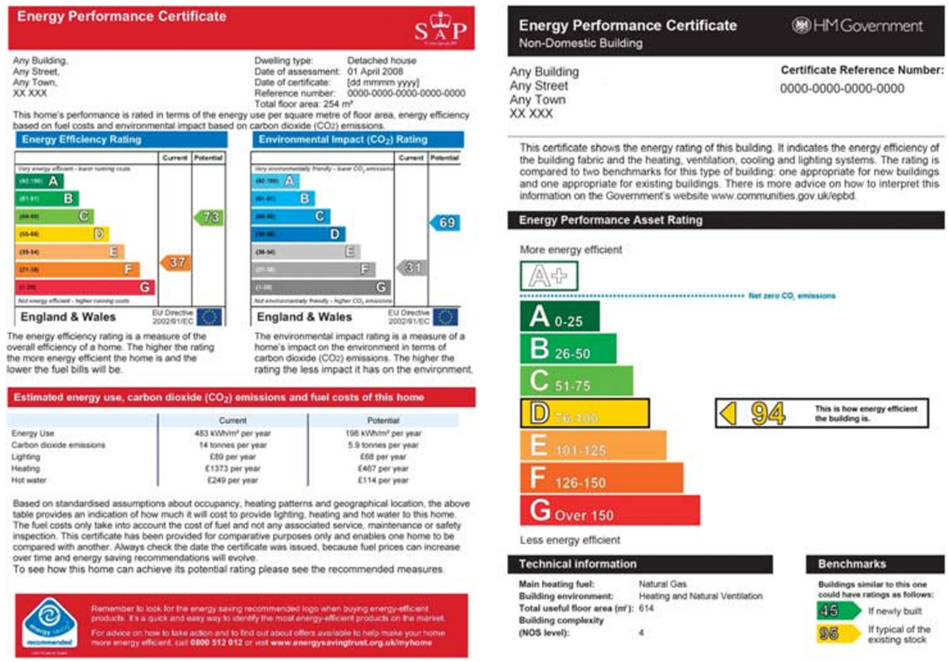

Figure 1: Domestic and non-domestic (commercial) EPCs in England and Wales (left-hand side shows domestic EPC).

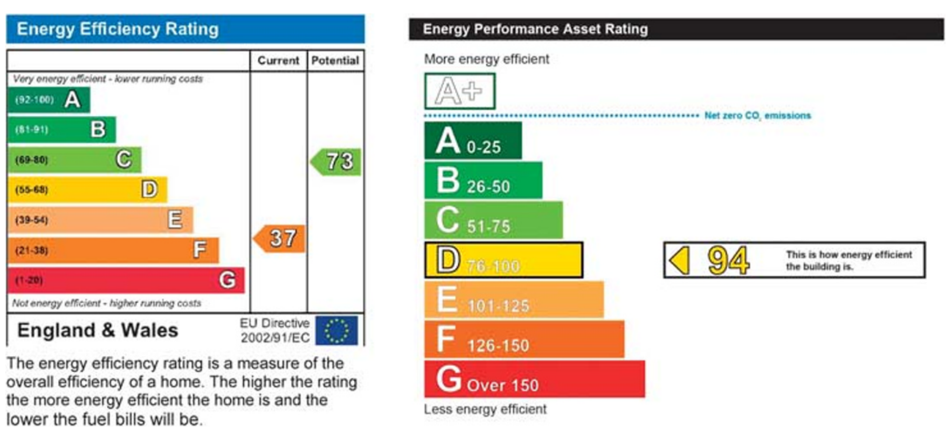

Figure 2: Extract of domestic and non-domestic (commercial) EPCs showing key rating charts (left-hand side shows domestic EPC).

their interest. A building is defined in the EPBD as '… a roofed construction having walls, for which energy is used to condition the indoor climate, and a reference to a building including a reference to part of a building which has been designed or altered to be used separately'. Thus, a building must have a roof and walls along with services for heating, mechanical ventilation or air conditioning; however, the presence of fixed hot water provision and lighting are not considered.

Where it is expected that a building will have heating, mechanical ventilation or air conditioning, the EPC is to be based on an assumed fit out. This is apparently to stop unscrupulous landlords from removing the heating ventilation and air conditioning (HVAC) systems and claiming that their building is not a 'building' according to the EPC regulations. This means that buildings being constructed and sold as 'shell and core'

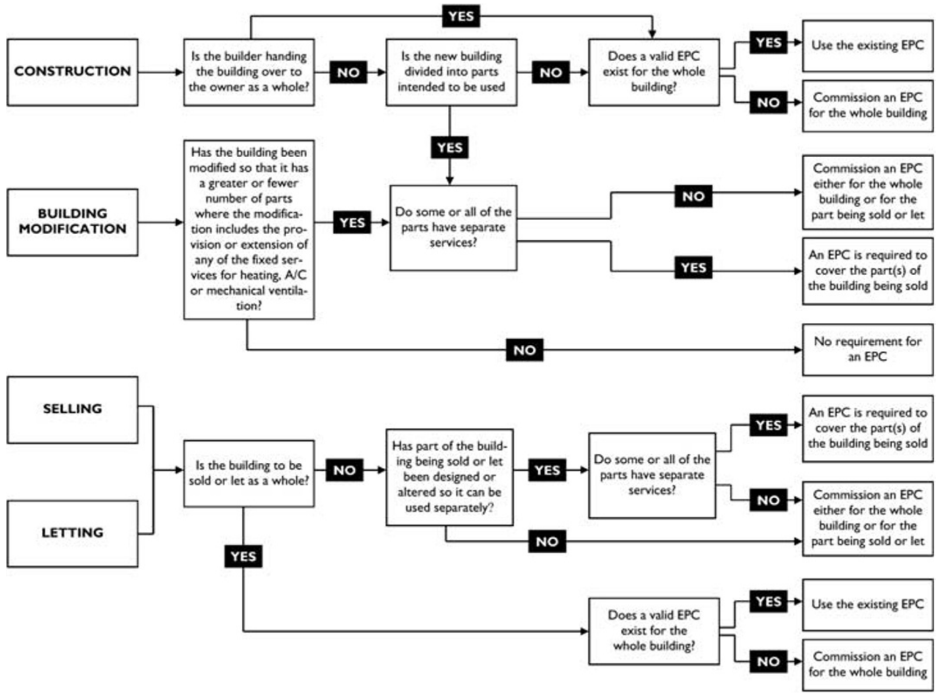

Figure 3: EPC decision-making flowchart (Adapted from Department for Communities and Local Government, 2008a).

buildings also require an EPC; the assumed fit out should be in line with the minimum standard of services efficiencies allowed under the building regulations.

It is clear from the EU directive that a 'building' may be either the whole of a structure or part of a structure. If a multistorey structure designed so that each floor is occupied by a separate company is sold, then assuming that there are different HVAC systems in the structure supplying individual floors, each 'building' (floor) would require its own EPC. Structures that consist of separate buildings that share a common heating system may have one EPC prepared for the whole building, and this can be used in the future if separate parts of the building are sold or leased.

Figure 3 provides a flow diagram based on the Communities and Local Government (CLG) in their publication *Improving the Energy Efficiency of Our Buildings: A Guide to Energy Performance Certificates for the Construction, Sale and Let of Non-dwellings* (Department for Communities and Local Government, 2008b; the first version from Jan 2008 has been used as the revised document in July 2008 has an error on the flowchart) to assist in the decision-making process. One must note that an EPC is an asset rating, and that it relates to the building's fabric and services; and it is not a measure of how much energy is actually consumed by the occupier. This is one of the issues regarding EPCs that many commercial clients and members of the public are unaware of, as they do not realise that the calculation process to produce an EPC makes numerous assumptions about the energy use in the building and only seeks to approximate the energy likely to be used by an occupier. This means that energy-saving 'housekeeping' or good management, such as turning off lights or turning down the thermostat will produce no change in the EPC rating.

The following are exemptions from the requirements to produce EPCs:

- places of worship;
- temporary buildings with a planned use of less than 2 years;

- standalone buildings of less than $50m^2$;
- low energy demand buildings, for example, barns; and
- buildings due to be demolished.

ROLES AND RESPONSIBILITIES

In relation to the provision of EPCs, there are two categories: construction, and selling and letting. Under the category of construction, the following rules apply:

- on construction, the person carrying out the construction is responsible for providing the EPCs to the owner of the building and to notify the relevant Building Control authorities. Building Control will not issue a completion certificate unless they are satisfied that an EPC has been produced;
- on modification (when a building will have more or less parts than it had originally), and including provision or extension of fixed services, an EPC is required, and the person carrying out the modifications is responsible for its production. Extensions do not require an EPC unless the 'modification' definition can be applied.

Under the category of selling and letting, the following rules apply:

- when the building is offered for sale, the seller is responsible for making the EPC available to the prospective purchasers;
- when a building is offered for letting, the landlord is responsible for making the EPC available to prospective tenants;
- a lease assignment is considered to be a sale or letting, and the assignor should provide the EPC;
- the seller/landlord still remains responsible even if an agent is acting on their behalf.

The following are examples of certain transactions that would not amount to a sale or let to a new owner or tenant and therefore do not require an EPC: lease renewals or extensions, compulsory purchase orders, sale of shares in a company and lease surrenders.

Where an EPC is required, it must be made available free of charge to a prospective buyer or tenant at the earliest opportunity. This means that for all buildings currently on the market, an EPC should have been produced and made available whenever information on the building is sent out, a viewing is held, or a contract to buy or lease the building is entered into.

The enforcement agency responsible for policing EPCs required due to a sale or a lease are the relevant local authorities, and the section that has been charged with enforcement is the Weights and Measures (Trading Standards) officers.

NATIONAL CALCULATION METHODOLOGY

In order to meet the requirements of the EU directive for providing EPCs on all buildings in England and Wales, a National Calculation Methodology has been developed. This methodology contains four different approved calculation methods related to particular types of buildings; it also includes important differences between new and existing buildings. The four methods and their respective building types are as follows:

- New dwellings – Standard Assessment Procedure (SAP).
- Existing dwellings – Reduced Data Standard Assessment Procedure (RdSAP).

Condition requiring an Energy Performance Certificate	Assessment Methodology
A dwelling on completion of construction	**SAP**
Building not intended as a dwelling on completion of construction	**SBEM** or **DSM**
A dwelling being sold or rented out	**RdSAP** (unless the unusual nature of the building indicates that a more accurate assessment could be obtained using the **SBEM** or **DSM** methodology
A building catering for mixed use (i.e. combining dwelling and non-dwelling) is constructed, sold or rented out	It should be treated as single dwelling as described above if the commercial part can be converted back to residential use and there is common access i.e. each part does not have a separate access (for example; where within a house a portion has been separated out as a workshop, office, or surgery); For other scenarios, treat the dwelling and non-dwelling parts separately using the most appropriate methodology for each element. For example, where a building contains both flats and offices use **SAP** or **RdSAP** for the flat and **SBEM** or **DSM** for the offices
For all other buildings being constructed, sold or rented out	**SBEM** or **DSM**
When a Display Certificate is required for public display	Operational Rating Mthodology

Figure 4: Assessment methodologies for EPC production (Adapted from Assessment methodology and software, 2009).

- New and existing non-dwellings (commercial) – Simplified Building Energy Model (SBEM) if the building is classed as level 3 or 4 or Dynamic Simulation Modelling (DSM) if the building is classed as level 5.

Figure 4 provides an overview of the assessment methodologies.

SBEM AND EPC

When producing an EPC using the SBEM methodology, there is a requirement to describe the building in terms of the following:

- General information
  - Building address, owner, certifier and appropriate weather location. There are only 14 weather locations, and the one nearest the property being assessed is selected (see Figure 5).
- Geometry
  - Overall building layout, the number of floors and orientation.
  - Distribution of activity areas – SBEM has a large number of activities and all areas inside a building need to be described by using one of the designated activities, that is, ‘cellular office’, ‘circulation space’, ‘WC’ and so on. However, how rooms within buildings are actually used is very varied and thus frequently the energy assessor has to make subjective decisions, which can have a significant impact on the EPC rating.
  - For every zone (activity area) in a building the areas of each wall, floor, window and ceiling/roof must be entered. The construction of the element also has to be defined in relation to each area.
- Construction
  - Wall, floor, ceiling and roof constructions need to be defined, including internal floors and walls.

Figure 5: Weather locations used in SBEM. (Adapted from Department for Communities and Local Government, 2008c).

- *U*-values and thermal capacity values are either entered directly or the SBEM engine makes suitable assumptions based on descriptions chosen, for example, a masonry wall built to 2002 regulations will have a *U*-value of 0.35 W/m^{2}K. There are inherent problems with this approach, for example, many buildings are built to the minimum standard at the time, but many have subsequently been altered. Further, establishing the date of construction and/or the applied regulations at the time is often impossible. As an example, if a building was finished in the mid-1980s and is of a cavity wall construction and built to the 1981 regulations, the assumed *U*-value will be 1.0 W/m^{2}K, but if it was built to the 1985 regulations then the *U*-value will be 0.65 W/m^{2}K, thereby reducing heat loss through the wall by 35 per cent. As it is possible to start a building and then leave it incomplete for a number of years, it is not always possible to ascertain which regulations it was approved under. The same is true for the floor and roof construction.
- Glazing area and performance – *U*-values along with the light and heat transmittance values are required. Overshading can make significant improvements to the cooling energy required by a cooling system; however, the tables provided to energy assessors for use with SBEM are inadequate as there are only three latitudes given in the tables: 45°, 55° and 65° North. Therefore, if your building is at 50° North, for example, you need to interpolate between 45° North and 55° North. This is clearly not a significant problem and it is unclear why the three given latitudes equate to the following loations:
- 45° North – Milan (Italy)
- 55° North – Carlisle and
- 65° North – the middle of Iceland. You are left wondering what rationale if any went into designing these tables for ease of use when it would have been more efficient to give the 50–60° that would cover the vast majority of the entire UK.
- Infiltration rates – where an air pressure test has been conducted, the result should be entered; otherwise a very approximate figure is used by the calculation method.

- HVAC systems for heating, ventilation and cooling
  - The type and seasonal efficiencies for the plant that provide the heating and cooling are required.
- Lighting
  - For existing buildings, the lamp type is required; for new buildings the actual design data are required.
- Controls
  - Presence of time, temperature and other HVAC and lighting controls.
- Low and Zero Carbon Technologies
  - The type and essential aspects of any solar thermal, photovoltaic, combined heat and power or wind turbine need to be detailed.

Once all of the required data have been collated, entered and checked, the SBEM engine calculates the monthly demands for the required levels of heating, ventilation, cooling, lighting and hot water. The required levels are based on the inputted geometry, construction types and assigned activities, along with the services system types, efficiencies and control corrections. Once the total energy requirements are established, the SBEM calculation then converts the energy into CO_2 emissions based on the carbon densities of the various fuels as set out in the building regulation-approved document L2. The resulting emissions are expressed in terms of $KgCO_2/m^2$; this value is known as the building emission rate (BER).

In order to provide the EPC rating, the BER is compared with a standardised emission rate (SER) based on the building that has been assessed. The SBEM calculation engine further calculates the notional Building energy requirements. In simplistic terms, the notional building is identical to the actual building being assessed, except that all of the elements of construction that were described for the actual building are replaced with a similar element that is 'built' to the 2002 elemental U value standards.

In addition, the notional building is the same size and shape as the actual building; it has 'spaces' with the same 'activities'; it has the same orientation and is located in the same part of the country and it is assumed to be occupied to standard operational patterns.

Once the energy required by the notional building has been established, the notional building is converted into the reference building. This means that the fuel type is assumed to be gas for heating and electricity for cooling and lighting. The CO_2 emissions generated from the energy required and the fuel type 'used' are calculated and these are then reduced by 23.5 per cent, which includes a standardised improvement factor for all buildings. The resulting emissions are known as the SER and are again in $KgCO_2/m^2$.

To calculate the EPC 'rate', the BER is divided by the SER, and the resulting number is then divided by 2 and multiplied by 100. This produces a ratio that has no units and this ratio is then displayed on the EPC as the main 'rating'.

The screenshot in Figure 6 illustrates the values that are produced by the software. The illustration shows the energy required (kWh/m^2) for heating, cooling, auxiliary, lighting and hot water by the actual, notional and reference buildings. Below these numbers are the emissions ($kgCO_2/m^2$) for the actual building, as follows:

- If it was built to meet current part L standards, this is known as the target emission rate (TER).
- Assuming that it was built to meet 1995 standards – this is known as the typical emissions rate and is deemed by government to be the average of all existing buildings.

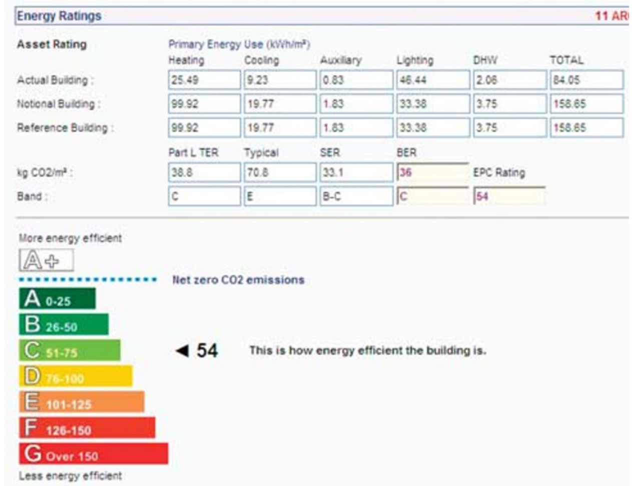

Figure 6: Energy performance asset rating efficiency data.

- SER as explained previously.
- Actual building's BER.

Finally, the EPC rating is given. In this example, the 54 is obtained by the following calculation (that has already been explained).

$$EPC = \left(\frac{BER}{SER}\right) \Big/ 2x100$$

$$EPC = \left(\frac{58}{53.7}\right) x50$$

$$EPC = 54$$

One aspect that is often underestimated by people, before they understand the SBEM methodology, is the length of time that producing an EPC takes. Even if the client is in possession of relatively up-to-date drawings, these need to be checked for accuracy and the required detail needs to be sourced and collated.

The production of an EPC can be broken down into the following stages:

1. Data collection – full measured survey with additional data collection.
2. Zoning – dividing the building into activity areas that have different parameters.
3. Data extraction/verification – from plans and specifications.
4. Data input and checking.
5. Production of EPC and recommendation report.

CONCLUSIONS

This paper has endeavoured to establish the rationale for fully engaging with the CO_2 debate and the use of Energy Performance Certification as a means of reducing CO_2 emissions. However, the SBEM methodology is very subjective, complicated and time-consuming to produce. Although at present it is a legal requirement to have an EPC for a building when it is constructed, sold of leased, there are no current legal requirements to act on the results. To add some validity to the calculations as a means of addressing CO_2 emissions, owners and tenants need some form of incentive to address the results of the calculations. One suggestion would be to have some form of sliding scale related to business rates for commercial buildings and council tax rates for domestic buildings. This would be similar in principle to the new car tax system in which the least polluting cars cost £35 per year and the most polluting cost £400 per year. If all commercial building owners and users were made aware that from next year, if their building is rated 'G' (worst band) their business rates would quadruple; but, if they have an 'A'-rated building, their business rates would be reduced by 90 per cent. This would produce a real incentive for building owners and tenants to improve their insulation envelope and upgrade their HVAC systems to reduce their carbon footprint, save fuel costs and avoid a hefty tax burden.

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