Field Test of Methodology to Produce Building Energy Certificates Based on Operational Ratings

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ABSTRACT

The EPLabel project addresses the EU Energy Performance of Buildings Directive (EPBD) Article 7.3: the requirement for 'Public Buildings' over 1,000 m² to display an Energy Certificate prominently, OJEC (2003)[1] and is supported by the EC's Intelligent Energy for Europe (EIE) SAVE programme. The project's main technical objective is to develop a methodology for energy benchmarking and certification based on Operational Ratings (actual annual energy consumption), offering sufficient flexibility to accommodate national diversity whilst seeking the harmonisation the EC desires. 'Public' buildings required to display an energy certificate are a special case, in that the need for a certificate is not triggered by a change of occupancy or ownership, but to inform the occupier and the public about the true energy efficiency of the building. Here, a Certificate based on measured energy use is not just relevant but essential to a meaningful rating - it is widely recognised that the real in-use energy performance of buildings rarely matches up to theoretical expectations.

This paper describes the experiences of the field tests undertaken by the ten full project Partners[2].

KEYWORDS

Energy certification, public buildings, operational rating, energy performance

BACKGROUND

The EPLabel project addresses the EU Energy Performance of Buildings Directive (EPBD) Article 7.3: the requirement for 'Public Buildings' over 1,000 m² to display an Energy Certificate prominently. It started in January 2005 and finishes in early 2007 and involves nineteen countries, ten with full Partners. The project's main technical objective is to develop a methodology for energy benchmarking and certification based on Operational Ratings (actual annual energy consumption). It covers six sectors: Public administration offices, Universities, Schools, Sports facilities, Hospitals and Hotels.

THE BENEFITS OF OPERATIONAL RATINGS

In buildings with ongoing activities, a well-designed procedure of energy certification based on Operational Ratings has several important advantages:

a) it can be easy, low cost and appropriate;

b) it can build on existing energy management activities and initiatives;
c) it can get started quickly, without the need to train experts;
d) it can incentivise building owners, managers and occupiers to make immediate reductions in energy use and CO2 emissions; and to seek more advice where necessary;
e) it is easy to understand by the public; and
f) it can help to close the gaps between client and design aspirations and actual performance.

The aim of the EPLabel project is to ensure that the implementation of Operational Ratings can capitalise on all these advantages.

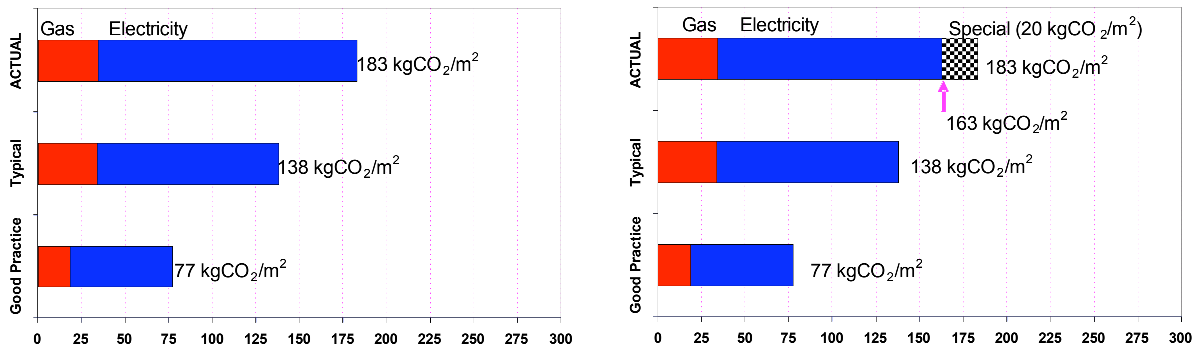
Five Steps to produce a certificate based on an operational rating

The process required to produce a certificate based on an operational rating can be described in five main steps:

Step 1	*What have we got?* Collect relevant data and calculate the appropriate building energy performance indicator(s).
Step 2	*What does it mean?* Identify appropriate benchmarks with which the indicators can be compared.
Step 3	Compare the indicators with the benchmarks to grade the building's energy efficiency.
Step 4	*What can we do?* Identify cost-effective energy saving measures.
Step 5	*Tell everyone about it.* Bring together all the relevant data onto the energy performance certificate (EPC).

BENCHMARKS

For initial statutory implementations of Article 7.3, EPLabel proposes two levels of benchmarking for Operational Ratings, as illustrated in Figure 1:



Level 1: simple, usually reconciled with stock statistics for the type of building concerned.

Level 2: corrected, taking account of special energy uses not included in the Level 1 benchmarks.

Figure 1 Two levels of benchmarking for a measured (Operational) Rating

At Level 1 (Figure 1, left), a building's actual CO2 emissions are compared directly with fixed Typical and Good Practice benchmarks appropriate to the building type. If any special energy uses (not included in the benchmark reference) are identified by measurement (e.g. survey or sub-metering), then a “Level 2” correction can be made, deducting them from the total emissions before making the benchmark comparison.

Implementation of Benchmarking Levels 1 and 2

CEN Draft Standard prEN 15217 proposes two benchmarks are used:
- Rr: the value typical of the requirements of energy performance regulations for new buildings.
- Rs: the median value for the building stock.

Rr is most important for new construction and Rs for existing buildings. The standards recognise that good benchmarking data may not be available: if Rs is not known, they recommend obtaining rough estimates by collecting data from a small subset. They also appreciate that Rr is difficult to define for buildings in operation. Therefore they say alternative definitions can be adopted for Rr until sufficient data become available on the operational performance of new buildings.

A state-of-the-art review revealed that there is substantial variation in the availability of energy benchmarks in the countries represented in EPLabel. Only the UK (and by extension Ireland), Denmark and Germany have anything approaching a complete set. In other countries, data are available for certain sectors, but they are not considered definitive statistics from which official values for medians or quartiles might be generated. In principle, for the UK building stock, the Typical values from energy consumption guides published in the UK should be appropriate for Rs. In practice, however, a review in 2005 by the EPLabel UK team showed that UK benchmarks were in need of an overhaul. Good Practice benchmarks are inherently less robust - and less reliably derived from small samples.

EPLabel has adopted a pragmatic approach to overcome these shortcomings. The implementation of the ‘Initial’ benchmarking approach requires two benchmark values, Rr (regulatory standard) and Rs (stock median), for both the electricity and fossil fuel use, to be designated for each building sub-type in each country. The choice of building categories is thus strongly connected to the availability of corresponding benchmarks.

Partners have been given three choices:
1. Use national building sub-types which have associated national benchmarks.
2. Use another country’s national sub-types and associated national benchmarks.
3. Use national sub-types without benchmarks.

With choice 3, it will be possible to produce only a Level 0 Certificate i.e. just the Energy Performance Indicator, without an A to G grade. Due to their lack of national benchmarks, some countries are currently using UK sub-types and benchmarks.

Climate Correction of the Benchmarks

Current benchmarking practice often includes making corrections for climate. It has been customary to adjust the actual energy used for space heating to the national average climate. This has the benefit of enabling all similar buildings across the country to be compared on a single basis. However, in most buildings the energy used solely for space heating purposes is not separately metered. Given that most countries have substantial regional climatic variations, the potential error that might be introduced by correcting an estimated value for heating energy use is unacceptably large. Also, by adjusting actual energy to a national average climate, one is effectively moving the building from its real location to an 'average' location. If one uses this adjusted building energy performance to assess the viability of energy saving measures, the results could be grossly misleading. We therefore recommend adjusting the 'national' benchmark for the regional average climate for the building, using a climate index such as degree-days. To avoid the above source of error, the climate-related part of the benchmark can be pre-defined. Similar corrections can be made for cooling, but this is seldom done and methods are less well established.

Weather Correction of the Actual Energy Use

The draft CEN Standard prEN 15603 recommends taking the average of three years energy data or correcting to the average local weather. EPLabel proposes to adjust the actual energy for the regional average climate if year-on-year comparisons are being made. A pre-defined percentage of the actual energy is corrected pro rata from the climate index for the building's region for the year of assessment to the 20 year average climate index for the region. This should be a relatively small adjustment and hence any error will be less significant. We do not intend making similar weather corrections for cooling unless the annual cooling energy has been sub-metered.

TESTING EPLABEL LEVEL 1 AND 2 BENCHMARKS

Preliminary Appraisal

The first version of the EPLabel software (V1.2) incorporating Level 1 and 2 benchmarking was issued to Partners for testing at the end of March 2006. The primary objectives were to obtain a definitive set of building sectors and sub-types for each country, corresponding benchmark data, climate correction indices and translations of all technical terms used, so the software works in eight languages.

Replicability

A critical requirement for energy certification software is to achieve replicability i.e. different assessors of the same building produce the same result. In addition to reviewing the correctness of the approach, an important part of the testing is to highlight any possible causes of discrepancies between the results from different assessors. These situations can then be dealt with either by adjusting the methodology to remove causes or by establishing a rule book for assessors to follow.

Initial Results

One of the first issues to try to resolve was the definition of floor area in different countries and in different building sectors. CEN proposes conditioned area, the floor area of heated and cooled spaces, excluding non-habitable cellars. However, it leaves the precise definition of both what is included and how it is measured to national authorities. The strategy suggested by EPLabel allows a building's size to be input in the units best known to the user. Where necessary, this is then converted to gross internal floor area (GIA), excluding unheated basements and attics, to create a common calculation metric for all sectors and countries. GIA is also the default size metric for presenting results. User can also elect for the results to be output using a different metric, e.g. the one they used for the input.

Another issue is that energy data are often taken from financial administrative systems, and do not refer to a one year period of 365 days. There should be a well-defined and transparent process for extrapolating or interpolating the data to 365 day values and converting from Net Caloric Value to Gross Caloric Value, if applicable.

The experience from testing V1.2 by Partners in EPLabel is summarized in Table 1.

United Kingdom	13 buildings from different sectors
Belgium	78 hospital buildings
Germany	13 office buildings
Denmark	10 higher education buildings
France	5 sports buildings, 2 university buildings
Greece	58 school buildings
Ireland	77 school buildings
Netherlands	23 hospital buildings
Sweden	115 schools, 27 hospitals

Table 1 Summary of buildings tested by EPLabel Partners in each country

Figure 2 summarises the results from the thirteen office buildings tested in Germany. In general the ratings were less good than expected. This is because the officially announced German benchmarks are the same for all office buildings, while all the buildings analysed had relatively high levels of technology and use. Two are considered the most energy efficient office buildings in Frankfurt, but only achieved a B rating. Simpler buildings will find it comparatively easier to achieve good grades.

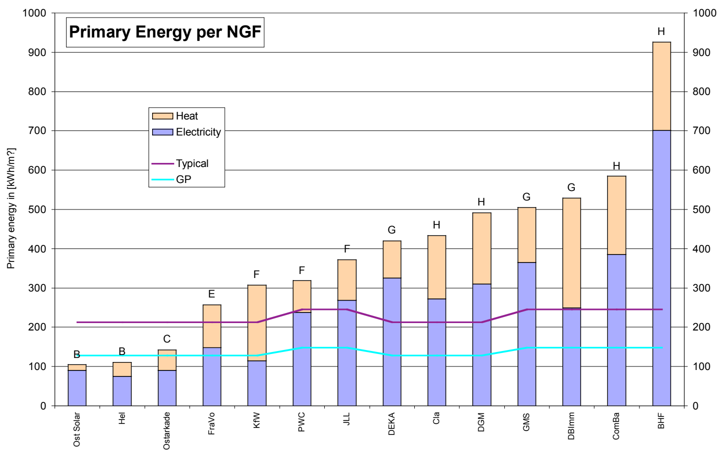


Figure 2 Results of testing software on 13 office buildings in Germany

Applying the Level 2 corrections, i.e. excluding 'Specials' from the energy use assessed worked very well. For example, the electricity used by the restaurant in one office accounted for one-third of the building's total primary energy consumption.

Collecting energy data for non-domestic buildings is sometimes difficult, but is much simpler than collecting the hundreds of design parameters needed for a calculated asset rating. It will also aid future energy management. The UK team tested the software on thirteen recently completed buildings from a variety of sectors which had been earmarked for inclusion in a new book on low energy architecture (see Figure 2). These were chosen deliberately to challenge the ability of the software to deal with the less conventional buildings and energy supplies which will become more common in the future. If it could cope with these, it could certainly manage more standard buildings e.g. those using only natural gas and grid electricity.

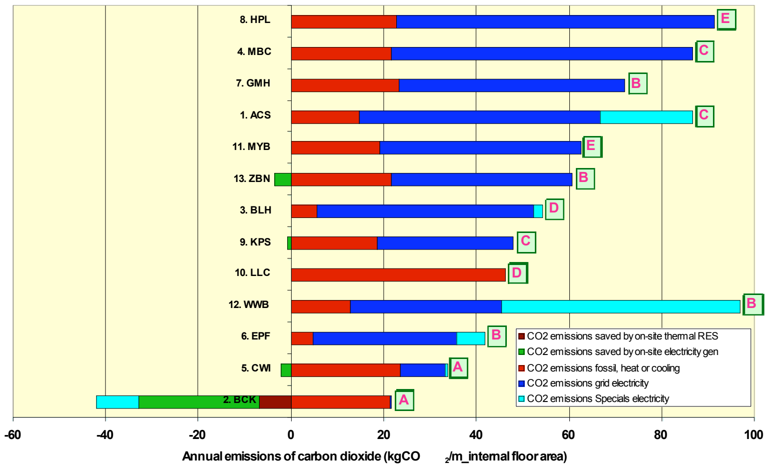


Figure 2 Results of testing software on 13 buildings from different sectors in the UK

Resources needed for the assessments

The testing proved very useful in identifying shortcomings and improvements to the software which can be addressed in subsequent versions. It also provided insight into the time needed to perform the assessments. The answer depends on the complexity of the building, how different from standard sub-types and the quality of energy monitoring systems. If there are no ''specials'', EPLabel allows a first answer from a very small set of data input which all building managers should know: the floor area and annual use of each energyware. This should not take more than one hour.

Analysis of special energy uses refines this analysis and might require a special survey depending on the abilities of the building manager. If an outside person has to be used then this could add 0.5 to 1 days for a typical building. The software could also generate an automatic list of measures tailored to the building sub-type to accompany the Certificate, as allowed by the EPBD. A more in depth analysis of measures would require an expert survey and this also could add 0.5 to 1 days, but could deal with special energy uses at the same time. Thus for typical buildings the EPLabel assessment will require between one hour and one day of external assessors time. Large and complex buildings with many specials would need more.

Notes:
1. OJEC - Official Journal of the European Communities (4 Jan 2003). The Energy Performance of Buildings Directive: Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the Energy Performance of Buildings.
2. The project Co-ordinator is the UK Partner, Energy for Sustainable Development Ltd, who are supported by sub-contractors Target Energy Services, William Bordass Associates and the Association for the Conservation of Energy. The project is funded in the UK by a Government Ministry (DCLG) and Constructing Excellence. The other partners are BBRI (Belgium), Energiereferat Frankfurt (Germany), Esbensen (Denmark), CSTB (France), NKUA (Greece), NUID (Ireland), DHV (Netherlands), Enerma (Sweden) and Motiva (Finland).