Bridging the gap between operational and asset ratings – the UK experience and the green deal tool

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Summary

To truly understand how a building uses energy you need to know something about the building itself and about how it is used. In current parlance, that requires both an Asset and an Operational energy rating. An asset rating models the theoretical, as designed, energy efficiency of a particular building, based on the intrinsic performance potential of the building envelope (the fabric) and its services (such as heating, ventilation and lighting).The higher the numeric rating, the worse the building is, and the greater the opportunity to reduce carbon emissions by improving the building itself. However, the asset rating provides no information about how the building is operated in practice.

The operational rating records the actual energy use from a building over the course of a year, and benchmarks it against buildings of similar type. Factors other than building quality, such as unregulated loads (e.g. IT, plug-in appliances) or building user behavior also create emissions, which are reflected in the operational rating.

There is significant confusion in the non-domestic property market between the two different building energy ratings currently in use. Property owners mistrust asset ratings because they don't map directly onto measured fuel bills.

This paper discussed the underlying principles of how the UK Green Deal tool was designed, using the Interface to the Simple Building Energy Modeling (iSBEM), and how it has bridged the gap between the two ratings to provide a more complete picture of how energy is used in a building.

Keywords: Building Energy Modeling; Asset energy rating; Operational energy rating; Interface to the Simple Building Energy Modeling (iSBEM); Green Deal Tool.

Introduction

The rising cost of energy in the UK since 2000 has highlighted the need for improved management of Energy. The UK's Department of Energy and Climate Change (DECC) updates its predictions of fossil fuel prices annually (Department of Energy and Climate Change (DECC), 2009). For example DECC's modeling of gas prices based on four scenarios - the worst of these scenarios predicts a 100% increase in prices over the 10 years from 2008 (Lewry A. J., 2011).

As well as rising prices, security of energy supply has also become an issue, particularly since the UK changed from being a net exporter of gas to being a net importer in 2004. UK production satisfied only about 70% of our demand in 2010 (Department of Trade and Industry (DTI), 2006). This loss of capacity has led to increasing concern over energy security, as reported in an article in *The Guardian* in January 2010 (Macalister T., 2010).

When managing energy one has to overcome the false perception that it is a fixed cost to business and can be reduced only by tariff negotiation. Considering energy as a variable cost to a business provides the opportunity to discover the size of the potential savings.

Finally, there is legislation to comply with, examples of which are the Climate Change Levy (CCL), Climate Change Agreements (CCAs) with DECC and Industrial Emissions Directive (Directive 2010/75/EU, 2010), legislation and Environmental Permitting Regulations (The Environmental Permitting (England and Wales) Regulations 2010) which mainly cover industrial and manufacturing organisations.

These, along with the carbon reduction commitment (CRC) energy efficiency scheme, are initiatives designed to help meet the government's carbon reduction targets (Figure 1) to which energy efficiency is a major contributor.

This all indicates the need for energy management as highlighted in a recent review of best practice (Lewry A. J., 2012). The review pointed out that establishing the facts and having a systematic approach to data collection and analysis was essential for good energy management. As part of this exercise both an asset and operational rating were needed to truly understand how a building uses energy.

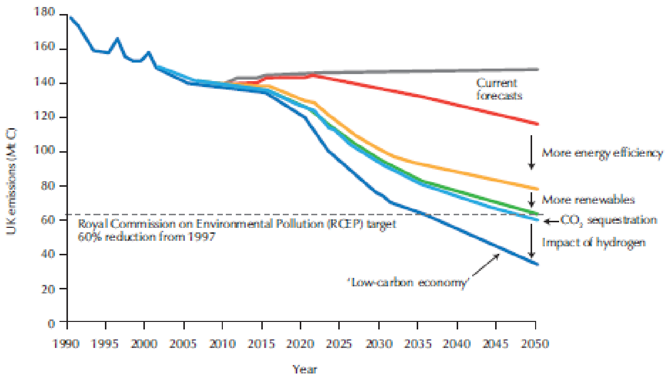

Figure 1: UK government carbon reduction targets (Sibback I., 2005)

There is significant confusion in the UK non-domestic property market between the two different building energy ratings currently in use. The legal requirement for the UK commercial sector is for a calculated Energy Performance Certificate (EPC) which provides an intrinsic Asset Rating. Public buildings have to display a Display Energy Certificate (DEC), which is an Operational Rating based on measured energy use. There is pressure to extend DECs into the commercial sector - initially on a voluntary basis. The two ratings measure different things - and each has its value. What is missing is a means of relating one to the other.

Bridging the gap between operational and asset ratings – the UK experience and the green deal tool

Asset and Operational ratings

The asset rating is a measure of building quality: the higher the rating the worse the building is, and the greater the opportunity to reduce carbon emissions and improve the building itself. However, the asset rating provides no information about how the building is operated in practice. The operational rating records the actual energy use in a building over the course of a year, and benchmarks it against buildings of similar type. An asset rating models the theoretical, as-designed energy efficiency of a particular building, based on the performance potential of the building itself (the fabric) and its services (such as heating, ventilation and lighting). Therefore, to understand and manage the energy use in a building, both ratings are required as they show different aspects of a building's total energy performance.

The building quality (provided by the asset rating) has a large impact on the total emissions, but does not explain all emissions. Other factors such as unregulated loads (e.g. IT, plug-in appliances) or building user behavior can also create emissions, which are reflected in the operational rating.

Two offices with the same asset rating could have very different operational ratings – a building with a low rating is used well by its occupants, a building with a high rating is used badly. In the latter, measures to change the behavior of the end users will be the best option for reducing energy use and carbon emissions.

An example of an asset rating is an EPC, as produced for buildings in the UK. One of the software tools used to create an EPC is the interface to the Simplified Building Energy Model (iSBEM). This was produced by BRE in 2006 for the UK Department for Communities and Local Government (DCLG) in England and Wales as a mechanism for calculating the energy used by buildings, and forms part of the department's process for implementing the EU's Energy Performance of Buildings Directive (Johnson T., 2010). An EPC can be generated using the tool iSBEM, the free downloadable user interface for SBEM (www. ncm.bre.co.uk) that was also developed by BRE for DCLG.

The asset rating is intended to inform people on first occupancy, i.e. at the point of construction, sale or rent, in order to help purchasers or tenants in selecting the right building. At this point in time, any previous metered information is not very helpful as the previous occupants' operation of the building, unregulated energy use, etc. could be quite different to that of the new occupants.

An example of an operational rating is a DEC that is required in the UK by all larger public buildings. The Operational Rating Calculation (ORCalc) is the software used to calculate the operational rating of a building from annual utility consumption and to produce the DEC and an advisory report (www.ukreg-accreditation.org).

BRE's Building Energy Modeling team identified a possible solution to the problem of linking the two rating methods, which has been rolled out as an Audit tool - the Mauritian Building Energy Audit Tool (MBEAT). This tool is able to join the two ratings together for the purpose of an Energy Audit. This tool was a pre-cursor in that it was simplified by the fact that only cooling needed to be considered which was satisfied by a single fuel type – electricity.

Using the lessons learnt from the production of MBEAT (Lewry A.J. et al, 2012), members of the team developed the Green Deal assessment tool for non-domestic buildings for the Department for Energy and Climate Change (DECC).

The Mauritian Building Energy Audit Tool (MBEAT)

The MBEAT tool comprises a calculation engine with a user interface. The purpose of MBEAT and its interface is to produce consistent and reliable evaluations of energy use in non-domestic buildings for energy auditing purposes. MBEAT consists of a calculation methodology (described in the sections below), which runs together with an Energy Audit generator (EAgenMA) which utilises some of the same data during the calculation. The user sees the interface software, which interweaves these components together and interacts with a series of databases to provide consistent data to the calculation while simplifying the user's need to obtain raw building construction data.

Defining the Asset

When comparing the Asset and its operation performance one must first define the building. There are a number of stages to inputting a building in iSBEM:

a. Enter general information about the building, the owner, and the energy auditor, and select the appropriate weather data.
b. Build up a database of the different forms of constructions and glazing types used in the fabric of the building.
c. After "zoning" the building (on the drawings), create the zones in the interface, and enter their basic dimensions, along with the air permeability of the space.
d. Define the envelopes of each zone, i.e., walls, floor, ceiling, etc. The envelopes' areas, orientations, the conditions of the adjacent spaces, and the constructions used all need to be defined.
e. Within each envelope element, there may be windows/ rooflights or doors. The areas and types of glazing or door within each envelope element need to be entered.
f. Define the HVAC (heating, ventilation, and air conditioning) systems, the HWS (hot water systems), and any SES (solar energy systems), PVS (photovoltaic systems), wind generators, or CHP (combined heat and power) generators used in the building.
g. Define the lighting system and local ventilation characteristics of each zone, and assign the zones to the appropriate HVAC system and HWS.
h. Run the calculation and assess energy performance.

The building services systems, zones, envelope elements, windows, and doors are all referred to as "building objects" in iSBEM. Each of these building objects is linked together so that iSBEM can calculate the energy consumption of the building.

iSBEM calculates the energy demands of each space in the building according to the activity within it. Different activities may have different temperatures, operating periods, lighting standards, etc. iSBEM calculates heating and cooling energy demands by carrying out an energy balance based on monthly average weather

Bridging the gap between operational and asset ratings – the UK experience and the green deal tool

conditions. This is combined with information about system efficiencies in order to determine the energy consumption. The energy used for lighting and hot water is also calculated. This requires information from the following sources shown in Table 1:

Table 1: Calculation parameters for iSBEM

Information	Source
Building geometry such as areas, orientation, etc.	Energy auditor reads from drawings or direct measurement.
Weather data	Internal database.
Selection of occupancy profiles for activity areas	For consistency, these come from an internal Activity Database – energy auditor selects by choosing building type and activity from the database for each zone.
Activity assigned to each space	Energy auditor defines within MBEAT by selecting from internal database (the user should identify suitable zones for the analysis by examining the building or drawings).
Building envelope constructions	Energy auditor selects from internal Construction and Glazing databases or inputs parameters directly. Energy auditor can also define their own constructions in the user-defined construction database.
HVAC systems	Energy auditor selects from internal databases or inputs parameters directly.
Lighting	Energy auditor selects from internal databases or inputs parameters directly.

Defining a poorly managed asset

MBEAT is unique in that it compares and adjusts both the asset and operation energy usage of a building. However, in order to adjust the asset energy usage, one must first address the issue of the Poorly Energy Managed Building (PEMB) definition.

The Poorly Energy Managed Building (PEMB) definition

The PEMB is needed to calculate one end of a scale between well managed (equivalent to the asset energy usage, where the building is perfectly controlled to the requirements of the activity databases) and poorly managed (where the activity database parameters are not adhered to). A separate scoring exercise places the actual building on this scale, which is transposed from the calculated to an "actual" scale. The position on the scale indicates where the metered performance is expected to be, and hence the theoretical split between asset and operational performance can be transposed onto the actual scale, and theoretical predictions about the impact of improvements can also be transposed to the actual scale.

How might the activity database parameters be degraded?

If a zone is not controlled to the "ideal" set points and timings in the database for the activity in that space, it can be regarded as inadequately managed. Alternatively, some parameters might change as a result of overloading rather than mismanagement. The question is: how far might they be expected to drift before the zone and building can be considered "poorly" managed? And in which direction might they drift?

a. The amount of change that constitutes poor management, or results from some issue, over which the energy manager has no control, has to be a judgment based on what could reasonably be expected in the situation

b. The direction we are concerned with is that which causes energy consumption to rise.

Defining and quantifying energy management within the asset

The definition of the PEMB allows the sliding scale to the well managed building to be calibrated. However, the extent of the energy management within the building needs now to be defined and quantified so that it can be positioned on this scale.

As a starting point the authors looked at a tool developed for The Energy Efficiency Best Practice programme, in the 90's – "Energy management priorities - a self-assessment tool" (UK Government's Energy Efficiency Best Practice Programme, 2001). This tool uses Energy management matrices which are performance based and are underpinned using detailed matrices covering all the technologies within the built environment within the UK.

The weakness of these matrices is that they give an equal weighting to each of the energy management issues and technologies considered. In addition, there is a need to identify any new parameters which are particular to the built environment of the climatic zone being considered and filter out those which are not relevant.

With MBEAT the production of a series of new matrices with weighted scores was initially carried out through a series of information and data gathering exercises which engaged the building professionals in Mauritius. This was then tailor by producing an energy management tool which dovetailed to the asset tool.

The Energy Management tool

The energy management tool for MBEAT, which is contained within a locked excel workbook, calculates an energy management score. This score is calculated on the basis of the data collected by the auditor from the real building. The tool contains a number of worksheets which address all the energy management issues

Operational data

As well as the energy management score obtained from the worksheet, meter data also needs to be entered. The metered data needs to be of a full year so that any seasonal variations are ironed out and each of the fuels types used within the building is entered separately in the tool. Once the metered data has been entered so can the energy management score based upon the audit

Bridging the gap between operational and asset ratings – the UK experience and the green deal tool

With MBEAT this score is entered into the tool with the model in Asset energy mode. The normalised management score of between 0 and 100 is entered in the current field in the management scores.

MBEAT calculations and outputs

The MBEAT tool calculates the asset rating using the standard activities and weather file contained within the tool. Using the metered data and initial energy management score entered by the auditor it then calculates a Transposed Asset and adjusted Operational performance using this data to correct for actual patterns of usage and microclimate.

Once the Asset and Operational performance is calculated, MBEAT then uses the improved energy management score to determine the:

a. The potential operational saving for the building if management improvements were applied based on the energy performance of the building that corresponds to the current and improved management scores as input by the energy auditor.

b. The potential asset saving if asset improvements were applied to the building, based on the energy performance of the current and improved building models as input by the energy auditor.

The mechanics of these calculations in MBEAT can be seen in Figure 2.

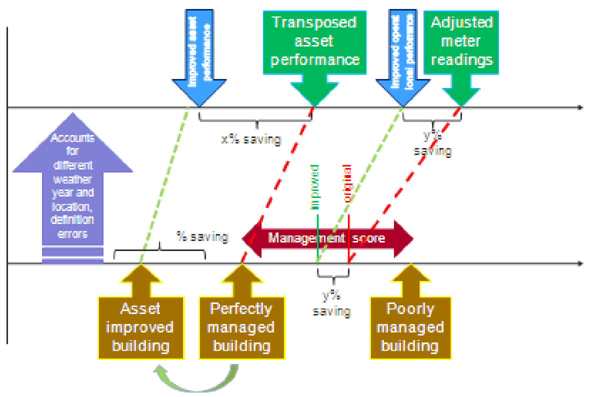

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Figure 2: Details of the MBEAT calculations

The resulting MBEAT outputs are shown in Figure 3, where the example building in question has all the potential savings as operational, indicating this is where investment should be targeted. However, at this stage it should be remembered that operational savings relate to how the building is run and not the quality of the asset.

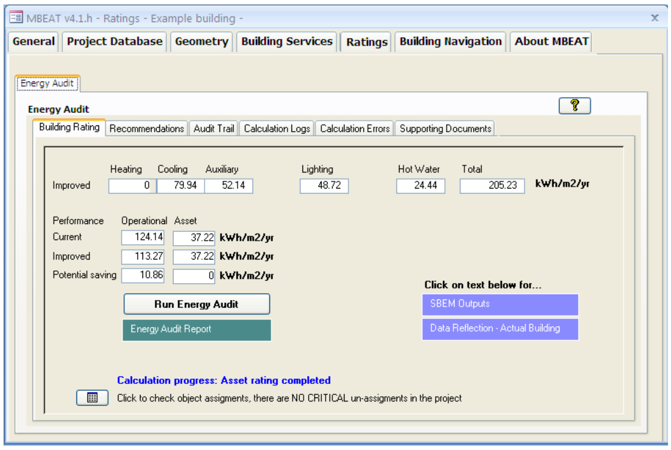

Figure 3: Screen shot of MBEAT ratings Tab

MBEAT suitability and adaptability

The calculation procedure implemented in MBEAT is suitable for use with the majority of buildings, but some designs will contain features that mean that more accurate energy calculations may be obtained by more sophisticated calculation methods.

All calculation processes involve some approximations and compromises, and iSBEM is no exception. The most obvious limitations relate to the use of the CEN monthly heat balance method. This means that processes which vary non-linearly at shorter time-steps have to be approximated or represented by monthly parameters. The HVAC system efficiencies are an example of this. On the other hand, iSBEM does have provision to account for processes that may not be present in software packages that contain more sophisticated fabric heat flow algorithms, such as duct leakage and infiltration allowances.

MBEAT was designed to be used within the construction types, practices, activities and climate of Mauritius with its scenario of a single serving strategy and fuel type.

In addition, the important Energy Management Issues need to be captured in order to populate the matrices. Alongside this each issue needs to be ranked and weighted to that a quantifiable Energy Management score can be produced.

Despite its limitations, MBEAT provided a fledgling methodology for linking the Asset and Operational performance of a building and thus bridging the gap between the two measures. The result was a more holistic view of building performance and a tool that allows possible savings to be quantified with more confidence and improvements to be prioritised.

The approach described will help to understand and improve the comparison between existing (asset and/or operational) approaches. Evidence from the initial use of the MBEAT tool in Mauritius, indicated that the underpinning methodology allows the asset and operational performance of a building to be compared for the purpose of highlighting where investment should be targeted.

Bridging the gap between operational and asset ratings – the UK experience and the green deal tool

The Green Deal assessment tool

The MBEAT tool had proved a valuable learning exercise but for this to be imported back into the UK following barriers need to be overcome:

a. How to capture the energy management scores within the iSBEM tool.

b. How to deal with multiple servicing strategies and several fuel types.

This has led to the Green Deal assessment tool abandoning the ideal of a single energy management score for the whole building but instead having management scores for each individual building object and integrating these within the tool. This provides granularity for the fabric and services, as well as taking into account different fuel types because the fuel type is assigned at this level. As a result the transposition is done at an object level and then re-aggregated to give the overall level of performance of the building. This has led to a tool with a more in-depth picture of energy usage within the building where asset and operational rating can be used to quantify and prioritise investment (see Figure 4).

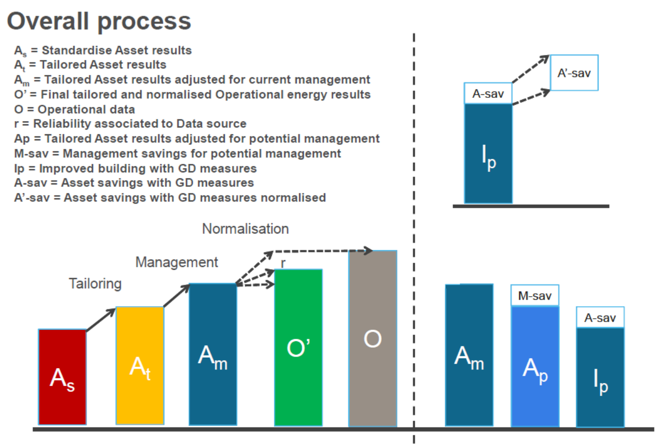

Figure 4: Green Deal Tool overall process

References

Department of Energy and Climate Change (DECC), Communication on DECC fossil fuel price assumptions, 2009, Available at: www.bis.gov.uk/files/file51365.pdf

Lewry A J., Literature review on the use of forecasted energy and water prices in construction projects. SCI-Network Report 4.2. London, SCI-Network, 2011, Available at: www.sci-network.eu/resources/reports.

Department of Trade and Industry (DTI), JESS: long-term security of energy supply, London, DTI, 2006.

Macalister T., Energy security questioned as National Grid cuts off gas to factories, The Guardian, 7 January 2010, Available at: www.guardian.co.uk.

Directive 2010/75/EU, Directive on industrial emissions, Brussels, European Parliament and Council of the European Union, 24 November 2010.

The Environmental Permitting (England and Wales) Regulations 2010. SI 675, London, TSO, 2010.

Lewry A J., Energy Management in the Built Environment – A review of best practice, BRE FB 44. Bracknell, IHS BRE Press, 2012.

Sibback I., Carbon Trust: innovation funding. Presentation given at 'Sustainable Renewable Energy Sources: an Environmental Challenge' meeting, 21 March 2005, Manchester Metropolitan University.

Johnson T., SBEM for non-domestic buildings: an introduction. BRE IP 7/10. Bracknell, IHS BRE Press, 2010.

Lewry A. J., Ortiz J., Nabil, A., Johnson A., Hussain S., and Davidson P., "Bridging the gap" - a tool for energy auditing that encompasses both asset and operational parameters, CIBSE ASHRAE Technical Symposium, Imperial College, London UK – 18th and 19th April 2012.

UK Government's Energy Efficiency Best Practice Programme, Energy management priorities - a self-assessment tool (GPG306), 2001.