ENERGY RATING OF NON-DOMESTIC BUILDINGS

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The BRE is developing an energy rating scheme for non-domestic buildings on behalf of the DoE, designed to encourage voluntary good practice and for possible future use within the Building Regulations. The scheme will allow building specifiers, occupiers and others to define and compare building performance in simple terms. The UK programme is in its early stages, and a key part of its technical development and implementation involves consultation with a wide range of potential users. This paper outlines the policy and commercial needs driving the programme. It then sets out the planned technical development, explaining the steps undertaken so far.

INTRODUCTION

There are many ways of helping a designer to assess the energy implications of various aspects of building design. Charts and graphs, hand calculations, spreadsheets and software packages of varying levels of sophistication are often used. There are also commercial energy audit services, advice schemes, published performance indices and other sources of information to guide and inform the building user. However, there are no schemes in the public domain which can be consistently applied from inception and early design through occupation to eventual refurbishment.

The BRE is currently developing a consistent methodology and calculation procedure to achieve this. The programme is being funded as part of the Department of Environment's (DoE) Energy-Related Environmental Issues (EnREI) research programme, with technical assistance from the Department of Trade and Industry (DTI) and the Ministry of Defence (MoD). The aim is to produce a rating scheme to encourage voluntary good practice and for possible future use within the Building Regulations.

In order to satisfy the different demands, a key part of technical development and implementation revolves around consultation with a wide range of potential users in the property development, construction and building services equipment manufacturing industries.

UK POLICY

The scheme will support the policy objectives of government, principally through initiatives from the Department of Environment (DoE) to encourage energy efficiency. All parts of the property industry, from clients to occupiers and building professionals would also potentially benefit from the scheme.

Within the DoE:

- The Construction Sponsorship Directorate (CSD) of DoE wishes to stimulate an integrated approach to energy efficient building design, including building services systems. The Construction Innovation and Research Management Division of CSD have the aim of facilitating the development of a common approach capable of supporting all policy objectives.

- The Building Regulations Division (BRD) of the Property and Buildings Directorate is interested in energy targeting as a possible future performance based means of demonstrating compliance with Part L of the Building Regulations. Such an approach would allow designers the freedom they desire to develop new building designs without being unduly prescriptive, but would encourage designs that adequately address energy efficiency and hence minimise CO_2 emissions.

- The Global Atmosphere Division (GAD) of DoE is interested in the partnership approach to reducing greenhouse gas emissions and fostering a 'best in class' philosophy, in particular through working with the private and public sector. A rating scheme is seen as an important element of this objective.

- The Energy and Environmental Management Division (EEMD) of DoE is interested in defining Good Practice and comparing buildings and designs, for which energy ratings are perceived as a useful tool. Their aim is to stimulate market demand for improved energy efficiency. They introduced an energy rating scheme for dwellings which was incorporated into the Building Regulations in 1995 and now wish to see a scheme developed for the non-domestic sector.

The Department of Trade and Industry are interested in the potential of the rating scheme to improve commercial efficiency and competitiveness and to stimulate the market for new energy efficient products and technologies.

The UK private sector has expressed the desire for a means of assessing the energy performance of non-domestic buildings at the early stages of briefing and design; for a simpler and more flexible approach to regulations; and for a means of defining, demonstrating and checking performance during a building's lifetime.

As part of a review of the BRE's Environmental Assessment Method (BREEAM), the use of new calculation methods within the energy component of the assessment are being considered. The rating scheme might be adopted to provide a common approach to energy performance assessment.

INTERNATIONAL APPROACHES

Many countries are now developing approaches for rating their non-domestic buildings. Four different approaches are outlined below.

USA (ASHRAE) "BUILDING ENERGY COST BUDGET METHOD"[1]
The ASHRAE building energy cost method requires the simulation of monthly energy consumption by heating, ventilation and air-conditioning (HVAC), lighting, hot water, small power and lifts. These are converted into energy costs and compared with an 'annual energy cost budget' for a similar reference or prototype building.

Nine categories of prototype building are defined, based on different activities;
assembly;
office;
retail;
warehouse;
school;
hotel/motel;
restaurant;
health institutional;
multi-family.
Each prototype is a notional building having the same floor area and number of floors as the proposed design. It is rectangular with preset dimensions, fenestration, etc. It also meets the various system/component criteria for fabric and services set out in ASHRAE Standard 90.1.

Alternatively, a reference building can be used as the basis for assessing unusual designs, including those which fall outside the categories listed above. The reference building is a particular building having the same form, orientation and basic systems as the proposed design, and which meets the Standard 90.1 criteria for fabric and services.

A design is deemed to have complied with the standard if its annual design energy cost is not greater than the annual energy cost budget for the prototype or reference building.

The Building Energy Cost Budget approach does not allow easy comparison of the performance of different buildings. This is a key requirement for the UK if we are to encourage market led voluntary use of the scheme. Differences in the way Regulations are applied and enforced in the UK could also make this approach difficult to marry into our Building Control system. Hence, although knowledge gained in the USA is valuable, a different approach is required in the UK.

DUTCH "ENERGY PERFORMANCE CODE FOR NON-RESIDENTIAL BUILDINGS"[2]
The Dutch approach is based on a calculated total annual primary energy consumption for space heating, fans and pumps, lighting, comfort cooling, humidification and water heating. Buildings are grouped into the following categories;
office;
health (clinical/non-clinical);
schools;

industrial;
railway stations;
restaurants;
shops;
assembly;
hotels;
prisons;
sports buildings;
non-habitable buildings.

Targets for each category are based on a dimensionless Energy Performance Coefficient. This is a function of the predicted annual primary energy consumption, the fractional area that is cooled, the ratio of heat loss to floor area, a ventilation constant and other factors. The purpose of the coefficient is to allow for different environmental requirements (eg for cooling and ventilation) and to encourage the use of natural daylighting and ventilation.

Simplicity, transparency and low cost are key requirements of a UK approach, both for Regulation and voluntary use. Hence, although there is much to be learnt from the Dutch experience, a simpler index is though desirable for the UK.

DANISH "ENERGY FRAME METHOD"[3]
Denmark is developing targets based on annual energy demand for space heating and ventilation in kWh/m^2. They have developed "energy frames" which are defined to be the maximum permitted energy demand for these uses. Monthly heating demand can be calculated by hand, or using a simple computer package. The energy frames for non-domestic buildings take into account heated floor area and number of storeys. An additional allowance is available where mechanical ventilation is provided and the air supply rate exceeds 2 air changes per hour.

Many European countries are developing approaches based on annual energy demand calculations. Some further examples of these are outlined below.

The Norwegians[3] are developing targets based on the overall energy requirement for space heating and ventilation.

A similar approach has been developed in France and Germany[4], which use thermal energy targets for the building envelope based on annual kWh/m^2. Different targets are set for different building types, related to the building surface to volume ratio.

UK "ENERGY PERFORMANCE INDEX METHOD"
The Energy Performance Index Method (EPIM) is an approach recently developed by BRE and UK industry for the assessment of mechanically ventilated and air conditioned buildings, for consideration as a means of demonstrating compliance with the aims of Part L of the Building Regulations. The EPIM derives an index from a simple formula based on installed refrigeration capacity and installed fan and pump capacity, weighted by multiplication factors which take into account provision for energy efficient control and management. The multiplication factors act to improve the score obtained and hence encourage energy efficient design options. Power ratings are defined in primary energy units ($kW_{primary}/m^2$) and exclude standby capacity and both plant capacity and floor area used for exempt 'process' purposes. Target compliance levels are proposed based on knowledge of the performance of the existing stock of buildings. At present, these have been proposed for shops, offices and hotels.

THE BRE PROGRAMME

The current BRE programme aims to deliver a practical method for rating non-domestic buildings over the next 2-3 years, with proposed standards of performance for different classes of buildings becoming available roughly in order of their contribution to CO_2 emissions.

The technical development involves three main elements:

- A calculation procedure (to assess relative performance).
- The definition of standards of performance (rated value or target).
- Building definition.

CALCULATION PROCEDURE
Technical development is being undertaken in consultation with senior representatives from the property and building services industries. In addition, a series of three national workshops have been held in March 1996 to obtain a wider industry view on the possible approaches and priorities for implementation. After reviewing national and international research into the development of targets and undertaking a preliminary industry consultation, it was decided to pursue two methodologies.

The first is an extended Energy Performance Index Method (EPIM). This approach is advantageous as it is simple, allows design flexibility and encourages early dialogue between the architect and building services engineer. The intention is that techniques already developed to address the energy used by air-conditioning and mechanical ventilation in buildings should be extended to include space heating and fixed lighting capacity and control.

The second approach is to develop an annual energy calculation linked to explicit energy targets (say in kWh/m^2). This would also give the advantage of design flexibility and encourage early dialogue between design professionals. However, a number of issues arise from this approach relating to the calculation method used. In particular, assumptions and values of input parameters, either implicit within the methodology, or explicitly made by the designer, must be consistently applied from building to building if the ratings are to be used to compare buildings. In addition, the definition of the target, and its relationship to the calculation method used, requires considerable data and careful consideration. For example, calculation methods typically take one of three approaches; steady state, semi-empirical or dynamic simulation. These approaches have increasing complexity, may focus on one particular aspect of design, and require differing quantities of input data. All techniques have an implied level of accuracy and different levels of acceptance and familiarity amongst designers. Particular models tend to address some aspects of energy use more comprehensively than others and consequently the choice of model can affect the result obtained. If may therefore be inappropriate to compare results obtained from different models. Furthermore, this approach will not necessarily provide a mechanism for dealing with novel designs and systems because of the limitations of the software or calculation used.

The basis for a UK rating system will be selected following consultation with industry.

DEFINING STANDARDS OF PERFORMANCE

Methods for defining performance in use are reasonably well established for some key building types. Performance yardsticks and Energy Consumption Guides are produced as part of the DoE's Best Practice Programme, using data on the energy performance of the existing building stock and examining good design and management practices.

The new rating scheme will take into account the range of achieved performance found within new and existing buildings. This information will be used as the basis for defining levels of performance, although the definition of any performance standards must also be linked to the calculation method used, as discussed above.

BUILDING DEFINITION

A method of distinguishing between different types of non-domestic building is essential for two main reasons. Firstly, to determine what are reasonable and good practice levels of energy performance. Secondly, so that the user can calculate the appropriate rating for his or her building, using any assumptions appropriate to that building type and function. The method of definition (and the energy rating scheme) must be able to accommodate;

- a user wishing to calculate a rating for a new design, for instance as part of a planning application;
- a user wishing to calculate a rating for an existing building;
- buildings which may themselves be;
    - one physically isolated structure (one building);
    - one element of a multi-purpose building;
    - a site containing several buildings, (for example, a school);
- premises which, over a number of years, may be used for any number of widely diverse business activities.

A key point is that the methodology must be consistent and must take account of any inherent differences.

A practical approach to this problem may be to categorise on the basis of different ranges of typical design temperatures, illuminance levels, ventilation rates, and occupancy hours and to link these ranges to the different activities and business uses found. The calculation procedure and targets could then be devised to accommodate any assumptions and modifications necessary given, for example, the required internal environment, reasonable gains and typical operating hours for a given activity. This would ensure consistency within the methodology. A user would then identify which ranges the building falls within by virtue of the business activity being undertaken. An alternative set could be selected, where a user feels that the internal environment allocated does not reflect a particular or peculiar energy use.

CONCLUSION

Many countries have recognised the need for flexibility within their regulations, as novel systems and designs are proposed and greater demands are made on buildings to be adaptable for different uses. It is also clear that people want a simple way of recognising building performance. Internationally, several different systems have been developed, stimulated by governments' aims to set minimum standards.

In the UK we are developing a scheme to suit our Regulatory and commercial practices. The flexibility we intend the scheme to include may be of interest to other countries. However, we still need to address a number of uncertainties, notably;

- plant performance data collection
  There are considerable physical, commercial and financial constraints associated with developing and maintaining a national database of building performance data of the extent that will be necessary to aid the development of standards.

- versatility of calculation procedures
  Due to the diverse range of applications required in the UK, considerable effort will be needed to arrive at a calculation procedure which is sufficiently flexible but also robust. In particular, for the purposes of Regulation, the calculation procedure will need to provide a means of excluding exempt floor area, energy demand, and plant capacity in a simple way.

ACKNOWLEDGEMENT

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