

GREEN BUILDING CHALLENGE '98

Raymond J Cole¹ and Nils Larsson²

¹School of Architecture, University of BC, Canada

²CANMET Energy Technology Centre, Ottawa, Canada

ABSTRACT

This paper gives an overview of *Green Building Challenge '98*, an international building performance assessment project. It argues that the assessment framework developed for *GBC '98* will have a strategic value as a second generation performance assessment system for a wide variety of applications, including the specification of building performance and as a tool for green labeling systems.

1. INTRODUCTION

The *Green Building Challenge '98* (GBC '98) project consists of a two-year process of international building performance assessments and a major international conference to be held in Vancouver, Canada in October 1998. The project has been initiated by Canada, but is being carried out in partnership with representatives from more than ten participating countries. The overall goal of *GBC '98* is to inform the international community of scientists, designers and builders about advances in green building performance. Specific objectives include:

- To develop a generally acceptable definition of 'green building';
- To show that it is possible to develop common environmental goals and assessment protocols while respecting regional and technical diversity;
- To offer direction to participating countries in the development of regionally-specific assessment models;
- To identify process-related factors behind the success of individual projects;
- To establish internationally comparable benchmarks for building performance;
- To promote an international exchange of information and ideas;
- To provide an opportunity for the promotion of green building technologies.

The process involves the development of a framework designed to assess the energy and environmental performance of buildings that builds on the experience developed in first-generation systems developed in the UK, Canada and elsewhere. The system is being developed with a core component reflecting universal issues complemented by overlays reflecting energy, environmental and other priorities in specific countries and regions. National teams will develop these overlays and will also develop reference building criteria against which specific candidate buildings can be compared in a meaningful way. The process is non-competitive and the results of the process are likely to focus as much on the strengths and weaknesses of the framework itself as on the performance of the buildings that are assessed.

2. EXISTING ASSESSMENT METHODS

The past five years have seen a significant increase in interest and research activity in the development of building environmental assessment methods:

BRE Environmental Assessment Method (BREEAM): BREEAM [1] was initiated in 1990 and is the most widely known assessment method. It is jointly operated by the Building Research Establishment (UK) and a private firm, ECD Ltd. The system is designed as a green labeling system and building owners who use it, are free to use the resulting certificates for marketing purposes. Sub-variants of the system have been developed for new and existing office buildings, superstores, schools and other building types. BREEAM is widely promoted and take-up of the program is greatest for office buildings -- estimated at between 15% and 20% of all new UK office building construction.

The Building Environmental Performance Assessment Criteria: BEPAC [2] was developed in British Columbia, Canada in 1993, and provides a more detailed and comprehensive assessment than BREEAM, although it is limited to office buildings. Work has been done in Ontario and Nova Scotia to develop variants suitable for those regions. However, the *BEPAC Foundation* has oriented its efforts towards carrying out a small number of in-depth trial assessments rather than attempting to establish a widely used green labeling system. The main value of the system is therefore for in-depth assessments and in the lessons it offers for the development of new systems.

Leadership in Energy and Environmental Design (LEED): The US Green Building Council (USGBC) launched LEED [3] in 1996 -- a system designed specifically for use as a green labeling system for rating the performance of commercial office buildings. LEED is simply structured and has 10 prerequisites and 13 design criteria areas, ranging from building materials to water quality, that are assigned credits. There are four levels of achievement, Bronze, Silver, Gold and Platinum, depending upon the number of total points received out of those possible. The system combines performance and prescriptive measures, using established standards established by other credible bodies.

2.1 The Need for a Second-Generation Assessment System

Although the field of performance assessment is in its infancy, there is intense interest around the world in developing a system that combines robustness, sophistication and an ability to reflect regional or national values. Given suitable modifications, such a system potentially has three basic applications:

1. A detailed and comprehensive assessment of building performance, primarily to determine renovation needs, or to specify required levels of performance;
2. A design guideline tool, although the system must be elaborated for such use.
3. A simplified performance assessment system for the purpose of awarding green "labels."

It is anticipated that the last of these opportunities, either to encourage market demand for high performance by potential tenants, or to determine the eligibility of owners for favourable tax treatment, will have the most widespread appeal. Most small and mid-size commercial tenants have little current knowledge or involvement in building performance, but the potential take-up of such a system is huge, given the strong effect of indoor environmental conditions on the health and productivity of employees, and the economic penalties imposed by space that is inefficient, inflexible or poor in energy performance. The application of such a system also has considerable potential benefits for governments since, although the performance rating process itself is complex, the resulting certification offers a simple and non-controversial way for governments to determine eligibility for tax or other benefits, while assuring a steady flow of data on performance of the building stock.

A performance labeling system that is to be widely used requires the establishment of an organization to manage the process of data collection, training, assessments and data analysis. There is also a need for extensive marketing of the system, which necessitates the active participation of one or more major private sector partners. These are modest barriers compared to the immense potential benefits.

2.2 The Potential Role of GBC '98

The concept of a generalized framework for building performance assessment presupposes that there is agreement on what constitutes "performance", and that a common set of features for building performance assessment procedures can be defined that are applicable to all buildings in all regions. While different research agencies will, and indeed should, continue to explore creative approaches to building performance assessment, it would seem timely to propose some generalizable characteristics or features.

GBC '98 accepts the premise that there are a common set of underlying characteristics relevant to the structure of all assessment methods. When made explicit, these can provide a clear starting point for developing customized methods for specific building types, geographic regions and specific intentions. There is an emerging trend in the development of environmental *design* tools which facilitate the linkage between specialized software. In a similar way, it would seem desirable to have a building performance assessment framework which can accommodate a variety of building assessment tools and be configured to meet a variety of different output requirements. Simply stated, the next generation of environmental assessment methods must be set within a broader context of decision making as distinct from their current independent status.

Although the BREEAM, BEPAC and LEED systems are aimed at fulfilling the need for performance assessment systems, there are three major issues which may limit their widespread application:

1. Conceptually they are not structured to handle different levels of assessment, e.g., it is difficult to simplify BEPAC or expand on BREEAM and LEED for more in-depth assessments;
2. They were not explicitly designed to handle regional-specific issues. Although many countries are using BREEAM as a reference document, few are adopting it whole. This, in part, reflects the fact that the system was not originally designed to accommodate national or regional variations;

3. Though they are used as design tools, they were not specifically designed to do so.

These difficulties relate to the basic structure of these programs. A framework intended to handle regionally-specific issues must be designed from the outset to handle a wide range of parameters. A tool designed to provide guidance on design requires the development of considerably more detailed information than one intended for simple, or even detailed, assessments. The "first-generation" frameworks are not capable of addressing these multiple functions, even though they are closely related.

There is an obvious advantage if a tool can be developed that will, with various adjustments, handle the related functions of simple assessments, detailed assessments and design guideline formulation. A basic requirement for such a capability is that the information handled at one level of detail must be consistent, in terminology and approach, with information handled at another level of abstraction. Thus, a series of variables providing design guidance on energy-efficiency in mechanical ventilation systems should be compatible with the range of variables covered in the detailed assessment of the performance of such a system and this, in turn, should be upwardly compatible with a broad-brush assessment of the same system. The *GBC '98* framework is explicitly intended to allow for regional variation and will, in fact, be difficult to use without such elaboration. The framework is also designed to be read at various levels of detail, so it can be used for simple or detailed assessments and, with further development, as a design guideline tool. There is therefore a significant opportunity to position the *GBC '98* framework as a suitable *second generation* system for a broad range of applications.

2.3 Building Performance

Although the term building performance is simple, its specific definition is more complex. It is well understood that different actors involved with buildings have different interests: investors tend to focus on economic performance, occupants may be concerned with air quality, and maintenance staff worry about maintainability.

Another aspect of building performance that is of special relevance to the development of *GBC '98* is the difference between *potential* performance and *actual* performance. Many would argue that the actual performance of the building in use is the only thing that matters, since this is what affects the environment. On the surface this is a strong argument, but other considerations have led us to focus most of our efforts on assessing potential performance. Beyond external factors such as specific weather conditions during a specific time period, actual performance is dependent on the real behaviour of occupants, tenants and building operators, and this bring into play many idiosyncratic factors that are not generally applicable. On the other hand, the assessment of potential performance is based on assuming normal or default patterns of occupant behaviour and building operation. Although this is less "real" it produces vastly more useful information to guide the future actions of developers, owners, designers and anyone else who is involved with the production of buildings. A strong focus on actual performance can be useful if the intent is to influence the behaviour of tenants or occupants, but this is too complex and broad an issue to enter into for *GBC '98*.

The focus on potential performance does not mean that occupied buildings are excluded from assessments, but it does require that performance parameters are tied to information generated at the design stage, including specified systems and materials and default assumptions for modes of operation and occupancy. Certain process issues are also seen as relevant because their application increases the possibility of actually achieving potential performance: examples include a multi-disciplinary design process, energy simulations and systems commissioning.

3. THE STRUCTURE OF THE GBC '98 FRAMEWORK

The structure of the assessment protocol for *GBC '98* is premised on the notion that it is essential to have a clear, explicit framework for the range of performance criteria covered in a building assessment and that:

1. A performance assessment is only a means to an end, it is the ability to make informed decisions based on the outcome of the assessment that is most critical;
2. The framework must have the ability to show a variety of performance characteristics both individually or and combination, i.e., it must communicate many 'stories' about building performance and recognize that there will be many different audiences and users of the assessment results;
3. The structure of the framework must also respond to several practical considerations including data collection, application of weighting factors etc.

The *GBC '98* framework is structured hierarchically, with the higher levels derived from the weighted aggregation of the lower ones. The three levels are: *Performance Categories*; *Performance Criteria* and *Performance Sub-Criteria*. A parallel data set at this level provides a series of design criteria and strategies which can form the basis of pick-lists used to evaluate the performance of sub-criteria on the one hand and provide a link between *design* and *assessment* protocols on the other.

3.1 Performance Categories

The *Performance Categories* of the assessment framework are defined as the principal performance characteristics of the building which collectively define its overall performance. The *Performance Categories* form the basis of communicating and comparing the results. As much as is practically possible, these performance categories have the following characteristics:

1. Each is independent of the others, thereby minimizing the possibilities of double-counting in the assessment;
2. Each is sufficiently descriptive so as to be readily understandable by those referring to the assessment output;
3. Each is meaningful in its application to all building types in all regions;
4. Each is sufficiently robust to account for current and anticipated developments;
5. Collectively, they provide a comprehensive description of building performance.

Because of the emphasis on energy and environmental performance of *GBC '98*, performance categories are divided into two distinct types:

1. 'Green' Performance Categories: those explicitly related to resource use and environmental loadings associated with building construction and operation, e.g., energy use, land use, materials use, airborne emissions, liquid effluent etc.;
2. 'Basic' Performance Categories: the more generally accepted performance issues which must be successfully accommodated if a building is to be acceptable to building owners and users, e.g., functionality, maintainability, economic performance etc.

Further, to minimize the added complexity of accounting for operational differences of multiple tenancies, *GBC '98* will assess building performance of both building designs and built projects assuming a standard set operational procedures and occupancy patterns. However, in recognition that this 'potential' performance is more likely to be realized if procedures such as commissioning are undertaken, a set of process issues are also acknowledged within the framework.

3.2 Performance Criteria

Performance Criteria are the specific characteristics of the building which will be assessed explicitly, and represent the basic building block of the overall *GBC '98* assessment framework. The framework will include a core set of *Performance Criteria* applicable to a specific building type. Two regionally specific modifications will be included:

1. The assessment scale of each of these core *Performance Criteria* will be customized by the National Teams to make them appropriate to the specific region of the case-study building;
2. National Teams may add *Performance Criteria* that are specific to the region.

3.3 Performance Sub-Criteria

The majority of the *Performance Criteria* and the indicators for assessing them will be derived through the aggregation of several *Performance Sub-criteria*. For example, annual operating energy will be derived through the summation of annual heating, cooling, lighting energy etc. The performance of these sub-criteria will not be assessed separately relative to a reference condition but will remain accessible within the output as a means of explaining the final performance of the respective *Performance Criteria*. For *Performance Criteria* dependent on several *Sub-criteria* with different performance indicators, each of the *Sub-criteria* will be evaluated separately and their scores then weighted to derive the *Performance Criteria* score.

3.4 Performance Indicators

Performance Indicators are the specific units of measurement that will be used to describe the performance of each *Performance Criteria*. Two distinct types of *Performance Indicators* are used:

1. *Quantitative Measures*: Many performance criteria can be measured in quantitative terms - energy use, water use, greenhouse gas emissions etc., and can be derived through the simple aggregation of sub-criteria having similar units.
2. *Non-Quantitative Measures*: For those performance criteria which are not quantitative or which can only be adequately described by combining several quite different constituent sub-criteria, a *pick-list* approach is used.

4. SCALE OF MEASUREMENT

Building performance assessments include both hard data (e.g., kWh/m²) and soft data (e.g. estimated durability of a component), and this leads to a difficulty in the necessary merging of the two types of data. The *GBC '98* framework attempts to address this by using a scalar rating approach. Specifically, assessments of performance for each performance criterion will be made relative to an explicit scale of measurement. This scale forms the basis for allocating *performance points* for each of the individual performance indicators and the performance in each major category following the weighted aggregation of their constituent performance indicators. In all cases, the better the performance, the more points are awarded. Where appropriate and possible, assessments are made by comparing the performance characteristics for each *Performance Criterion* of the case-study building relative to the equivalent performance of a reference case. A *Reference Case* is usually a hypothetical building of the same type, size, location and use pattern as the case-study building but designed to meet typical or minimal legal standards, but may also include reference procedures such as local industry norms for C&D waste handling.

4.1 Measurement Scale

The primary measurement scale for *GBC '98* is 0 to 5, where 0 represents the performance of the reference and 5 represents the best or ideal performance. The *Reference Case* represents current standard practice in 1996 for the particular building and region, i.e.,

- Building practices which fully conform with those conditions currently required by ordinance, code or other applicable laws;
- For those criteria not required by regulation, the base condition would be taken as typical practice;
- For those criteria involving the assessment of consumption (e.g., energy, water etc.) a datum building would be defined as a building of the same size, number of storeys and schedule of operation as the case-study building but which meets minimum performance characteristics and typical practice.

Although most environmental design strategies in *GBC '98* projects will represent advances over typical practice, the physical limitations on renovation projects may prevent them from meeting required levels of environmental performance in all categories. As such, a contingency for 'negative' performance scores is provided within the assessment framework for such situations.

Best Condition: The specification of a target performance based on reasonable extrapolation from current practices and the significance of the performance issue.

4.2 Intent of Performance Scale

Since the general framework is to be applicable across a wide range of regions and building types, each having differing building practices, materials palettes and expectations, it is impossible to offer a precise universally applicable metric. The key point is that the criteria used to evaluate a *Performance Criterion* in different situations should have a common *intent*. As such, the following approach is adopted in *GBC '98*:

- For each *Performance Criterion* the general framework will identify the *intent* of the requirements to meet performance scores of 1, 3 and 5 respectively along with the required *Performance Indicators*;
- These general intentions will be customized by authorities within the respective regions in terms of specific strategies, targets and appropriate language for the building type and region.

4.3 Assessment of Basic Performance Criteria

Unlike the 'Green' criteria where the primary objective is to measure advances in these areas, the 'Basic' performance criteria can be handled in a simpler fashion. Within the context of *GBC '98*, it is only necessary to assess if a case study building has achieved an acceptable level of performance. As such these performance sub-criteria and criteria will simply be evaluated on a pass-fail basis against a declared reference level, with an acceptance of a limited number of failures in non-critical performance sub-criteria.

5. WEIGHTING OF SUB-CRITERIA AND CRITERIA

Weighting remains a controversial aspect of building performance assessment but is an essential requirement to distill a wide range of *Performance Criteria* scores into a manageable number. Two levels of weighting are incorporated in the *GBC '98* framework:

1. Deriving a *Performance Criteria* score from several constituent *Sub-Criteria*;
2. Deriving a *Performance Category* score from the constituent *Performance Criteria* scores.

5.1 Weighting of Sub-Criteria to derive Criteria

Performance Criteria will be the aggregate of several *Sub-Criteria*. Each *Sub-Criteria* will implicitly carry an equal weighting. In the case of quantitative performance data where the sub-criteria have the same units as *the Performance Criteria*, the equal weighting is clear. However, for criteria based on a range of qualitative sub-criteria selected from a pick-list, or a mixture of quantitative and qualitative sub-criteria such an assumption is clearly more problematic, and it may be necessary to explicitly declare a weighting of the respective sub-criteria.

5.2 Weighting of Performance Criteria

Weightings must be explicitly applied to each *Performance Criterion* to derive a performance score for their respective *Categories*. In all cases, the value of weightings will be *judgmental* and assigned by the National Teams and/or accepted experts who are familiar with the environmental issues in the region. It is proposed that the general performance assessment framework deal with the assignment of weightings in the following manner:

- For each *Performance Criterion*, a set of common considerations that should be accounted for in the derivation of appropriate weightings will be provided in a similar way as the designation of the intentions for the performance scores of the sub-criteria;
- National teams will use the guidelines to generate weightings appropriate to the regional context of the building.

Given the considerable political sensitivities and technical difficulties associated with the prioritizing of environmental and other performance issues, is expected that this will prove to be a difficult exercise. Notwithstanding, the mere declaration of the resulting weightings, their applicability, the confidence of their generation etc., for various regions will provide considerable insight into potential directions for this aspect of performance assessment.

6. ASSESSMENT

A building performance assessment within GBC '98 involves an evaluation of 'Basic,' 'Green' and 'Process' performance criteria (see *Figure 1*):

1. An assessment will first be made of the 'Basic' performance sub-criteria/criteria on a pass/fail basis and aggregated to determine if the building has achieved an acceptable level of performance in the *Basic Performance Categories*;
2. An assessment will then be made of the 'Green' performance sub-criteria/criteria using a -2 to +5 point scale and weighted to determine *Green Performance Categories* scores;
3. An assessment will be made of the 'Process' performance criteria using a simple evaluation of whether certain protocols have been specified or not and, if so, credits may be given to the *Green Performance Category* scores.

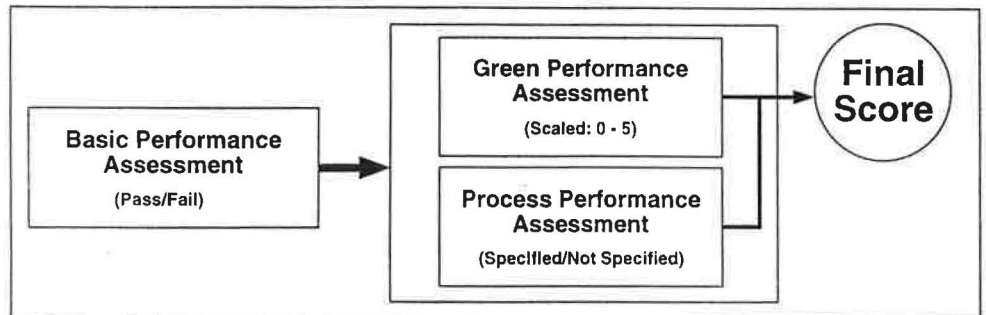


Figure 1: Three Main Components of an Assessment

6.1 Graphic Output

Figure 2 shows the proposed format of the output of an assessment of the 'Green' performance categories. The performance categories form the principal dimensions of the output graphic with the scale of -2 to +5 defining the centre and outer circle respectively. The inner zero circle represents the performance of the reference building across all categories. The 'Basic' performance categories and 'Process' performance may also be handled graphically which, in combination with the Green performance would provide a comprehensive profile of building performance.

Experience from the implementation of existing environmental assessment methods clearly suggests that the explanation of the performance assessment and 'debriefing' to the building owner is probably the most important part of the whole exercise. This means the assessment procedure is directly linked to the *assessor* as the instrument in the final communication of the performance results and the 'story' told about the building performance must be an important part of the assessment process.

7. CONCLUSION

This paper has provided an overview of the intentions of *Green Building Challenge '98*, and the assessment framework which is being developed to evaluate the projects selected for presentation. There is clearly an inherent contradiction of assessing state-of-the-art building using an assessment tool which itself is still under development. This is an inevitable and appropriate circumstance at this point in time. Indeed, the process recognizes that *GBC '98* represents a *starting* point for dialogue and exchange not only among researchers or among designs but *between* the research community and the design community. Moreover, it assumes that as much improvement will inevitably be needed in the framework as in the buildings that were assessed by it, and that the assessment framework will continue to evolve over time.

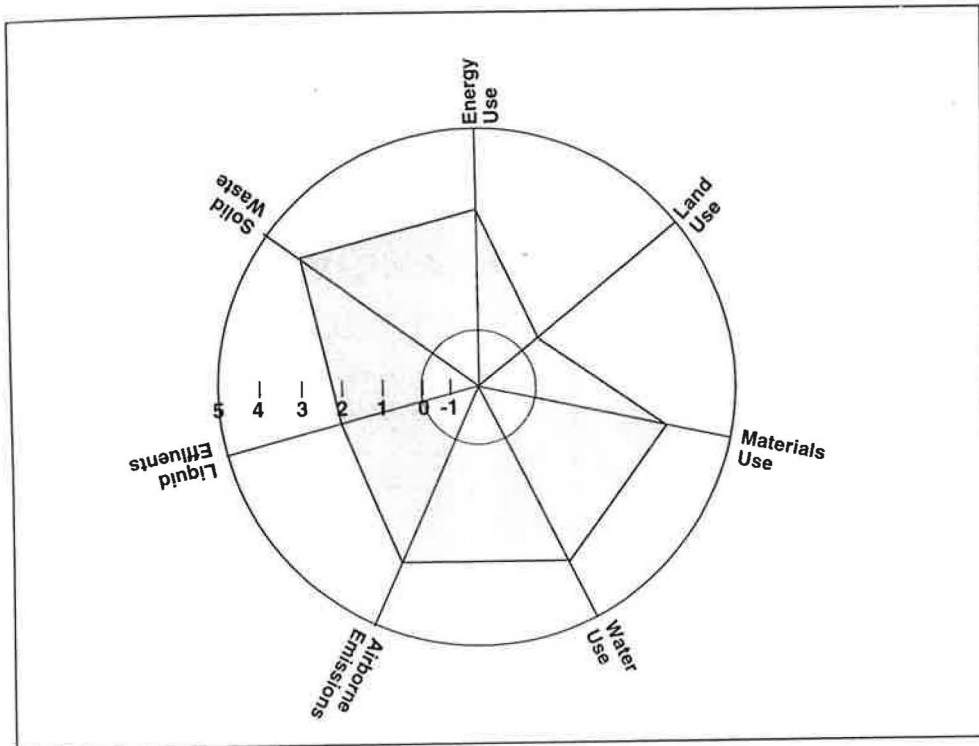


Figure 2: Performance Profile of a Case Study Building

8. REFERENCES

1. Prior, J. (Ed) (1993) *Building Research Establishment Environmental Assessment Method, (BREEAM) Version 1/93 New Offices*, Building Research Establishment Report, Second Edition.
2. Cole, R.J., Rousseau, D., and Theaker, I.T. (1993) *Building Environmental Performance Assessment Criteria: Version 1 - Office Buildings*, The BEPAC Foundation, Vancouver, December 1993
3. US Green Building Council, (1996) *LEED (Buildings: Leadership in Energy and Environmental Design), Environmental Building rating System Criteria*