THE VERIFICATION OF HIGH PERFORMANCE BUILDINGS IN NORTH AMERICA

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Summary

This paper explores issues surrounding the achievement of high building performance in North America, and suggests a model for designing a green building validation protocol that will promote high performance, and will reflect the actual performance of the building.

In a market driven economy such as North America, the building industry continues to resist mandatory measures, contending that they are costly. As a result, sustainability policies still consist largely of voluntary measures, and labeling protocols are still used primarily for the purpose of marketing.

Since design teams naturally seek the highest possible rating for their designs, it is not surprising that energy performance estimations are based on ideal assumptions and best-case scenarios. Yet with growing evidence that actual performance is typically far lower than predicted, green building rating systems may in fact be contributing to what scientist and building performance consultant, Bill Bordass, calls a “credibility gap” between what the design team promises and what is delivered.

The question is: Do labels reflect the true performance of a building? If not, how can the validation process be set up to reflect the performance attached to a green label?

Keywords: High performance buildings, building performance validation, certification and rating, North America

1 Characteristics of the green building industry in North America

The following issues characterize today’s green building market in North America:

Consumers want green but it is not clear whether they are willing to pay. The development industry in North America is increasingly attuned to environmental issues. But while it recognizes that consumers care greatly about the environment, it contends that they are not yet prepared to pay for the additional features needed to make a building environmentally friendly. Meanwhile, it appears that consumers expect governments to provide all the solutions, through regulation, or at least through incentives. In either case, whether environmental performance results from developers’ initiatives or through additional government regulation, there is a perception that there are increased capital costs associated with high performance green buildings. For this reason, the development industry is reluctant to accept mandatory measures, but prefers to have the freedom to decide how much greening is “enough” to achieve their marketing objectives

Developers want to market green projects. There is no question that developers can and do use their sustainability position for marketing. As long as green is not the norm, and as long as it is not legislated, any voluntary measures they take will make them stand out in the marketplace. Given today’s attitudes, a green building is seen as something providing added value. This “carrot” dynamic is currently the greatest motivator for the private sector to spend resources on greening.

Once green becomes the norm, the pressure will be on buildings that are NOT green to meet the new norm. It is likely that as more and more buildings adopt environmental best practices, developers who avoid doing so will stand out in a negative fashion and will feel pressure to change their ways. There will therefore no doubt come a time, when such buildings will not only be viewed unfavourably as toxic or energy hogs, but when environmental measures will be legislated. This can be described as the “stick”. However, in order for green to become the norm, it is desirable to fuel the process by first using the carrot approach.

Raising the bar within the marketplace through voluntary programs will validate government efforts to make environmental measures mandatory. There is little doubt that a time will come when green building will become not only the norm but a legislated requirement. Ideally, greening legislation ought to occur with some degree of general support from the industry. The way for this to occur is to first encourage industry to demonstrate green leadership within its ranks. As these measures, done voluntarily, gain positive feedback in the media and kudos within the marketplace, governments can then raise the bar for all buildings by introducing increasingly stringent legislation. To impose stringent green requirements all at once, without first allowing a period for the industry itself to demonstrate what is possible, will raise objections from the industry. In other words, making green the norm is best achieved as a result of leadership within the industry, working in close collaboration with government.

Validation must be appropriate to the product or service that is being validated. At present, green labeling is done for primarily for marketing purposes. In time, certification or labeling will will also help intuitional investors and municipal authorities to ascertain whether the buildings are truly performing as claimed. To be credible, a certification needs to be verified or validated by an independent, credible, third party. A key element of any certification process therefore is verification or validation. In the case of a voluntary green building program, the validation process must not be so onerous and expensive as to discourage participation. At the same time, for the certification award to be credible, the validation must be credible and transparent.

2 Validation Success Factors

Given the above considerations regarding the greening of buildings, the following are some of the factors which should be considered when designing a validation protocol.

2.1 Marketing – or the power of “buzz”

Developers want to be recognized for being good corporate citizens. A recognizable label provides that market recognition for doing what is good for the environment. For example, the success of LEED has resulted from the fact that it is now a recognizable label.

Private and public institutions have long known that if there is enough “buzz” and market recognition, this can provide credibility with respect to a product or service – irrespective of whether its true quality has been proved. However, when it comes to assuring the credibility of a labelling system, marketing the labelling system alone will not suffice. A robust validation process is essential to the credibility.

2.2 To “certify” or to “label”? – Choosing the appropriate approach

Product **certification** is the process of verifying that a certain product has passed performance and/or quality assurance tests or qualification requirements stipulated in regulations such as a building code and nationally accredited test standards, or that it complies with a set of regulations governing quality and/or minimum performance requirements. As such, the verification protocol should be extremely thorough. For example, products that are certified are typically examined using laboratory testing.

Labelling on the other hand simply informs the consumers about the content or performance of a product, without under-writing the product with an iron-clad guarantee that it meets the performance stated. For example, a label such as Energy Star informs consumers of the comparison of the energy performance of one building with another.

While there is great deal of similarity between “labeling” and “certification”, it is important to understand that labeling may not require as thorough an examination as a certification program. For a labeling program to be credible, the claims of the product may be validated by a third party through an auditing process, which establishes the likelihood that the claims are true. This is not the same as testing the product.

2.3 Liability

The difference between certification and labeling has implications with respect to liability. A certification program carries with it more risk of liability, for example, the risk that a product may not meet the performance standards as claimed in the certification, or the risk that the validation procedure be interpreted as professional advice – with all the legal implications this brings.

2.4 Cost

The cost of validation is related to the complexity of the process. If the process is too complicated, then the cost is high. A certification program can be more expensive to operate due to the additional costs to test performance. However, even a validation procedure can be costly depending on the process used. It is also noteworthy that costs may be kept artificially high by a monopolistic situation of an organization or system.

2.5 Capacity of the verifiers

Capacity is also related to the process. If the process is too complicated and the knowledge bar too high, there are very few individuals who can meet and implement it. This has been the problem of number of energy and environmental initiatives in the past.

2.6 Practical process

For a validation program to be practical, it must bring value within an acceptable period of time, cost and effort. A well designed process should:

- Follow logically from the core policies in one or two steps
- Be memorably summed up in one or two sentences
- Be flexible enough to handle unusual and special circumstances
- Be transparent enough not to create unnecessary strain
- Show good common sense in general
- Be intuitive so that a new participant could pick up on the process by seeing the process in action without ever reading the process protocol itself

3 Validation procedures for LEED and Green Globes

There are two main green building assessment programs in North America: LEED and Green Globes. The performance criteria are very similar in both. However, the format and validation procedures differ significantly.

3.1 LEED

To earn a given LEED rating, the applicant project must satisfy all of the prerequisites and a minimum number of points.

Although the process of putting together the LEED submission takes place throughout the design and construction phase of the project, the assessment is initiated upon having completed the project’s construction. Although the building is, at this stage, already “existing”, the project is evaluated for its design. Hence the team can not be really certain whether it will achieve the level aimed for. The certification review process requires that two copies of all of the following project application materials be submitted in the form of a binder:

- LEED registration information, including project contact, project type, project size, number of occupants, date of construction completion, etc.;
- LEED letter template both in hard copy and on a CD;
- An overall project narrative including at least three project highlights; illustrative drawings and photos of the project
- Submittals for each prerequisite and credit, separated by tabs. The submittals consist of a form for each credit signed by the licensed architect or engineer. In addition to the submittal templates for each credit there must be supporting documents such as detailed engineering studies, material sheets, etc
- The LEED Project Checklist/Scorecard indicating projected prerequisites and credits and the total score for the project

This documentation is then sent to the selected verification firm. The verification firm may seek clarification of certain submission items. There is also a verification decision appeal process.

3.2 Green Globes

To receive a final rating of one, two, three or four globes, the data submitted online must be verified by a GBI-approved and Green Globes-trained Validator, who may be a licensed engineer or architect or person with significant experience in building sciences and sustainability.

The first step in the assessment process is a self-assessment at the Concept Design Stage. It is done by completing the online Green Globes assessment questionnaire for the Concept Design Stage. Once the questionnaire is completed, an automated report is generated that lists the project’s achievements and scores. This provides the team with feedback on how they are doing in meeting the best green design practices, and what score they are likely to achieve in the final rating.

Users can start the second validation step immediately following completion of the construction documents, at which time the design team fills the Construction Stage questionnaire and then sends it - along with the working drawings and specifications – to the Validator.

Other supporting documents may include supplementary studies, such as energy modelling that have been done during the course of the project. The Validator reviews the documents and confirms that the report accurately reflects what has been achieved the project. If the Validator finds that incorrect claims were made in the report or that a positive practice was not recorded, he or she modifies the input, justifying why they have made the change.

Unlike LEED, there is no need to create special additional submittal documents, other than those which are needed to complete the project. A quality assurance protocol helps to ensure that Validators conduct their assessments properly and consistently. It consists of checking a sample number of building validations. Results should be repeatable. Following completion of the assessment, a certificate is issued for the project design.

The final validation, which allows the developer, owner and design team, to promote the building as having earned one, two, three, four or five globes happens after a site inspection by the Validator, following construction of the building. This typically occurs at the Occupancy permit stage.

One year after the completion, building owners are encouraged to certify their building under the Existing Buildings program run by BOMA Canada. The objective is to avoid performance slippage and set the building on a process of continuous improvement.

4 Measuring “true” performance

The credibility – and therefore the usefulness of a validation procedure – will depend largely on whether the criterion is verifiable and whether the system is measuring the “right” things. Numerous studies demonstrate that a new, so called high-performance or “green” building, once it is up and running, may not always fulfil the energy and environmental performance as promised on paper at the design stage. This is referred to as “performance slippage”.

Since design teams naturally seek the highest possible rating for their designs, it is not surprising that energy performance estimations are based on ideal assumptions and best-case scenarios. Yet with growing evidence that actual performance is typically far lower than predicted, green building rating systems may in fact be contributing to what scientist and building performance consultant, Bill Bordass, calls a “credibility gap” between what the design team promises and what is delivered.

In addition to overly optimistic predictions, this can also be the result of lower than expected budgets, less-than-rigorous adherence to specifications, insufficient commissioning and factors which occur long after the building design has been rated, such as changes in occupancy or poor building operations, which were not taken into account during assessment.

While a validation system can not guarantee continual high performance, nevertheless, it is more likely to accurately reflect the performance if it evaluates the right thing at the right time. For example, validating the **intended** energy performance can be done by reviewing the results of energy modelling at the design stage; whereas validating the **actual** energy performance can be done by reviewing energy bills once the building has been in operation.

For this reason, a true measure of a building’s performance is best done **after** the building is up and running.

5 Design Performance vs. Operational Performance

Studies by Dr. Bordass indicate that the performance of many designs falls significantly short in the operational stage. The figure below shows the data from an environmental award-winning office in the United Kingdom.

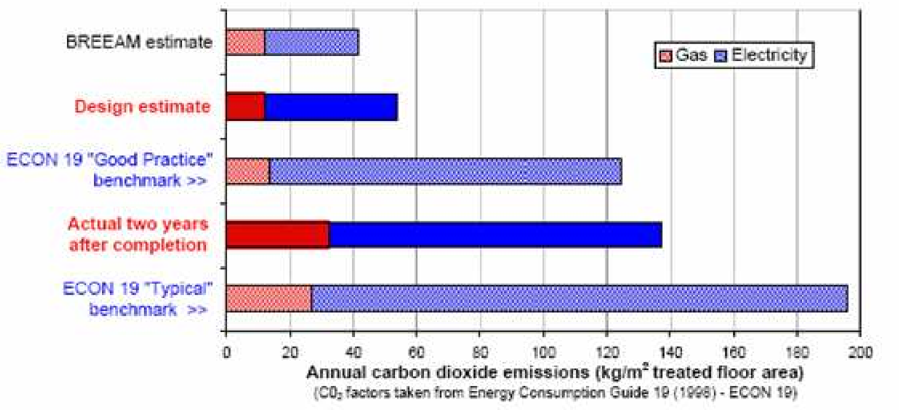

Fig. 1 Bill Bordass: Annual carbon dioxide emissions from a "green" award-winning office building[1]

Buildings where the Green Globes assessment was used purely for rating and not as a part of project delivery process show similar results, with performance ratings at the design stage considerably better than actual performance once the building is completed. For

[1] FACTORS FOR SUCCESS—Some ingredients of a good building by Bill Bordass, William Bordass Associates, www.usablebuildings.co.uk

example, the predicted energy consumption of one building was 150.2 kWh/m^2 whereas actual consumption two years after occupation is significantly higher at 240.5 kWh/m^2.

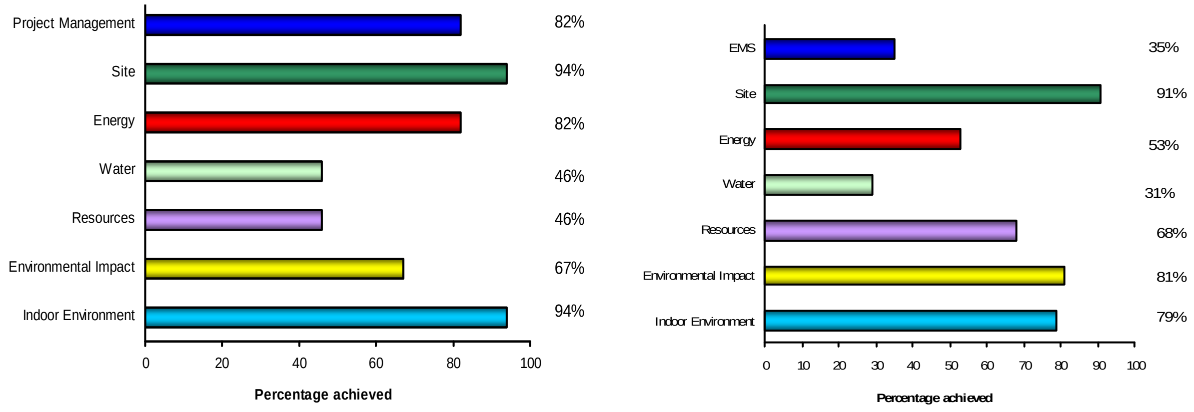

Fig. 2 Green Globes Design and Green Globes Existing Buildings assessment of the same building in the Construction Documents Stage and for the Existing Building, two years post-occupancy.

Studies conducted on one of the best monitored high performance buildings, the Adam Joseph Lewis Center for Environmental Studies at Oberlin College in Ohio[2], indicate that it took considerable effort for an exceptionally qualified team of researchers from the National Renewable Energy Laboratory (NREL) to reconcile the modelled and actual energy data. The first year utility data were almost equal to the "bad" or standard benchmark building and significantly higher than the modelled performance. Through significant operational changes and equipment upgrades over three years, the facility staff and the NREL managed to reduce the actual building performance to levels initially modeled.

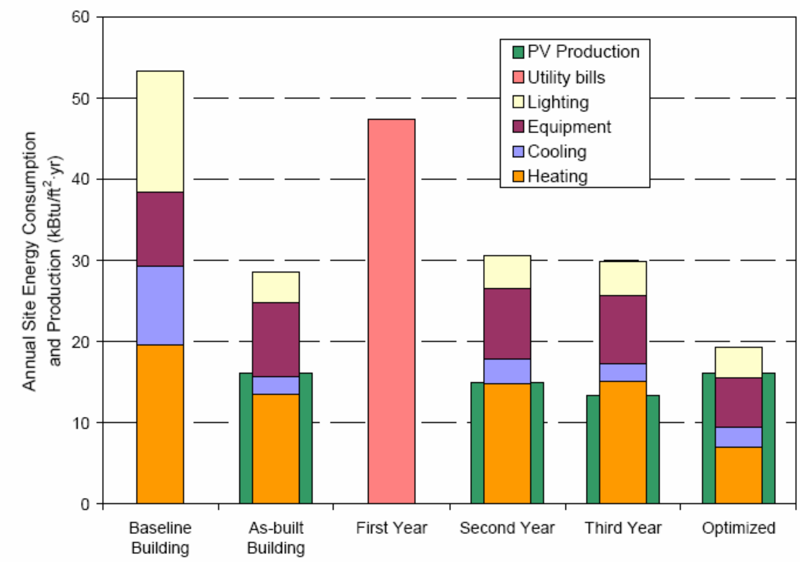

Fig. 3 Annual site energy performance of building models and measured data

[2] Energy Performance Evaluation of an Educational Facility: The Adam Joseph Lewis Center for Environmental Studies, Oberlin College, Oberlin, Ohio by S.D. Pless and P.A. Torcellini, National Renewable Energy Laboratory, NREL/TP-550-33180 November 2004

While there are not many proven studies of LEED[3] buildings once in operation, there are indications that they fare no better. Performance problems have been reported with Seattle City Hall (lower energy performance than predicted) and other LEED buildings, where, for example, some certified design attributes (such as restricting the use of high VOC content materials) are not carried through by the tenants.

According to Dr. Bordass, the problem arises not because predictive techniques aren't accurate, but because they don't fully account for the realities of an operational structure—and because few designers stay involved with a project long enough to monitor building performance. As a result, they remain unaware of strategies that either failed or, for that matter, succeeded beyond expectation. In some cases, the gap may be justifiable—when the building is used more intensively than planned, for example, or has more equipment. More likely, it's due to waste caused by poor briefing, design, or construction and commissioning. As a common example, Dr. Bordass points to control systems with poor management and user interfaces, which cause equipment to default unnecessarily to ON.[4]

6 Energy Slippage

When performance falls short of expectations, building owners tend to blame members of the design team, says Dr. Bordass, who in turn claim that the problems are due to construction issues, that the occupiers don't fully understand the design, that the building is being used in unintended ways, or that it isn't being maintained or properly managed. And, while these complaints are sometimes legitimate, they're just the beginning. Energy slippage can occur at any stage of a building's life cycle—from the initial estimation through design, construction and commissioning, and operation. For example:

At the **design stage**, energy estimates may be unrealistically low. Perhaps the designer took into account only the energy used by building services such as HVAC, lighting and hot water and overlooked functions such as plug load or elevators. Or, assumptions may have been made incorrectly that systems would be off at night, or that sensors and controls for regulating systems that consume energy would work perfectly. Energy predictions based on these best case scenarios tend to be extremely favorable, especially when evaluated against the real energy data of comparable existing buildings (which are used as effective benchmarks in programs such as **Energy Star** and **CalArch**).

Slippage at the **design development** stage may occur as a result of functional or budgetary considerations as the design evolves. It is likely to remain undetected if the designer doesn't wish to incur costs for repeating the energy modelling exercise at each design iteration.

Slippage during **construction** may result from cost-cutting measures or technical shortcuts. Likewise, if **commissioning** isn't sufficiently thorough, many of the systems and controls designed to save energy may be less than effective.

During **occupation**, the building may use more energy than predicted as a result of changes in occupancy, poor operation and maintenance, improper fit-ups or poor energy habits of the occupants.

[3] Leadership in Energy and Environmental Design, www.usgbc.org
[4] Energy Performance of Non-Domestic Buildings: Closing the Credibility Gap by Bill Bordass, William Bordass Associates, Robert Cohen, Energy for Sustainable Development Ltd. and John Field, Target Energy Services Ltd.

Since the actual performance of the building will depend on early decisions combined with a series of uncertain events that may occur as a consequence of these decisions, the obvious question is whether it's even possible to predict the high energy performance of a building with accuracy. The answer is yes.

7 Solution: Limit the Slippage and Use a Building Rating Continuum

In order to assure that a project will deliver a truly high performance building, slippage factors must be addressed at each stage where they're likely to occur. An effective assessment methodology tracks the process in a seamless continuum with respect to best practices of integrated design, construction, commissioning, building operations and tenant involvement. For example, if an assessment indicates a high performance design, there should be a follow-up assessment to demonstrate that the outcome is a high performance building. This should be followed by additional assessments to demonstrate that the building has high performance operators and high performance tenants. Establishing an assessment paper trail makes it possible to assign accountability, diagnose where slippage has occurred and take corrective action.

It seems clear that the most practical and effective approach to detecting and addressing performance slippage is one in which each project delivery stage or period is evaluated as part of a continuum using data obtained from decisions made earlier.

Use of the Green Globes approach to address the key stages of project delivery makes it possible to confirm the **intended** implementation of the high performance objectives.

Green Globes is a modular, questionnaire-based system in which definitions of high performance relate to specific stages of the building's life cycle. It is unique in that it includes an assessment protocol and rating system and also guides the improvement of energy-efficiency and other performance measures **during the design process**. Although there are separate ratings for high performance design and high performance during post-occupancy, the modules can "communicate", thus ensuring a continuum in assessment from one stage to the next.

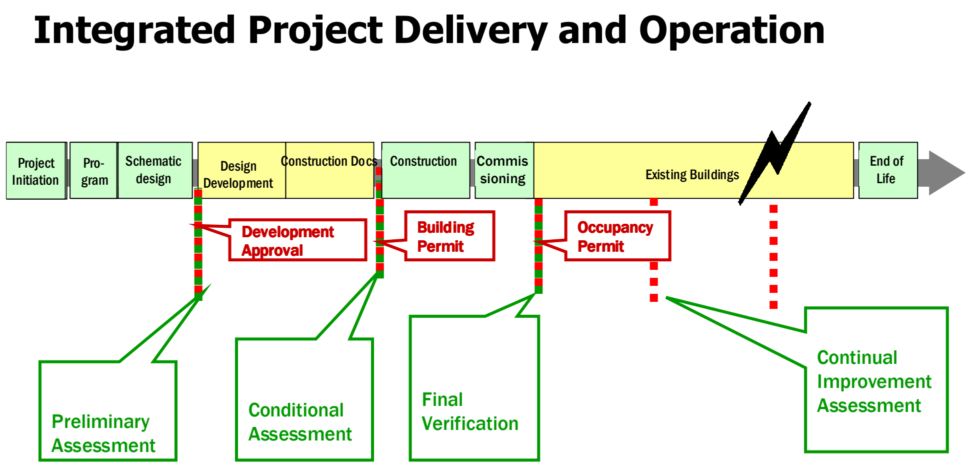

Fig. 4 Stages of Integrated Project Delivery

The tracking occurs in four stages:

- **Preliminary assessment at the Concept (Schematic) Design Stage**. This stage typically corresponds to the Development Approval Stage. The purpose of this assessment is **demonstrate** the Developer's **intended** implementation of the Standard. is no external validation at this stage, but a self assessment by the proponent. The self assessment report (whether generated through a paper checklist or electronic report) would be attached to the development application.
- **Conditional design assessment and rating at the Construction Document Stage**. This stage typically corresponds to the Building Permit Stage. The purpose of this assessment is to **confirm** the Developer's **intended** implementation of the Standard. Validation at this stage involves the review of the Construction Documents submission and be conducted by trained and certified validators.
- **Site visit and final design rating at the Construction Completion Stage**. This stage typically corresponds to the Occupancy Permit Stage. The purpose of the validation is for the developer to obtain a certificate that can be used immediately for marketing. Validation at this stage consists of a site visit by a trained and certified Validator. Alternatively, validation can be conducted one year after building completion under the BOMA Go Green existing building protocol.
- **Existing building assessment at the operational stage of the building**. This stage typically corresponds to the operation of the existing building based on one year of operational data. The purpose of this assessment is to ensure continuous green operations, avoidance performance slippage and implementation of cycle of continual improvement. The assessment of the building is conducted through the BOMA Go Green program. The assessment verification includes a review of utility bills, measurements (such as those pertaining to air quality, light and acoustics), and supporting documentation (such as preventive maintenance records), plus a walk-through survey to review building features and systems, and an interview with the property manager regarding the operational policies and procedures. The final report highlights performance values, building features and systems as well as operational and management measures including tenants' communications

This combination of data on 1) performance, 2) features, and 3) energy and environmental management can help identify where slippage is occurring and provide insights for building managers and owners on where to take corrective action.

Suppose, for example, that an existing building scores low on energy performance and low on operation and management, yet scores high on energy-efficiency features. This could indicate potential opportunities to improve performance by implementing low-cost or no-cost operational measures.

Having improved energy and environmental management, what if the building still has poor energy consumption scores? This could be an indication that controls aren't working properly or the envelope is leaking, or signify other issues that require deeper investigation.

Or consider the case where consumption performance is good, despite the fact that energy-efficiency features are modest, and there are high operation and management scores. Clearly, this is evidence that the building operator deserves to be commended for excellent energy management.

At the occupancy stage, the building operator must ensure that control systems are used correctly, that maintenance and energy management are up to standard, and that systems and equipment are properly set. Tenants must also do their part, by implementing energy conservation measures that will reduce base-building and plug-load consumption.

There is value in conducting assessments at key milestones such as 12 to 24 months post-occupancy, and at three years intervals after that. Likewise, in-house self-assessments should be carried out at regular intervals (preferably on an annual basis) as a part of asset management. This continual monitoring is a simple way to identify and correct performance slippage when and where it occurs.

8 Conclusion

In North America, green building is largely voluntary, and green building labeling is still chiefly used as a marketing device. Buildings which may rate a high performance at the design stage, may in fact, not perform so well once they are up and running. There are many reasons for this so-called "energy slippage".

In time, as environmental requirements become more stringent, a more effective approach will be needed to validate performance claims. The credibility of a green label depends largely on measuring the right things at the right time. Green Globes uses a series of assessments including self-assessments, during the design stages of a project to monitor intended performance from the goal-setting stage, through the concept development and finally the construction documents. It then validates the claims once the building is up and running.

References

[1] SKOPEK, J., BRYAN, H., VYAS, U. *Mind the Gap: The Green Globes Approach to Bridging the Gap between Building Design and Performance*. Rethinking Sustainable Construction 2006: Next Generation Green Buildings, Sept., 2006.

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