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A COMPARISON OF ENERGY-EFFICIENCY RATING SYSTEMS FOR EXISTING BUILDINGS IN ASIA AND THE MIDDLE EAST, AND IMPLICATIONS FOR SYSTEM ADOPTION

Steve Burroughs

Adjunct Professor (Architecture), University of Canberra. Consultant, Architecture and Project Management, Dr Steve Burroughs and Associates Ltd., 38 Blackman Crescent, Macquarie, ACT 2614, Australia. Email: drsteve@drsteveburroughs.com

Abstract

The region of the world extending from Australia (Oceania) through to Asia and the Middle East contains countries with a wide variety of built environment characteristics and economic, political, and environmental conditions. In response to sustainability concerns, these countries are in various stages of adoption (from not adopted to fully adopted) of green building rating systems, which include both international-based systems and locally developed systems. With respect to the geographic region of interest, this study makes a comparative evaluation of 11 rating systems (or the components/modules of systems) that measure the operational energy efficiency of existing commercial buildings. The focus on existing buildings is because attention given to performance rating existing buildings has lagged that given to design rating new buildings.

Based on an examination of documentation (guides, manuals, and technical briefs), the studied systems are found to vary with respect to the following aspects of energy measurement: (1) The weighting given to the energy-efficiency category relative to the overall rating and to other sustainability components/categories such as water and indoor environmental quality; (2) The use of feature-specific energy items versus the use of performance-based energy assessment to assess energy efficiency, or a hybrid combining both; (3) The particular energy subcategories and items used and their weightings; (4) For the feature-specific and hybrid approaches, the particular feature subcategories and items that are used to indicate/represent energy efficiency; (5) For hybrid approaches, the weighting of performance-based assessment versus feature-based assessment in the energy-efficiency category; (6) The method used to assess energy performance (simulated or measured directly from data); and (7) The use and mode of energy-efficiency benchmarking.

The implications of the study include the following. (i) Considerations in developing an assessment system for those countries yet to adopt should include attention to the above points, with such considerations being made with respect to the characteristics of the host country's building stock and intended environmental goals, with decisions being justified to ensure that the most suitable system is devised in each case. (ii) Data from early national adopters of rating systems (e.g., Australia) show that ratings of existing commercial building drive building financial metrics such as building asset values, rents, and investment returns. The expectation is that similar effects will occur in those countries adopting later or yet to adopt, thereby subdividing the commercial property market according to measured sustainability.

The take-up by building owners/operators of rating system assessments for existing buildings is currently low, and generally much lower than that for new buildings. The rate of take-up should increase as government incentives are used, as systems become mandatory rather than voluntary, and as building life cycle analyses become fully embedded into rating systems.

Keywords: building energy efficiency, rating systems, Asia and the Middle East, adoption, stakeholders

1 INTRODUCTION & BACKGROUND

Buildings account for 40% of global energy annually, considering all their life cycle stages, including material production and procurement, construction, use/operation, and demolition [1]. In response to concern about the environmental impact of buildings, various countries (both developed and developing) in the Asian and Middle Eastern region are in various stages of adopting systems for assessing/rating building sustainability. These systems cover a range of environmental aspects including energy efficiency, site characteristics, water use, waste, indoor environmental quality (IEQ), materials, and ecology. Some countries have developed local systems whereas others have borrowed/adapted international systems either in addition to or instead of a local system, providing an opportunity to compare these systems.

Various building rating systems are used across the Middle East and Asia, and include: the Pearl Building Rating System (UAE), QSAS (Qatar), Green Building Design Label Three-Star (China), BEAM Plus (Hong Kong), CASBEE (Japan), LOTUS (Vietnam), Green Mark (Singapore), Greenship (Indonesia), NABERS (Australia), and LEED (various countries, e.g., India). Although most of these systems cover a wide range of environmental aspects, the present study is concerned with rating systems (or the modules/components of systems) that measure the energy efficiency of existing buildings, with specific respect to commercial buildings in Asia (including Australia) and the Middle East. Although previous studies (e.g., [2]) have examined and compared different building rating systems (also referred to as tools or schemes), the vast majority of those studies have focused on systems that cover sustainable building design and new buildings rather than those that cover existing buildings and their operation.

Some rating systems were set up from inception to specifically assess actual energy consumption (e.g., NABERS – National Australian Built Environment Rating System) without reference to building design. However, early iterations of most building rating systems addressed only the design and features of new buildings, neglecting the assessment of operational characteristics (including energy use) of existing buildings. In most cases, more recent iterations of such systems have been developed that assess the performance of existing buildings, such as the LEED Existing Building Operation and Maintenance module (LEED O&M), BEAM Plus for Existing Buildings (Hong Kong), and BREEAM In-Use.

The approaches to energy performance assessment for the building sector can be classified into two major categories, namely performance-based and feature-specific (or feature-based) approaches [3]. Using the performance-based approach, assessment results are obtained by comparing the performance indicators (e.g., energy use intensity or CO_2 emissions) against established benchmarks. For feature-specific approaches, credits are awarded according to specified features attained across different items and categories that have different weightings. The final score is the sum of the awarded credits across all items and categories assessed, taking into account credit distribution and weighting. Building rating systems may use the performance-based approach, or the feature-specific approach, or both.

Birt and Newsham [4] noted that although there are a number of green building programmes available to help design more sustainable buildings, the question of whether these buildings are delivering on their original design intent is difficult because of the relatively small number of publicly available post-occupancy evaluations to draw upon. This has been echoed more recently by other authors, including Goh and Rowlinson [5] in a study of green building construction and assessment in Hong Kong. There remains a widespread assumption that 'green design equals green performance'. In addition, rating systems that focus on design are relevant to new buildings rather than to existing buildings. This relative neglect of assessing existing buildings (cf. new) provides part of the rationale for the need for further studies of green performance, including the assessment of building energy efficiency.

Furthermore, because of their very high overall energy consumption, buildings are a key target of policies and practices that aim to promote environmentally sustainable development. Labelling and certification (through building rating systems) is one of the most cost-effective policy instruments to address the environmental impact of buildings, and hence many countries have now adopted one or more such systems. The systems include international-based systems such as BREEAM and LEED, as well as a large number of domestic systems claimed as being customised to suit local conditions and contexts. Therefore, building rating systems have political importance, and despite most of the rating systems being voluntary currently, mandatory participation may occur in some countries in the future if incentive-based encouragements (including subsidies) do not drive acceptable participation in rating systems by building owners/operators.

The use of building operational energy rating systems and the particular characteristics of those systems have implications for a wide variety of stakeholders, including investors [6, 7], building owners, tenants, and governments. On this basis, it is important to more closely examine building energy-efficiency rating tools, particularly across a region where there are both early and more recent adopters of such tools, as well as nations yet to adopt. The goals of this study are: (1) To examine and compare sustainability rating schemes for existing buildings with particular focus on energy-efficiency assessment; and (2) On the basis of the comparison and observed similarities and differences, to inform decisions about and identify implications for the development and adoption of rating schemes for existing buildings.

2 THE STUDIED RATING SYSTEMS

2.1 Method and Information Sources

The comparative evaluation of building energy-efficiency rating systems for existing buildings in this study involved comparing various characteristics of the systems, gained primarily from an examination of official documentation, including official rating system guides, manuals, checklists, and technical briefs. In addition, industry reports and published articles were consulted. The information was used to identify similarities and differences between the systems, and to examine issues surrounding rating systems for existing buildings.

2.2 Characteristics of the Systems

The studied rating systems and selected characteristics are given in Table 1. Eleven rating systems were tabulated, covering a range of countries and both international-based and local systems.

Table 1. Selected Characteristics of Building Energy Rating Systems/Tools for Energy Efficiency in Existing (i.e., operating / in use) Commercial Buildings in the Oceania–Asia–Middle East Region.

Rating System (year of inception)	Country	Rating System Information and Energy Performance Assessment Method	Governance	Market Penetration	Rating & Certification
NABERS (1998) [see section 2.4]	Australia, New Zealand	Measured energy consumption data converted to CO_2 emissions, which are then normalized and compared to a benchmark. The NABERS energy tool is a stand-alone system, although other related tools include those for water, IEQ, and waste.	National Government	2750 existing buildings. Ratings cover 79% of floor area of national office market.	Rating from 1.0 to 6.0 stars. Evaluation done annually.
LEED Operations & Maintenance (O & M) (2004)	India (also China, Vietnam)	Energy one of 8 categories, valued at 38 points out of total 110 (34%). Energy category has 8 items, a mixture of feature-specific items (18 points) and measured energy performance (20 points). Two options for assessing energy performance: 1. Energy star rating using ASHRAE standard 90.1-2010 for climate (involves using 12 months energy consumption data; or 2. Benchmark against national average or comparable buildings or historical data.	Green Business Certification Inc. on behalf of US Green Building Council	India has 1657 buildings rated in overall scheme (both new and existing) (2014)	Four levels from certified (40–49 points) to platinum (≥80)
BEAM Plus for Existing Buildings (2010)	Hong Kong	Energy use one of 5 categories, and has 41 credits out of 121 in overall scheme (33%). Energy category is a mixture of feature-specific items (e.g., HVAC, renewables, lighting, appliances, management) (15 credits), and measured reduction of annual energy consumption (15 credits) on sliding scale from 1 credit for 3% reduction to 15 for 45%, relative to the benchmark criteria evaluated from an equivalent baseline building model. Energy consumption is simulated using specified methodology and with reference to the latest Building Energy Code or ASHRAE Standard 90.1-2007.	Hong Kong Green Building Council. Assessments undertaken by independent assessor engaged by BEAM Society.	400 projects registered or certified in overall scheme (both new and existing)	Four levels according to % of credits gained: bronze (40–54%), silver (55–64%), gold (65–74%), platinum (≥75%)
QSAS Operations Scheme (2009)	Qatar	Eight categories assessed: energy, water, indoor environment, cultural and economic value, site, urban connectivity, materials, and management & operations. The energy category has 24% weighting and consists of five items: energy demand performance (22% weighting in category); energy delivery performance (22%); fossil fuel conservation (15%); CO_2 emissions (19%); and NO_x, SO_x, and particulates (22%).	Governmental: Gulf Organisation for Research & Development	128 existing buildings (2013)	The total score is translated to a six-star certification level, with a score of 0 to 0.5 being 1 star and 2.5 to 3.0 being 6 stars.

LOTUS Buildings in Operation (2013) [see section 2.5]	Vietnam	Building energy use intensity (BEUI) calculated using utility bills or metered data over 12 month period. BEUI compared with benchmark and historical change. Energy category is 33% of overall scheme. BEUI item is 45% of energy category, other items are feature-specific.	Vietnam Green Building Council	~15 existing buildings (2015)	Points-based system giving 3 levels of certification: certified, silver, gold.
Energy Smart Office Label (2005)	Singapore	Compute whole-building energy use intensity from metered data, not simulated or calculated. Compare result with benchmark data derived from 120 office buildings. Features of AirCon and lighting systems included, as well as IEQ. The rating system is essentially stand-alone.	National University of Singapore. Independent audit by accredited third party.	NA	Label awarded to top 25% band of the total building cohort
Green Mark for existing non-residential buildings (2005) [see section 2.3]	Singapore, Vietnam	Feature-specific based system. Energy efficiency one of 5 categories. Energy category rated by points awarded to 10 items covering HVAC, lighting, and other features/practices. Energy efficiency has 89 points available from a total of 180 (49%) in the overall sustainability assessment.	Building and Construction Authority of Singapore (agency under Ministry of National Devt) (bca.gov.sg)	2500 buildings in overall scheme (2015) (both new and existing buildings)	Four certification levels ranging from certified (50–74 points) to platinum (≥90)
Three Star green standard (second stage – operational performance) (2006)	China	Feature-specific based system. Energy reduction is one of 6 categories. Energy utilization is 25% weighting of overall rating.	National Government (Ministry of Housing and Urban Affairs). Evaluation practices vary depending on province.	110 existing buildings (2013)	Green Building Operation Label. Evaluation done once, 1 year after construction.
GreenRE (2013)	Malaysia	Feature-specific system generating a maximum of 90 credits over 10 items. Energy-efficiency rating is 48% weighting of overall scheme. No energy measurement input.	Real Estate and Housing Developers' Association Malaysia	15 existing buildings (2014)	Four award levels dependent on score: bronze, silver, gold, platinum
Greenship for Existing Buildings (2011)	Indonesia	Energy efficiency assessed by combination of feature-specific and measured. 24 of 36 points awarded for measured energy consumption intensity with respect to standard reference of 250 kWh/m^2/year for offices, 450 for malls. Other feature-based items include lighting, HVAC, maintenance, and management. Energy constitutes 36/117 available points (31%).	Certifying body is Green Building Council of Indonesia	10 existing buildings certified or registered (2014). ~50 in overall scheme, including new buildings.	Certification levels: Platinum (min.73% achieved points), Gold (min. 57%), Silver (min. 46%), Bronze (min. 35%)
BREEAM In-Use International (2009)	Turkey	Combination of feature-specific items and measured energy consumption/intensity	BREEAM national scheme operator or other authorized assessor	NA	Seven levels ranging from unclassified (<10%) to outstanding (≥85%)

Note: 'NA' means data not available, unknown, or not existing.

The data and information about rating systems for existing buildings (Table 1) reveal that the importance of the energy use/efficiency category in the sustainability assessment systems (which include other aspects such as materials, water use, IEQ, ecology, and building management) varies between the studied systems. Three clusters of systems are identified. The first cluster is characterized by systems in which the energy use category is weighted at about one-quarter to one-third of the available credits/points (LEED O&M 34%, BEAM Plus 33%, LOTUS 33%, GSAS 24%, Three-Star 25%, and Greenship 31%). The second cluster is characterized by systems in which the energy category is weighted at just under half of the available credits/points (Green Mark 49%, GreenRE 48%). The third cluster contains the two systems that are stand-alone (i.e., 100% dedicated) energy rating tools, namely, NABERS and Energy Smart Office Label.

The data and information about rating systems for existing buildings, and with particular respect to energy-efficiency assessment, indicate that the systems can be divided into three types based on the way that such assessment is handled: (1) Systems based entirely on feature-specific items for assessing energy efficiency (feature-based assessment): GreenRE, Green Mark; (2) Systems based entirely on energy consumption measurement (performance-based assessment): NABERS; and (3) Systems that include a combination of feature-specific items and performance-based assessment (hybrid system): LOTUS, LEED O & M, BEAM Plus, GSAS, Energy Smart Office Label, Three Star, Greenship, and BREEAM In-Use.

The hybrid systems vary with regard to how much weighting within the energy category is given to energy performance measurement versus energy effiency features. The points/credits documented for the schemes indicate the following percentage weightings for energy performance versus features: LEED O&M 53% v. 47%; BEAM Plus 50% v. 50%; LOTUS 45% v. 55%; and Greenship 67% v. 33%. The hybrid systems can also be divided into how energy performance is assessed, that is, either by simulated energy use/efficiency, or by measured (metered data) energy use/efficiency. In addition to these differences, the systems that use energy performance measures also show variation in whether they use benchmarking of energy efficiency and, if so, how the benchmarking is performed.

Three of the systems are now described in more detail as examples of the three types of system classified above with respect to how energy-efficiency assessment is handled: a feature-based system (Green Mark), a performance-based system (NABERS), and a hybrid system (LOTUS).

2.3 Green Mark (Singapore): A Feature-Based Energy-efficiency Assessment System

The BCA (Building and Construction Authority) Green Mark Scheme was launched in early 2005 to help drive Singapore's construction industry towards more sustainable buildings. The overall scheme has modules covering residential buildings and commercial or industrial ('non-residential') buildings, both new and existing. The Green Mark for Existing Non-Residential Buildings scheme is now at Version 3.0, and covers the operational performance of buildings in terms of five sustainability categories: energy efficiency, water efficiency, sustainable operation and management, indoor environmental quality, and other green features.

The energy-efficiency category has 89 points available from a total of 180 (49%) in the overall sustainability assessment. The category is rated by points awarded to 10 items covering: 1.1, the thermal performance of the building envelope (5 points); 1.2 and 1.3, air conditioning system plus natural/mechanical ventilation (32); 1.4, artificial lighting (13); 1.5, carpark ventilation (4); 1.6, common area ventilation (5); 1.7, lifts/escalators (2); 1.8, energy-efficient practices and features (12); 1.9, energy policy and management (1); and 1.10, renewable energy (15). The points for air conditioning (1.2) and natural/mechanical ventilation (1.3) are adjusted based on the floor areas of the building covered by each.

Four levels of award are made in the scheme: Certified (50–74 points, minimum 30 points for energy category); Gold (75–84, min. 35 for energy); Gold-Plus (85–89, min. 40 for energy); and Platinum (≥90, min. 45 for energy). A total of 2500 buildings are included under the Green Mark scheme as of 2015, including both new and existing buildings. Buildings are reassessed every three years to maintain Green Mark status.

2.4 NABERS (Australia): A Performance-Based Energy-efficiency Assessment System

NABERS was devised in 1998 (although under a different name) for assessing the operational energy efficiency of a building in use by directly measuring actual energy consumption and without reference to design. It is a performance-based system that rates a building from 1.0 to 6.0 stars according to its performance using 12 months of energy use (obtained from electricity/gas invoices and meters), with the rating being valid for one year. Lower utility consumptions are awarded higher NABERS ratings, with greater degrees of energy efficiency being required to attain equivalent increments in NABERS rating as star ratings increase.

The NABERS tool converts the energy used into greenhouse-gas equivalents according to the source of electricity generation. The emissions values are then normalised using algorithms that account for the building's location, size (lettable area), hours of occupation, other usage factors (e.g., number of computers), and climate, to yield a value of emissions per m^2. This value is then compared with a benchmark, on which basis a rating is computed.

There are two main NABERS energy rating systems available for office buildings. One is the 'base building rating', covering the energy consumption resulting from the central building services supplied or managed by the landlords/operators of the buildings, such as heating, air conditioning, and lifts/elevators, and also energy consumption from common areas (i.e., areas of the building shared by different tenants, such as foyers, stairs, and designated meeting rooms). The other is the 'tenancy rating', covering energy use in the areas and activities that are under the control of office tenants, such as office lighting and computers. The separation of base building and tenancy consumption for NABERS ratings is the usual case and means that tenants' behaviour does not affect the level of efficiency established by the building owner for the base building services.

Although there are other NABERS tools for water use, IEQ, and waste, these tools are independent of one another in their administration, assessments, and ratings, and do not form part of a wider sustainability assessment system characterized by categories and weightings.

2.5 LOTUS (Vietnam): A Hybrid Energy-efficiency Assessment System

LOTUS Buildings in Operation (BIO) is the third LOTUS rating tool to be developed by the Vietnamese Green Building Council (vgbc.org), and was officially released in mid-2013. LOTUS BIO covers existing building operation and is intended to be a complementary tool for LOTUS NR and R (non-residential and residential), both of which are focused on design and construction stages. The LOTUS system was developed by drawing on and adapting several rating systems, including Green Star, Green Mark, BREAAM, and LEED.

Any commercial building type that has been in operation for more than 2 years and has over 50% occupancy can be assessed using LOTUS BIO (regardless of whether or not the building has already been certified under NR or R). The 'performance period' over which the building is assessed lasts for 12 months. Alterations, refurbishments, and additions can be assessed under the BIO system.

The overall BIO system assesses eight categories for which points are awarded: energy, water, ecology, waste & pollution, health & comfort, adaptation & mitigation, community, and management. Points total to 100, and the energy category accounts for 33 of these. The points translate to three certification levels: certified (41%–55% of available points), silver (56%–70%), and gold (71%–100%). The certification is valid for 3 years, but during that time the applicant (usually the building owner/operator) can submit operational data, which for the case of energy are measured energy consumption data, to extend the period of validity to 5 years.

For the energy category, points are awarded across 9 items: perform energy audit, a calculated building energy use intensity (BEUI) lower than benchmark, natural ventilation, HVAC, artificial lighting, hot water, renewable energy, peak electricity demand, and energy management. Of the 33 points, 15 are available for energy use intensity, with 1 point being awarded for each 2.5% below the benchmark (up to 10 points) as well as 1 point for every 5% reduction over time compared to the historical baseline (up to 5 points). The BEUI is calculated using 12 months of utility bills or energy metering data, divided by net floor area. The calculation of BEUI takes into account fuel type calorific value and typical operational hours. Operational hours for office buildings (retail buildings) are standardised at 52 (84) hrs/week, and the benchmark BEUI is 150 (300) kWh/m^2/yr. The calculated BEUI is compared with the benchmark as a percentage, and may be less than or more than 100%.

3 DISCUSSION AND IMPLICATIONS

Green building rating systems have tended to emphasize the design and construction of new buildings to the detriment of considering the performance of existing buildings. This is reflected by the fact that most green building rating systems in their initial iterations covered only new buildings, and only subsequently have modules for existing buildings been developed. Environmental assessments of existing commercial buildings are of importance because: (1) the vast majority of such buildings are 'existing' rather than 'new'; (2) such buildings have great potential for improving their environmental performance through better management and monitoring, altered practices, and refurbishments; and (3) ratings provide market signals to stakeholders regarding 'green-ness', including potentially influencing building and property industry financial metrics. Furthermore, energy use in the operation phase of a building (recurrent energy) is generally considerably greater than the energy involved in other parts of a building life cycle [1], particularly in the climatic conditions applying to most of Asia and the Middle East, and therefore assessment and ratings of energy use in existing buildings deserve more attention than is currently being given.

The data in Table 1 reveal that the number of buildings that have been assessed using rating systems for existing buildings is low. In fact, in most cases, the data are not available because reports generally focus on ratings performed for new buildings or for new and existing buildings combined. There is a need for better reporting by the relevant authorities regarding the take-up of conducting ratings on existing buildings.

The low rate of assessment of existing buildings in most countries is due partly to the recency of implementation of the rating systems. However, the voluntary nature of the systems is also responsible. Various incentives are being offered in countries including Malaysia, Indonesia, China, and Singapore to encourage building owners/operators to register and proceed with rating assessments. For example, the Chinese government subsidises 3-star-certified green buildings at US$13.2/$m^2$ and 2-star buildings at $7.4/$m^2$, and Singapore's Green Mark Incentive Scheme encourages building owners to implement energy-efficient solutions and to conduct energy audits in their buildings.

In addition to the effect of incentives, the incorporation of life cycle analyses (LCAs) into green rating tools, assessing all life stages of a building with attention to both embodied and recurrent energies, is likely to mean that the take-up of systems for assessing energy (and other components of sustainability) for existing buildings will continue to increase.

3.1 Implications for the Development and Adoption of Rating Schemes

The systems studied here for the Asia and Middle East region reflect the responses of these nations to the need to address the sustainability aspects of existing buildings. The systems presumably differ partly as a result of the different building stock characteristics, economic conditions, climatic conditions, building/construction industry characteristics, the political environment (e.g., policies and regulations), stakeholder characteristics, and the socio-cultural features of the countries concerned. The systems also differ because of the mixing that has occurred in their development, with many systems borrowing and adapting elements and components from other systems. However, it is not always clear from the documentation of the systems as to the rationale given for various aspects of asssessing energy efficiency. Although systems are commonly described as 'catering for the specific environmental, social, and economic aspects of the adopting country', the justifications for aspects such as category and subcategory weightings, feature-based versus performance-based approaches, and the particular features/items included to measure energy efficiency are commonly unclear or unavailable. The fact that there is wide variation in these aspects (Table 1 and accompanying descriptions) points to the need for considerations and decisions to be made regarding the structure and content of assessment schemes for countries that are yet to adopt.

Many countries in the studied region are just starting or considering to develop/adopt sustainability rating systems. On the basis of the results of this study, the following aspects should be considered with regard to decisions about the measurement of building energy efficiency in the scheme being developed or whose adoption is being contemplated: (1) The category weightings for the scheme and particularly the weighting given to the energy-efficiency category compared with the other categories, and the rationale for such weightings; (2) The points weightings for subcategories and items in the energy category, and the rationale for such weightings. (3) The way in which energy efficiency is measured in the scheme: whether it is feature-specific based, performance based, or a hybrid of the two approaches, and the rationale for which approach is adopted. (4) For the feature-specific or hybrid approaches to energy, the particular subcategories of features and items that are used to indicate/represent energy efficiency. (5) For the hybrid approach, the weighting of energy performance versus the weighting of energy features in the energy-efficiency category, and the rationale for the weightings. (6) Whether energy-efficiency benchmarking is required, how this is done, and the reliability of it. (7) For energy performance, whether such performance is assessed by simulated energy use/efficiency, or wholly by measured (metered) energy use. (8) Whether the weightings given for the various subcategories or items of the energy-efficiency category actually correspond to the anticipated or actual energy savings made, and whether this can actually be verified. (9) The levels of rating award given (e.g., bronze, silver, gold), and how these are divided and geared with respect to energy-efficiency category scores.

The above considerations need to be made with respect to the sustainability goals of the host country government or environment department as set by policy or guidelines, with respect to the characteristics of the commercial building stock and to the prevailing climatic conditions. A scheme that is mis-matched to the identified goals/requirements, and for which no or limited rationale or attention has been given regarding the above considerations, is unlikely to give uniform, fair results, instead favouring some building types and characteristics over others and with no justification for doing so. The development and documentation of QSAS is one of the clearer examples giving a good account of the rationale for the structure and content of the scheme. For example, an Analytic Hierarchy Process was used in QSAS to determine the relative importance or weights of the eight scheme categories, based on a survey of built environment stakeholders including industry and government representatives. This approach could be used by other countries in developing aspects of their assessment systems.

3.2 Implications of Green Building Sustainability Ratings for the Commercial Property Market

Of note with respect to the sustainable property industry, Bannister [8] observes with respect to the NABERS rating tool that it is 'only one small but important part of the overall machinery of the system. By creating a rating, one is setting a standard in which a very wide range of stakeholders have interest, and a great deal of conscious effort is required to manage the interests and expectations of these stakeholders while maintaining the technical integrity of the scheme.' It is clear that the technical aspects of rating existing buildings, and the technological aspects of improving the environmental sustainability of such buildings, must be considered within the commercial realities of the industry. These realities include whether (or to what extent) ratings produced by building assessment systems influence the asset values of commercial buildings, rents, and investor returns, as well as the costs of improving environmental sustainability versus the benefits.

The NABERS energy tool was introduced in 1998, the first such tool for measuring energy performance in existing buildings, and data now show that the energy ratings positively influence commercial building financial metrics such as building asset values, rents, investment returns, and tenant quality and occupancy [7]. For the newer systems in other countries, it is as yet unclear how the ratings for existing buildings produced feed into building/property financial metrics, partly because of lack of data. The case for NABERS energy is clear-cut partly because it is a long-established tool and is also dedicated to assessing energy efficiency. Energy efficiency in most other rating systems is one of several categories leading to an overall rating. This means that it is more complex to establish relationships between building energy efficiency and financial metrics. However, countries adopting any scheme to rate the environmental efficiency of buildings should expect, in time, that premiums will be placed on more efficient buildings in terms of asset value and income, therefore differentiating the commercial building market according to the level of 'greenness'.

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