CIDB MALAYSIA

BUILT IT GREEN

An Overview of

Sustainability Green Building

Rating Tools in Malaysia

PREFACE

The construction industry has been long characterized to be responsible for a significant amount of resource use and carbon emissions. Researches have shown that about 40% of the total world energy consumption is consumed by built environment, while the property industry was found to contribute to about 20% of CO2 emissions via energy use, waste and water production. The processes of producing construction materials, as well as the construction process, are energy intensive, utilizing considerable amounts of natural resources. Buildings account for 30% of raw material usage, 12% of fresh water usage, and 30% of greenhouse gas emissions; transportation of materials and other sundry tasks account for a further 18% of greenhouse gas emissions, 45% to 65% of waste to landfills, 71% of electricity consumption and 31% of mercury in solid waste.

However it has been established that the construction industry, by reusing end-of-life resources and maintaining existing structures instead of building from the ground up, can reduce waste and resource consumption. It has also been noted that with the available stock of virgin material diminishing and the availability of by-products increasing, it makes sense economicaly and environmentally to reuse by-products in the construction process. By implementing such measures, construction projects have proven to be sustainable. In other words, only by encouraging the development of more efficient buildings or through improving energy efficiency in the buildings, harmful impact of the buildings to the surroundings can be mitigated, and issues related to climate change can then be addressed.

To CIDB, all these figures suggest that sustainability is the way forward for the country's construction industry, and buildings are key target of policies that aim at promoting environmentally sustainable development. As such, there is a need to have understanding on the existing sustainable rating tools as well as systematic benchmarking on the strengths and characteristics of different tools for reference of industry players. In line with one of the environmental sustainability initiatives, E2, as stipulated in the Construction Industry Transformation Programme (CITP), this report was formed with the aim of driving compliance to environmental sustainability ratings and requirements. It is hoped that the report and its findings are desirable for the stakeholders, in enhancing their awareness and understanding with regard to the characteristics of different sustainable rating tools, either locally or internationally developed, which, towards the end, entail the coordination and sharing of research efforts

EXECUTIVE SUMMARY

Sustainability has increased in popularity as a key indicator for construction development. With such movement, evaluating the sustainability of projects has become a necessity. Among its counterparts, green building rating tool is the most well-established sustainability rating tool. Its development has surpassed other sustainable raring tools such as infrastructure and township rating tools. Ever since its first introduction in 1990 (i.e. BREEAM), the adoption of green building rating tool has proliferated around the world. Many countries have introduced and are advocating their own rating tools over the past few years in order to guide them towards sustainable development (Reed et al., 2009). Amongst the typical examples of these rating tools are BREEAM (Building Research Establishment's Environmental Assessment Method) in the United Kingdoms, LEED (The Leadership in Energy and Environmental Design) in the United States, CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) in Japan, and Green Star in Australia.

In Malaysia, the rapid growing of sustainability rating tools has been observed since the development of its very first green building rating tool – Green Building Index (GBI) in 2009. To date, there are 10 sustainability rating tools developed by Malaysia, encompassing green building, township, and infrastructure. Given the number, variability, and specificity of sustainability rating tools available in the country, a compilation and introduction of these tools is necessary, so that industry players can have a thorough understanding on these tools, and are able to determine to what extent a given tool suits their preferences. It is with this purpose this present handbook is formulated, to discuss and to analyse the sustainability coverage and attributes of each of these tools. Similarities and differences of these tools are highlighted, in order to lessen the confusion accompanying the adoption of each of these tools. Last but not least, the handbook also provides a comprehensive review on metrics of criteria-based green building rating tools, in comparison with other international green building rating tools.

TABLE OF CONTENT

An Overview of Green Building Rating Tools in Malaysia

INTRODUCTION

01

Introduction

Sustainable development is a common and contemporary goal of many urban development policies in various countries. Bruntland Commission defined sustainable development as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The efforts of sustainability practices embrace the rigorous use of the scare natural resources through a good implementation of economy but without neglecting the environment and social factors. The philosophy of sustainability emphasizes the achieving of sustainability that integrates the economic, environmental, and social into performance.

While being position as an enabler of growth in other sectors, the construction industry has been long characterized to be responsible for a significant amount of resource use and carbon emissions. Rapid economic growth and the increasing level of urbanization have led to the extensive development of buildings and infrastructures. Various aspects of construction, design, use and demolition can have significant impact on the environment. The sustainable urban development involves ecological, economic, technological, cultural, and social sustainability. Since buildings and other structures are normally planned to last for 50 to 100 years, the impact on climate change posed by these constructions should not be overlooked.

In fact, researches have shown that buildings (as well as built environment) are one of the major CO2 emitters and contribute substantially to climate change due to their high energy and water consumption, raw material employment, and the usage of land. About 40% of the total world energy consumption is initiated from built environment, while the property industry was found to contribute to about 20% of CO2 emissions via energy use, waste and water production. Besides, the processes of producing construction materials, as well as the construction process, are energy intensive, utilizing considerable amounts of natural resources. Buildings account for 30% of raw material usage, 12% of fresh water usage, and 30% of greenhouse gas emissions; transportation of materials and other sundry tasks account for a further 18% of greenhouse gas emissions, 45% to 65% of waste to landfills, 71% of electricity consumption and 31% of mercury in solid waste (Yudelson 2008).

It has, however, been established that the construction industry, by reusing end-of-life resources and maintaining existing structures instead of building from the ground up, can reduce waste and resource consumption (Kibert 2002). It has also been noted that with the available stock of virgin material diminishing and the availability of by-products increasing, it makes economic and environmental sense to reuse by-products in the construction process. By implementing such measures, construction projects have proven to be sustainable. In other words, only by encouraging the development of more efficient buildings or through improving energy efficiency in the buildings, harmful impact of the buildings to the surroundings can be mitigated, and issues related to climate change can then be addressed.

As stated by the US Green Building Council (USGBC), green buildings can offer a 30% energy saving, 30% to 50% water saving, 50% to 90% reduction in construction waste, and a 20% to 35% reduction in greenhouse gas emissions (McKinsey, 2007; Yudelson, 2008), which is equivalent to one-fourth of the reduction necessary to keep atmospheric carbon emissions below 450 ppm in 2030. Another added benefit of green building is the improved air quality for occupants of indoor spaces. Occupants may spend up to 90% of their time indoors and, as such, any contaminants in buildings could affect the health of building users (CEM, 2008). Therefore, it is important to build green, limiting the amount of potentially harmful substances that may be incorporated into the end products of construction projects. In addition, knowledge on trends of climatic development as well as the estimated amount of CO2 contributed by the buildings and constructions are crucial, as these may help the engineers and other related professions in minimizing the negative environmental effects.

1.1 SUSTAINABLE RATING TOOLS

As the construction industry becomes more interested in sustainable development, the need to evaluate and measure the performance of projects with respect to sustainability has emerged. Many countries around the world have established tools for measuring sustainability for various types of development. The growth in the utilization of environmental performance assessment systems for new construction has contributed to sustainability practices in various stages of building performance. Figure 1 summarizes the globally available sustainability rating tools based on seven categories: cities, planned neighbourhoods, existing neighbourhoods, all neighbourhoods, landscapes & parks, transportation & infrastructure, and special purposes. A closer look at these existing tools find that majority of them are devoted to the assessment of planned neighbourhood, followed by transportation & Infrastructure, cities etc. (Figure 2).

FIGURE 1: EXISTING GLOBAL SUSTAINABLE RATING TOOLS

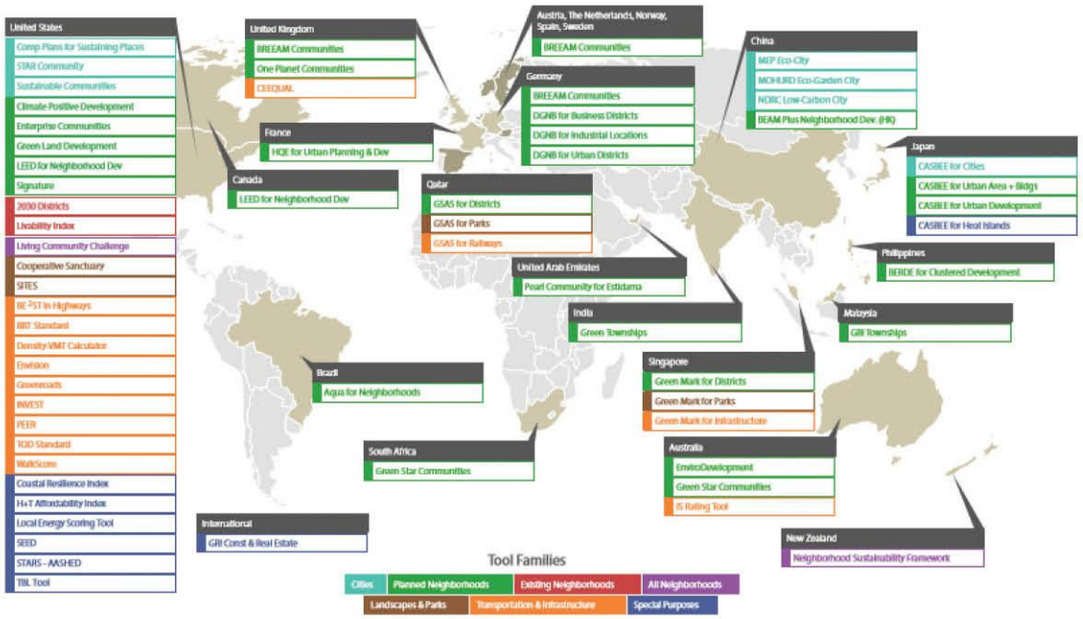
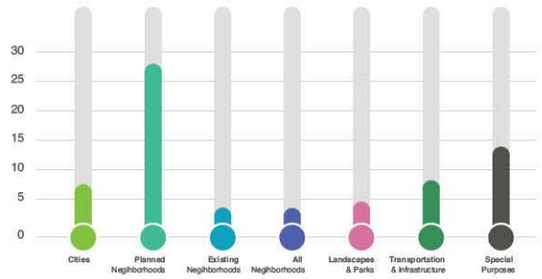


FIGURE 2: DISTRIBUTION OF SUSTAINABLE RATING TOOLS BASED ON TOPICAL FOCUS



Ever since its first introduction in 1990 (BREEAM), the adoption of green building ratings has proliferated around the world. Many countries have introduced and are advocating their own rating systems, with measurable criteria covering the socio, economic, and environmental parameters of design that can function as a positive tool in guiding them towards sustainable developments. Amongst the typical examples of these rating systems are BREEAM (Building Research Establishment's Environmental Assessment Method) in the United Kingdoms, LEED (The Leadership in Energy and Environmental Design) in the United States, CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) in Japan, and Green Star in Australia. The most widely used system is LEED, with over 40,000 domestically and internationally certified projects to date (Kubba, 2010; USGBC, 2013).

Green building rating tools benchmark buildings on their environmental sustainability, and conveys that information to a diverse audience in an intuitive, consistent manner. They vary in their approach and can be applied to the planning and design, construction, operation and maintenance, renovation, and eventual demolition phases of a green building. They can also differ in the type of buildings they are applied to, with specific tools or subsets of tools used for different building types such as homes,

commercial buildings or even whole neighbourhoods. Accordingly, the sustainable urban development is measured in terms of the area developed according to sustainability criteria, including the environment, social, economics, site/land uses, communication, transportation, and the assessment of building forms for housing performance. Rating tools typically assess a variety of sustainability categories, including energy and water efficiency, Indoor Environment Quality (IEQ), management practices, environmentally harmful emissions, resource consumption, and waste generation. Most rating tools assign a high value or weighting to energy efficiency measures. As Heating Ventilation and Air Conditioning (HVAC) typically accounts for approximately 40% of energy used in office buildings, HVAC design, commissioning and operation represents significant potential to maximise a building's energy efficiency and green building rating.

Another area that greatly contributes to climate change is the transportation sector. The transportation of goods and people has increased in demand in recent years as it has become necessary for social and economic prosperity. The use of rating systems, however, has been slow in coming for infrastructure works and the transportation sector in particular (Krekeler et al., 2010). Several systems have been developed or are under development to measure the sustainability of transportation projects. These systems employ different methods of determining sustainability emphasizing different sustainable factors (Martland, 2012). The 10 prominent systems that have been identified as applicable to transportation projects are BEST-in-Highways, Envision, Green Guide for Roads, Green Leadership in Transportation and Environmental Sustainability (GreenLITES), GreenPave, Greenroads, Illinois Livable and Sustainable Transportation (I-LAST), Infrastructure Voluntary Evaluation Sustainability Tool (Invest), Sustainability Assessment and Awards for Civil Engineering, Infrastructure, Landscaping and the Public Realm (CEEQUAL), and Sustainable Transportation Analysis rating System (STARS).

1.2 PROBLEM DEFINITION AND RESEARCH NEED

Many countries have introduced new rating tools over the past few years in order to improve the knowledge about the level of sustainability in each country's building stock. On one hand, it can be argued that the individual characteristics of each country, such as the climate and type of building stock, necessitate an individual sustainability rating tool for that country. The downside is that to varying degrees the rating tools for different countries are constructed on different parameters. This in turn has created complications for stakeholders, including property investors, who purchase buildings in different countries; an understanding of the many differences between each market has been increasingly harder to understand.

The same thing happens in Malaysia. Since the development of its very first sustainability rating tool – Green Building Index (GBI) in 2009, other sustainable rating tools have been developed or are under development to measure the sustainability of construction projects, such as GreenRE, MyCREST, PHJKR, LCCF, to name just a few. These tools employ different methods of determining sustainability emphasizing different sustainable factors. Given the number, variability, and specificity of sustainable rating tools available, a compilation and introduction of the available tools in the country to the stakeholders is necessary, so that stakeholders can have an overview as well as a thorough understanding on these tools. With this regard, the present study surveys and compiles all sustainability rating tools developed by Malaysia. The characteristics of these tools are, then, discussed and analysed. Meanwhile, through the analysis of sustainability coverage, the study provides insights on sustainability attributes of these tools to the stakeholders. Last but not least, the study provides a comprehensive review on metrics of Malaysian criteria-based green building rating tools, so that the stakeholders can determine to what extent a given tool suits their preferences.

METHODOLOGY

02

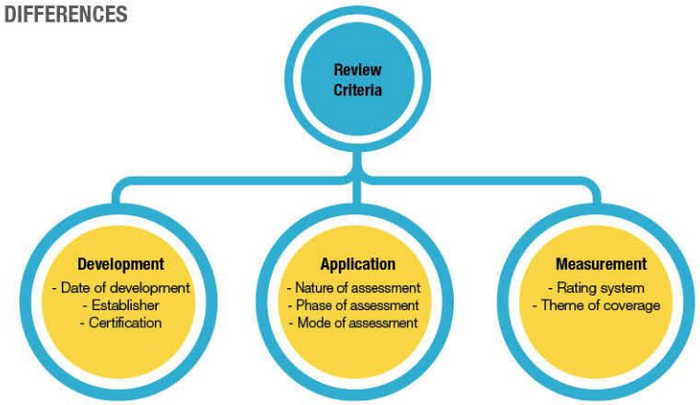
In the present study, data collections were mainly through qualitative approaches. Primary data was collected through interviews (mainly the rating tools owners); while secondary data was gathered from various reliable sources, such as journal, conference papers, international magazines, online database, government/business association publications, and the internet (Figure 3). Realising that the sustainability rating tools evolve as to adjust to the market, which makes capturing the current state behind the scenes a challenge, a time frame was used to create absolute boundaries of the study. To note, the information compiled in this study was collected from November 2016 – March 2017.

In order to have a better understanding on the characteristics and uniqueness of each available Malaysian sustainability rating tool, it is necessary to have a systematic review approach. Inspired by the BRE (2004) study, the review criteria selected for exploring the similarities and differences of sustainability rating tools in this study are (i) date of development, (ii) establishers, (iii) certification process, (iv) nature of assessment, (v) phase of assessment, (vi) mode of assessment, (vii) rating system, and (viii) themes of coverage, which can be categorized into three broad areas: (i) "Development", (ii) "Application", and (iii) "Measurement" system (Figure 4).

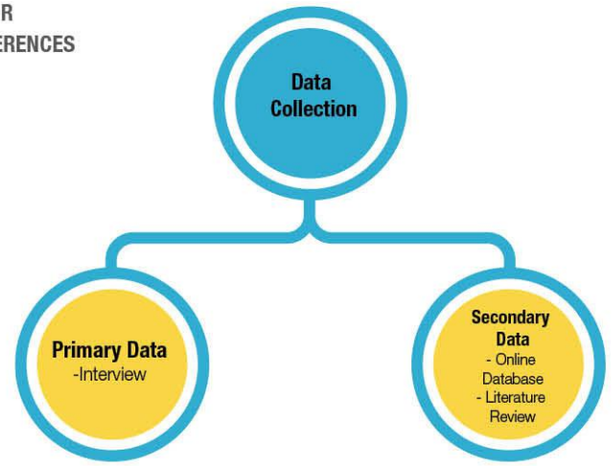
"Development" aims to review the physical characteristics of the tools; while "Application" looks into assessment characteristics of the tools. The scoring system and the sustainability aspects to be assessed fall under the coverage of "Measurement". Apart from the past literature review, the selection of these criteria has also been discussed and confirmed through focus group discussion organized by

the Construction Research Institute of Malaysia (CREAM) during its previous research (Hamid et al., 2014).

FIGURE 4: REVIEW CRITERIA ON TOOLS' SIMILARITIES AND DIFFERENCES



2.1 REVIEW CRITERIA FOR SIMILARITIES AND DIFFERENCES



2.2 REVIEW CRITERIA FOR SUSTAINABILITY ATTRIBUTES

The assessment of sustainability attributes aims to study on how well the rating tools address the primary areas of sustainability, such as siting, energy use, water use, indoor environmental quality, materials selection etc. At present, rating tools tend to be organised in different ways making analysis of scope difficult. Indeed Haapio and Viitaniemi (2008) noted that the complexity of frameworks and their different structures may even make them impossible to compare. Besides, criteria within themes are described and grouped differently. Different tools use different terminologies to describe the same entity, or the same terminology for different entities, in accordance with their respective local practices. In particular, sustainability attributes are often compared to a set of themes provided by the author: Luederitz (2013) developed nine principles for 'sustainable urban neighbourhood development'; Lee (2013) uses ten; Hamedani (2013) identifies eight criteria in his comparison; Haapio (2012) and Chandratilake (2013) use seven, though these do not correspond; the SBTool 2010 focuses on seven distinct issues which is the outcomes of the Sustainable Building (SB) Challenge – a continuation of the Green Building Challenge process began in 1996.

In the present study, major rating systems in practice such as Leadership in Energy and Environmental Design (LEED), Building Research Establishment Environmental Assessment Method (BREEAM), and Green Mark are referred to in establishing a set of review criteria for sustainability attributes. The reason of making such selection is due to the fact that BREEAM is the oldest sustainable rating tool in the world; while LEED is an international tool that often to be adopted in Malaysia. Green Mark is selected because it is developed by country – Singapore – which is a tropical country and shares a lot of issues related to climatic, cultural, and social. The sustainability attributes (including the sub-categories) of these tools are identified and studied in detailed. Similar aspects (including sub-categories) are then consolidated into a larger group, as to create the uniformity and standardization of sustainability aspect. Table 1 shows how the categorization is done in resulting nine major sustainability aspects eventually.

"Project Planning & Management" is a category that covers integrative project management. "Site Planning & Management" covers all aspects that related to site selection, site preparation, as well as site management so that the environmental impact or pollution to the surrounding areas are minimized. "Transportation" refers to those aspects that focus on providing public transportation connectivity, facilities and supports so that publics are encouraged to use alternative transportation. "Energy Efficiency" and "Water Efficiency" are quite straight forward in the sense that both categories focus on measures that can enhance efficient use of energy in terms of electricity and water, respectively. IEQ refers to aspects that look into the efforts that can enhance occupants' comfort, health, and wellbeing through indoor environment condition. Both the "Materials & Resources" and "Waste" categories

emphasize on the use of construction materials with a low environmental impact, and to promote resource efficiency via the effective management and reduction of construction waste, respectively. "Innovation" refers to those aspects that encourage projects to achieve exceptional or innovative performance.

OVERVIEW ON EXISTING SUSTAINABILITY RATING TOOLS DEVELOPED BY MALAYSIA

03

Overview on Existing Sustainability Rating Tools Developed by Malaysia

At present, there is no common standard set of criteria for the rating of sustainability, where each country has their own rating systems. Even Malaysia has more than one rating tools developed by various organisations. Based on the information gleaned from the literature review, ten sustainability rating tools developed by Malaysia were identified. As shown in Figure 5, there was launching of sustainable rating tool every year since 2009. The similarities and differences of these tools are stipulated in Table 2; while a brief introduction on each tool is given in the following sections, based on the alphabetical order.

TABLE 1: CATEGORIZATION OF SUSTAINABILITY ASPECTS

Primary Sustainability Theme	International Sustainable Rating Tool		
	BREEAM	LEED	Green Mark
Project Planning & Management	Project brief and design	Integrative process	
	Life cycle cost ad service life planning		
	Responsible construction practices		
	Commissioning and handover		
	Aftercare		
Site Planning & Management	Site selection	Neighbourhood Development Location	Greenery Provision
	Ecological value of site and protection of ecological features	Sensitive Land Protection	Environmental Management Practice
	Enhancing site ecology	High-Priority Site	Stormwater Management
	Long term impact on biodiversity	Surrounding Density and Diverse Uses	
	Surface water run-off	Construction Activity Pollution Prevention	
	Reduction of night time light pollution	Site Assessment	
	Water monitoring	Indoor Water Use Reduction	Water Usage and Leak Detection
	Water leak detection	Building-Level Water Metering	Irrigation System and Landscaping
	Water efficient equipment	Outdoor Water Use Reduction	Water Consumption of Cooling Tower
		Indoor Water Use Reduction	
		Cooling Tower Water Use	
		Water Metering	

Primary Sustainability Theme	International Sustainable Rating Tool		
	BREEAM	LEED	Green Mark
IEQ	Visual comfort	Minimum indoor Air Quality Performance	Daylighting
	Indoor air quality	Environmental Tobacco Smoke Control	Thermal Comfort
	Thermal comfort	Enhanced Indoor Air Quality Strategies	Noise Level
	Acoustic performance	Low-emitting Materials	Indoor Air Pollutants
	Safety and security	Construction Indoor Air Quality Management Plan	Indoor Air Quality (IAQ) Management
		Indoor Air Quality Assessment	High Frequency Ballasts
		Thermal Comfort	
		Interior Lighting	
		Daylight	
		Quality Views	
		Acoustic Performance	
Materials & Resources	Life cycle impacts	Fundamental Refrigerant Management	Sustainable Construction
	Responsible sourcing of materials	Enhanced Refrigerant Management	Sustainable Products
	Designing for durability and resilience	Building Life-Cycle Impact Reduction	Refrigerants
	Material efficiency	Building Product Disclosure and Optimization – Environmental Product Declarations	
	Impact of refrigerants	Building Product Disclosure and Optimization – Sourcing of Raw Materials	
	NOx emissions	Building Product Disclosure and Optimization – Material Ingredients	
Waste	Construction waste management	Storage and Collection of Recyclables	
	Recycled aggregates	Construction and Demolition Waste Management Planning	
	Operational waste	Construction and Demolition Waste Management	
	Speculative floor and ceiling finishes		
	Adaption to climate change		
	Functional adaptability		
Innovation		Innovation	Green Features & Innovations
		LEED Accredited Professional	

3.1 CASBEE ISKANDAR

Iskandar Malaysia (IM) aims to become a strong, sustainable metropolis with international standing by 2025. In an effort to achieve this goal and to accelerate IM's transition into a low carbon society, development of cities, neighbourhoods and buildings in the region have to be more energy efficient and in harmony with environment with low impact on the ecosystem. Thus, an internationally recognized built environment assessment tool plays a vital important role to encourage building owners and developers to "go-green" and help promote development of green cities, neighbourhoods and buildings in IM.

CASBEE is based on the concept of environmental efficiency or eco-efficiency in terms of built environment efficiency (BEE). It takes into account the level of quality within the targeted built environment, while accounting for environmental load outside the targeted built environment. It can be used for different scales of built environment performance, ranging from a single building (CASBEE Building) to a group of buildings (CASBEE Urban Development) and the wider context of city environment (CASBEE City). This is the uniqueness and holistic approach of CASBEE's compared to other assessment tools such as GBI, LEED, Green Mark and others. CASBEE has been successfully used in over 1,700 municipalities in Japan. In order to prove the CASBEE is able to become the assessment tools to encourage green development and to suit the local context in Iskandar pilot project has been carried out and well tested. The pilot project was conducted in collaboration with Institute for Building Environment and Energy Conservation (IBEC), Keio University, Hosei University and Universiti Teknologi Malaysia (UTM). The pilot project started in August 2015 and completed in May 2016.

Several buildings (i.e. industrial factories, office building and residential apartments), urban developments and local authority level in Iskandar Malaysia were selected to test the newly adapted CASBEE Iskandar Manuals to suit local context. They were: J.S.T. Connectors (M) Sdn Bhd (Score 4 stars of 5), Heng Hiap Industries Sdn Bhd (Score 3 stars of 5), JLand Tower, Komtar JBCC (both score 3 stars of 5) and the Molek Pine 4 (score 4 stars of 5). For CASBEE Islandar Urban Development, two townships were assessed scoring 4 stars of 5. They were The Seed, Taman Sutera Utama and Bandar Dato' Onn, Johor Bahru. For CASBEE Iskandar Cities, three local authorities were selected, they were Majlis Bandaraya Johor Bahru, Majlis Perbandaran Johor Bahru Tengah, and Majlis Daerah Kulai. The scorings were B+, B+, and B-, respectively.

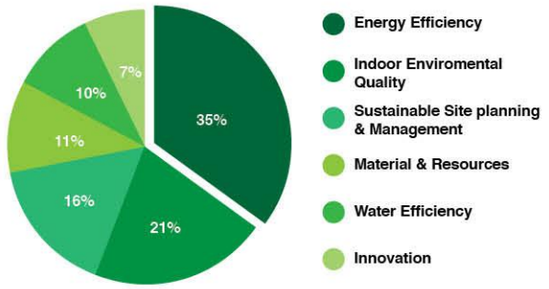
These results showed that an important milestone was achieved upon completion of the CASBEE Iskandar pilot project that can be readily applied within IM through criteria adaption and customization. The newly produced CASBEE Iskandar manuals fully complement other initiatives currently being undertaken by IRDA to contribute to the greening of the built environment including the development of the framework for Building Energy Monitoring and Reporting System (BEMRS) and Green Accord Initiative Award (GAIA). As a way forward, further studies are needed to convert and adapt the highly sophisticated Japanese CASBEE software. In addition, a CASBEE Iskandar Centre (CIC) is proposed to further promote, implement, and manage the CASBEE Iskandar development. CIC will be the centre for the training and monitoring of green buildings performance in Iskandar Malaysia.

3.2 GREEN BUILDING INDEX (GBI)

Green Building Index (GBI) is formed under the initiative of Malaysian Institute of Architect (PAM) and Association of Consulting Engineer Malaysia (ACEM), as to promote sustainability in the built environment and raise awareness among the industry players about environment issues. GBI provides an opportunity for developers and building owners to design and construct green, sustainable buildings that can provide energy savings, water savings, a healthier indoor environment, better connectivity to public transport and the adoption of recycling and greenery for their projects and reduce our impact on the environment. Building will be awarded GBI Malaysia rating score based on six key criteria including energy efficiency, indoor environment quality, sustainable site planning, material and resources, water efficiency and innovation.

Since its establishment, GBI keep expanding the types of building assessment. It is now covering non-residential new construction, residential new construction, non-residential existing building, industrial new construction, industrial existing building, non-residential new construction, non-residential existing building, and township. The main sustainability criteria of GBI includes: energy efficiency, sustainable site planning & management, water efficiency, indoor environmental quality, and material & resources innovation (Figure 6).

FIGURE 6: GBI WEIGHTING ON MAIN CRITERIA



3.3 GREEN PASS

Green Performance Assessment System (Green PASS) is developed by the Construction Industry Development Board of Malaysia (CIDB). The tool aims to encourage a sustainable construction by focusing on the construction and operation

stage through the reduction of CO2. It is an evaluation system that measures the impact of building construction works and building operations on the environment by estimating carbon emission from construction phase to operation throughout the building's lifecycle for 50 years. It applies to both new and existing buildings covering five elements: site, energy, indoor environmental quality, water, and waste.

An achievement of 100 % carbon reduction is designated carbon neutral, represented by six diamonds. The carbon emission baseline is the calculation of the sum of embodied and operational carbon conducted or projected in a Business As Usual (BAU) scenario. In any given project, the percentage of carbon reduction is based on the difference between the CO2 emission of the BAU scenario and the CO2 emission of the new/ retrofitted building.

The assessment of Building Construction begins from site possession until the issuance of certificate of completion and compliance (CCC). Renovation works involving major structural changes and with more than 50 % materials replacement will be considered major construction therefore qualifying for applicability of the Green PASS building construction award. The assessment of Building Operations will only be eligible upon meeting two conditions specified below:

- Receipt of certificate of completion and compliance (CCC) for newly completed building; and
- 12 months of operations with a minimum of 70 % occupancy for newly completed building and retrofitted buildings.

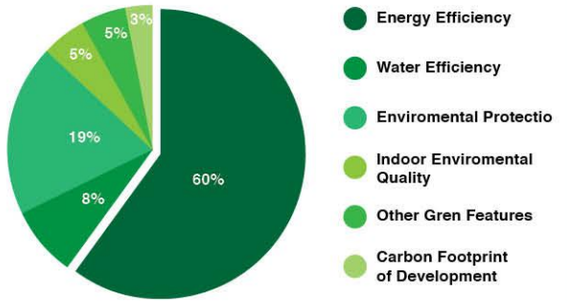
Green Pass was initially based on two reference models, which are the National Australian Built Environment Rating Australia (NABERS) and Green Globe USA. Unfortunately, it is not materialized due to some internal issues. It is now merged with PHJKR to form MyCREST.

3.4 GREEN REAL ESTATE (GREENRE)

Green Real Estate (GreenRE) is launched by the Real Estate and Housing Developers' Association (REHDA) in year 2013, with the aim of driving Malaysia's real estate industry towards a more sustainable and liveable built environment. The rating tool assesses a building's performance, in terms of energy efficiency, water efficiency, environmental protection, indoor environmental quality, and carbon emissions of the development, commencing from the conceptualization and design stage, construction and up to post completion. The tool is currently aimed for high rise residential building and landed houses.

The assessment criteria are broadly classified into two main groups, namely Energy Related Requirements and Other Green Requirements. The Energy Related Requirements consist of Energy Efficiency where credits are allocated for the various energy efficient designs, practices and features used. A minimum of 30 credits is required from this group in order to be eligible for certification. Other Green Requirements consist of Water Efficiency, Environmental Protection, Indoor Environmental Quality, Other Green Features, and Carbon Emission of Development. Credits are allocated for the water efficient features, environmentally friendly design practices, innovative green features used and carbon emission of development. A minimum of 20 credits are required from this group for certification. Figure 7 shows the percentage of weighting on the main criteria of GreenRE.

FIGURE 7: GREENRE WEIGHTING ON MAIN CRITERIA



3.5 LOW CARBON CITIES FRAMEWORK & ASSESSMENT SYSTEM (LCCF)

The Low Carbon Cities Framework and Assessment System or better known as the LCCF is a system developed by my ministry. The purpose of this system is to assist our stakeholders such as developers, local councils, town planners, non-governmental organizations (NGO's) and the public to lower the levels of carbon emission in our cities towards achieving sustainable urban developments.

This system serves as a guide that will propel stakeholders for cities, townships and neighbourhoods to re-assess their priorities in the planning and developing of new projects, as well as strategies that can be taken by existing cities, townships and neighbourhoods in reducing their carbon emission levels. Besides serving as a comprehensive guide, the LCCF also has an inbuilt carbon calculator with carbon equivalents that would help stakeholders assess their current baseline levels of the cities, townships and neighbourhood and target their intended levels.

LCCF is a national framework and assessment system to guide and assess the development of cities and to support holistic sustainable development in Malaysia. It will provide for equivalent

GHG as a result of human activities in cities so that there may be awareness towards how these GHG can be reduced. It is a performance based system which captures the actual environmental impact of a development in terms of total carbon emissions. This measure is carried out through:

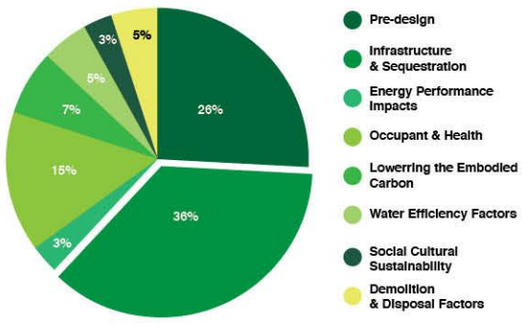
- The construction stage;
- The embodied carbon contained in the cities constructed form; and
- The operational carbon emissions during the life span of the cities.

It gives priority to performance criteria which have significant impacts on the environment and ensure that this priority is undertaken to reflect the targeted goal.

3.6 MALAYSIAN CARBON REDUCTION AND ENVIRONMENTAL SUSTAINABILITY TOOL (MYCREST)

MyCREST or the Malaysian Carbon Reduction and Environmental Sustainability Tool is created through the joint knowledge and expertise of members of government agencies, public as well as private institutions, corporations and companies, namely Kementerian Kerja Raya Malaysia (KKR), Jabatan Kerja Raya Malaysia (JKR) and Construction Industry Development Board Malaysia (CIDB). MYCREST essentially combines three basic tools in order to construct a 'scoring plan' which is then used to assess a building for certification. The primary objective of MyCREST is to create the Malaysian Carbon Reduction and Environmental Sustainable Tool (MyCREST) based on a performance-based objective, to emphasise the role of operations and create a tool that can quantify the resultant impact on the environment including carbon emission within the built environment. Therefore, it has the capacity to measure, monitor and quantify while at the same time being useable and adoptable in order to be effective within the construction industry. Figure 8 shows the percentage of weighting on the main criteria of MyCREST.

FIGURE 8: MYCREST WEIGHTING ON MAIN CRITERIA

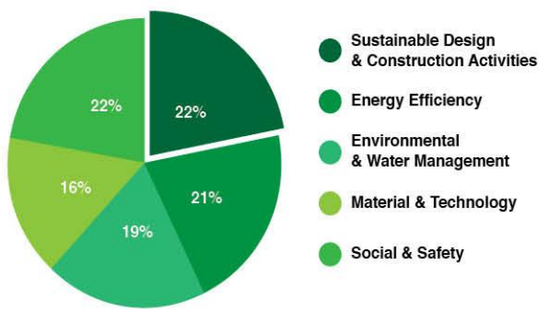


3.7 MY GREEN HIGHWAY INDEX (MYGHI)

A green highway is a roadway design which is based on a relatively new concept of roadway design that integrates transportation functionality and ecological requirements. A green highway will give benefit to not only the transportation infrastructure but also the ecosystem, urban growth, public health, and surrounding communities. The need for promoting sustainability and green highway construction require a green highway assessment system. Therefore, the Malaysia Green Highway Index is developed as a performance baseline standard in order to measure the level of greenness for current highways in Malaysia.

The Malaysia Green Highway index (MyGHI) is a localized study attempt for Malaysia's highway industry. This concept has never been attempted before in Malaysia. MyGHI is an outcome of collaboration research between UTM Flagship Project and Malaysian Highway Authority. This research project started since December 2012. MyGHI was launched by the Ministry of Work on 19th March 2014. MyGHI has highlights five main elements of Energy Efficiency, Sustainable Design and Construction Activities, Environment and Water Management, Social and Safety, and Material and Technology (Figure 9). Targets must be set in order to achieve the rating system, which will include the reduction of similar construction greenhouse gas emission, energy consumption, and waste materials. Evaluators will grade the highway projects by considering the action taken against storm water practices and other ecosystem considerations, and look at the life-cycle cost and recycled material content. Green highway is used to "certify" a project based on the total credit points achieved. Depending on the credit points awarded to the project, these levels can be called "achievement" or "certification" levels. There are four certification levels: Platinum. Gold, Silver, and Certified. Figure 14 shows the percentage of weighting on the main criteria of MyGHI.

FIGURE 9: MYGHI WEIGHTING ON MAIN CRITERIA



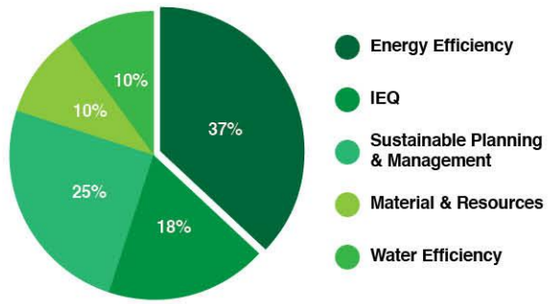
3.8 MELAKA GREEN SEAL

The Meterai Hijau Melaka or Melaka Green Seal is the first green building conforming rating tool for the state of Melaka. It is drafted by a sub-committee under Melaka Green Development Organization (MGDO) and Green Earth Design Solution (GEDS). It is first presented to the Chief Minister of Melaka in November 2011 and Melaka Green Council in December 2012. Several series of workshop/forum were held to engage the public in drafting the rating tool and to gather the feedback from the stakeholders. The first was held in January 2012 and the second in August 2013. The third and fourth were held in June and November 2014 respectively. Five criteria are covered, namely:

- Energy Efficiency
- Internal Environment Quality
- Sustainable Management & Planning
- Material & Resources
- Water Efficiency.

Each of these criteria is divided into subsections which consist of compulsory and option elements. Points are given for both the compulsory and option elements. They are referred to the criteria set by Uniform Building By Law, MS 1525 and Green Building Index (GBI). Figure 10 shows the percentage of weighting on the main criteria of Melaka Green Seal.

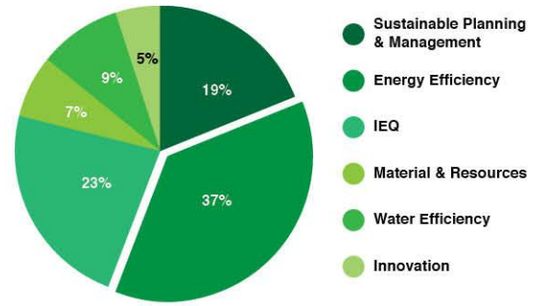
FIGURE 10: MELEKA GREEN SEAL WEIGHTING ON MAIN CRITERIA



3.10 SKIM PENILAIAN PENARAFAN HIJAU JKR (PHJKR)

PHJKR or Skim Penilaian Penarafan Hijau JKR is a green rating tool developed based on the performance of the existing building towards sustainability with the consideration of latest requirement by the government. JKR (Jabatan Kerja Raya Malaysia) or Public Works Department started to practice green initiative in projects implemented since the 8th Malaysian Plan. PH JKR is introduced and applied by JKR for evaluating the sustainability level of its construction projects. PH JKR focuses on the design stage and the assessment is based on a list of set criteria. It covers four types of building, including non-residential new building, non-residential existing building, non-residential without air conditioner, and the health service building. Figure 11 shows the percentage of weighting on the main criteria of PHJKR.

FIGURE 11: PHJKR WEIGHTING ON MAIN CRITERIA



3.11 SUSTAINABILITY INDEX (SUSDEX)

The Sime Darby Property (SDP) applies a bespoke sustainability assessment index, known as SUSDEX, to guide and measure the sustainability of its townships and the company's business processes. Initially developed in 2010, the tool was recently revised and is now referred to as SUSDEXPlus. SUSDEXPlus is based on the Global Reporting initiative G4.0 Guidelines, the Green Building Index (GBI) Township Tool (V1.0), LEED (Neighbourhood v4), Green Mark (House v1.0) and CPTED (Crime Prevention Through Environmental Design) Guidelines.

The results of SUSDEXPlus assessments provide a comprehensive operationally-focused measure of sustainability performance of townships throughout the value chain from planning a township through to maturity and eventual full handover. This in-house tool helps us to optimise resources whereby the focus is on ensuring a sensible balance by townships between delivering the pillars of People, Planet, and Prosperity during the development process and within the township developments themselves. The assessment process also provides townships teams with recommendations for enhancement, which are often implemented by the following assessment.

Presently, the company's Sustainability and Quality Management (SQM) Department conducts the assessments of all townships twice a year and internally rates their sustainability performance either with a Silver, Gold or Platinum rating. This tool and the rating system applied internally leads to a competitive environment where townships now aim to outperform each other in terms of sustainability. This tool has been under gradual progressive improvement ever since it was first applied in

2009/2010. To date, the tool has been independently evaluated twice by the Division Sustainability Advisor, Forum for the Future who are based out of the UK with regional offices. Further to this independent guidance for improvement, the Division engaged an academic institution mid-way through the last financial year for an academic review of the revised index, the results of which would only be forthcoming after the reporting period of this present report. Presently, SUSDEXPlus is applied to our townships from vision plan to hand over and evaluates the township planning and operational sustainability performance based on 88 indicators.

TABLE 2: SIMILARITIES AND DIFFERENCES OF SUSTAINABILITY RATING TOOLS IN MALAYSIA

Criteria	GBI	GreenRE	LCCF Assessment Tool	MyCrest
Date of establishment	2009	2013	2011	2016
Developed by	PAM and ACEM	REHDA	KeTTHA	CIDB
Certification process	Voluntary	Voluntary	Voluntary	Mandatory for JKR new projects worth RM50 million and above
Nature of assessment	Design based	Design based	Performance based	Design & performance based
Assessment design & Construction	Design &Construction	Construction & Operation	Design Construction Operation & Maintenance	Refurbishment & Demolition
Mode of assessment	Criteria checklist	Criteria checklist	Calculation of CO2 emission	Criteria checklist Calculation of CO2 emission
Building type	• Non-residential new construction • Residential new construction • Non-residential existing building • Industrial new construction • Industrial existing building • Data centre • Retail • Hotel • Resort • Township	• New residential • New non-residential • Existing non-residential • Township	• Township development	• Air-conditioned building • Non-air-conditioned building
Rating system	Score (by points): • 86+ points = Platinum • 76-85 points = Gold • 66-75 points = Silver • 50-65 points = Certified	Score (by credits): • 90 to 150 = Platinum • 85 to < 90 = Gold • 75 to < 85 = Silver • 50 to < 75 = Bronze	Diamond rating (percentage of CO2 reduction): • 70-99% CO2 reduction = 5 diamond • 50-69% CO2 reduction = 4 diamond • 30-49% CO2 reduction = 3 diamond • 10-29% CO2 reduction = 2 diamond • 1-9% CO2 reduction = 1 diamond	MyCREST rating (by percentage): • 80 – 100% = 5 stars • 70 – 79% = 4 stars • 60 – 69% = 3 stars • 50 – 59% = 2 stars • 40 – 49% = 1 star

Criteria	GBI	GreenRE	LCCF Assessment Tool	MyCrest
Themes of coverage	• Energy efficiency • Indoor Environmental Quality (IEQ) • Sustainable site planning and management • Material and resources • Water efficiency • Innovation	• Energy Related Requirements: 3 Energy efficiency • Other green requirements: 3 Water efficiency 3 Environmental protection 3 Indoor environmental quality 3 Other green features 3 Carbon emission of development	• Urban Environment 3 Site selection 3 Urban form 3 Urban greenery and environmental quality • Urban Transportation 3 Shift of transport mode 3 Green transport infrastructure 3 Clean vehicles 3 Traffic management • Urban Infrastructure 3 Infrastructure provision 3 Waste 3 Energy 3 Water management • Building 3 Low carbon buildings 3 Community services	• Design: 3 Pre-design 3 Infrastructure & sequestration 3 Energy performance impacts 3 Occupant & health 3 Lowering the embodied carbon 3 Water efficiency factors 3 Social & cultural sustainability 3 Demolition & disposal factors 3 Sustainable & carbon initiatives • Construction: 3 Infrastructure & sequestration 3 Energy performance impacts 3 Occupant & health 3 Lowering the embodied carbon 3 Water efficiency factors 3 Social & cultural sustainability 3 Demolition & disposal factors 3 Sustainable & carbon initiatives • Operation & Maintenance: 3 Infrastructure & sequestration 3 Energy performance impacts 3 Occupant & health 3 Lowering the embodied carbon 3 Water efficiency factors 3 Social & cultural sustainability 3 Demolition & disposal factors 3 Sustainable & carbon initiatives

Criteria	Green PASS	PH JKR	SUSDEX	MyGHI
Date of establishment	2012	2012	2010	2014
Developed by	CIDB	JKR	Sime Darby Property	Universiti Teknologi Malaysia (UTM) Lembaga Lebuhraya Malaysia (LLM)
Certification process	Voluntary	Voluntary	Mandatory for all Sime Darby development project	Voluntary
Nature of assessment	Performance based	Design based	Design based	Design based
Phase of assessment	Construction & Operation	Design & Construction	Design & Construction	Design & Construction
Mode of assessment	Calculation of CO2 emission	Criteria checklist	Criteria checklist	Criteria checklist
Building type	• New building • Existing building	• New non-residential • Existing non-residential • Non-residential non-air conditioned • Healthcare services	Township development	Highway
Rating system	Diamond rating (percentage of CO2 reduction): • 100% CO2 reduction = 6 diamond • 70-100% CO2 reduction = 5 diamond • 50-70% CO2 reduction = 4 diamond • 30-50% CO2 reduction = 3 diamond • 30-5%0 CO2 reduction = 3 diamond • 10-30% CO2 reduction = 2 diamond • 1-10% CO2 reduction = 1 diamond	Star rating (by percentage): • 40-49% = 2 star • 50-69% = 3 star • 70-84% = 4 star • 85-100% = 5 star	Score (by percentage): Old/Mature Development 50 – 75% = Silver-rated >75 – 85% = Gold-rated >85% = Platinum-rated New Development • 61 – 70% of total points or 40 – 65% = Silver-rated >65 – 75% = Gold-rated >75% = Platinum-rated	Score (by percentage or points): • 81 – 100% of total points or 250 – 310 points = Platinum • 71 – 80% of total points or 219 – 249 points = Gold 188 – 218 points = Silver • 50 – 60% of total points or 155 – 187 points = Bronze
Themes of coverage	• Building construction: 3 Site 3 Material 3 Energy 3 Water 3 Waste • Building operation: 3 Indoor environmental quality (pre-requisite) – 80% satisfaction of occupants 3 Energy 3 Water	• Sustainable site planning & management • Energy efficiency • Indoor environmental quality (IEQ) • Material & resources management • Water efficiency • Innovation	• Prosperity: 3 Direct & indirect GDV 3 Innovative design & connectivity 3 Risk management 3 Local economic impact 3 Business excellence 3 Product & responsibility • Planet: 3 Green design & construction 3 Environmental impact • People: 3 Labour practice & decent work 3 Society & security 3 Human rights	• Sustainable Design & Construction Activities (SDCA) • Energy Efficiency (EE) • Environmental & Water Management (EWM) • Material & Technology (MT) • Social & Safety (SS)

Criteria	Melaka Green Seal	CASBEE Iskandar
Date of establishment	2014	2016
Developed by	Melaka Green Development Organization (MGDO)	Iskandar Malaysia (IRDA)
Certification process	Voluntary	For Urban Development, for City and for Building
Nature of assessment	Design based	CASBEE ISKANDAR for Building (individual buildings) CASBEE ISKANDAR for Urban Development (for building block assessment) CASBEE ISKANDAR for City (environmental assessment at the city scale)
Phase of assessment	Design & Construction	Building - Industrial building, commercial building and residential building Urban Development and city - basic concept and principle
Mode of assessment	Criteria checklist	Building – Scoring systems or checklist Urban Development – Concept of Built Environment Efficiency Urban Development (BEEUD) calculation City - Concept of Built Environment Efficiency (BEE) calculation
Building type	• New residential building • New non-residential building	• Building • Urban development • City
Rating system	Score (by points): W = Compulsory items P = Optional items Residential building = 15W + 16P Non-residential building = 20W + 20P (To be issued MHM Certificate the building must satisfies all the compulsory items plus another 5 points optional items for a minimum total point of 20 points for Residential and 25 points for Non-residential)	-Building Ranks / Assessment / BEE value, etc. / Expression S / Excellent / BEE = 3.0 or more and Q = 50 or more / ★★★★★ A / Very Good / BEE = 1.5-3.0 BEE = 3.0 or more and Q is less than 50 / ★★★★ B+ / Good / BEE = 1.0-1.5 / ★★★ B- / Fairly Poor / BEE = 0.5-1.0 / ★★ C / Poor / BEE = less than 0.5 / ★ Urban Development – Built Environment Efficiency (BEE) = Q (Environmental quality of building) / L (Environmental load of building) City - Built Environment Efficiency (BEE) = Score for Quality (Q) (Environment, Social, Economic) (0 < score for Q <100) Score for Load (L) (Annual CO2 emission per capita) (0 < score for L <100)
Themes of coverage	• Energy Efficiency (EE) • Indoor Environmental Quality (IEQ) • Sustainable Site Planning & Management (SM) • Material & Resources (MR) • Water Efficiency (WE)	• Building – Scoring weightage, Emissions Coefficient, Life Cycle CO2, • Urban Development – QUD Environment quality, LUD Environment load, Concept for LUD assessment, LUD total score and conversion to LRUD • City - i) city environmental performance of efficiency, ii) "environmental quality of city (Q)" and "environmental load of emitted outside of the city (L)" and iii) newly-developed Built Environment Efficiency (BEE) criteria

ASSESSMENT OF SUSTAINABILITY ATTRIBUTES

04

Assessment of Sustainability Attributes

While these rating tools have various similarities and differences, several general trends can be identified. First of all, these tools can be categorized into "Criteria based" or "Measurement based" (Table 3). Criteria based rating tools include GBI, GreenRE, MyGHI, Melaka Green Seal, PHJKR, and SUSDEX; while measurement based rating tools include CASBEE Iskandar, Green Pass, and LCCF. MyCREST is the only tool that employs both criteria checklist and carbon calculation. In terms of topical focus, Green Pass, MyCREST, Melaka Green Seal, and PHJKR offer assessment for individual building; while LCCF and SUSDUX are applicable for township only. CASBEE Iskandar, GBI, and GreenRE are rating tools that offer assessment for both the individual building and the whole township. MyGHI is the only tool that make available for infrastructure assessment.

TABLE 3: TYPES OF MALAYSIAN SUSTAINABILITY RATING TOOLS

Group	Rating Tools	
Green building	Criteria based	GBI
		GreenRE
		Melaka Green Seal
		MyCREST
		PHJKR
	Measurement based	Green Pass
		MyCREST
Township	GBI	
	GreenRE	
	SUSDEX	
	LCCF	
	CASBEE Iskandar	
Infrastructure	MyGHI	

4.1 CRITERIA-BASED RATING TOOL

There are five green building rating tools developed in Malaysia; two of them (i.e. GBI and GreenRE) were established by the professional associations, while another three (i.e. Melaka Green Seal, MyCREST, and PH JKR) were government-driven. These tools are attempting to optimize building performance while reducing the associated environmental impact through the provision of measurement on the building's environment effect and a set of standards that allow for the building to be judged objectively.

At present, only GBI has achieved maturity as it continuously releasing various tools for specific building types and applications. The others are believed to have relatively lower awareness among the users (or public) as they were newly launched or still in the final stage of refinement before released to the public. Except for MyCREST, which also contains the mode of measurement based assessment based on the real-time measurement of carbon emission, the rest of the rating tools are based on the criteria checklist. In terms of application, all these tools are to be implemented during the design and construction stages, while MyCREST is also designed operational and maintenance stage.

To ensure the comparisons are conducted on the same basis, the following versions of each of the five rating tools for new commercial buildings was evaluated in detail. New commercial buildings were chosen because they collectively account for the greatest amount of resources consumption and environmental emissions, and are thus the first building type targeted by most rating tools. Accordingly, the assessment is based on the following document/manual user guides:

- GBI – NRNC Non-Residential Tool (V1.0)
- GreenRE - Non-Residential Building (NRB v3.0)
- MyCREST – Design Stage Certification (Version 1.0)
- Melaka Green Seal – Residential and Non-residential New Building
- PHJKR – Non-residential New Building

In order to produce meaningful results, the following manual or reference guide of international green building rating tools is referred:

- BREEAM UK – New Construction 2016
- LEED – Building Design and Construction (v4)
- Green Mark – New Non-residential Building (Version NRB/4.1)

Appendix 1 shows in detail how such re-categorization is done, while Table 4 summarizes the distribution of each primary theme according to each tool. It can be seen that MyCREST is the only tool

that covers all the primary sustainability themes, from "Project Planning & Management" to "Innovation", while the other tools do not have the full coverage – be it without the "Project Planning & Management" (i.e. GBI, GreenRE, PHJKR), without "Innovation" (i.e. Melaka Green Seal), or without "Waste" (i.e. Melaka Green Seal). In this sense, MyCREST is considered to be relatively comprehensive than the others.

A comparison of relative contributions of assessments on primary sustainability themes to the overall assessment in the five rating tools is shown in Figure 12. It can be seen that energy efficiency is the most dominant issue in all the five rating tools, which account for, ranging from 37% to 56% of the total score. Amongst them, GreenRE allocates 56% to "Energy Efficiency", followed by MyCREST (49%), PHJKR (39%), Melaka Green Seal (38%), and GBI (37%). This is followed by "Site Planning & Management" and "IEQ", either placed at the second or third. For example, GreenRE, MyCREST, and Melaka Green Seal place "Site Planning & Management" as second, in contrast to GBI and PHJKR which place "IEQ" as second. One commonality of all the five rating tools is that the contribution of "Transportation" is the least among the primary sustainability themes.

TABLE 4: PRIMARY THEMES OF SUSTAINABILITY BY MALAYSIAN GREEN BUILDING RATING TOOLS

Primary Theme of Sustainability	Malaysian Green Building Rating Tool				
	GBI	GreenRE	MyCREST	Melaka Green Seal	PHJKR
Project Planning & Management	-	-	✓	✓	-
Site Planning & Management	✓	✓	✓	✓	✓
Transportation	✓	✓	✓	✓	✓
Water efficiency	✓	✓	✓	✓	✓
Energy efficiency	✓	✓	✓	✓	✓
Materials & resources	✓	✓	✓	✓	✓
Waste	✓	✓	✓	-	✓
IEQ	✓	✓	✓	✓	✓
Innovation	✓	✓	✓	-	✓

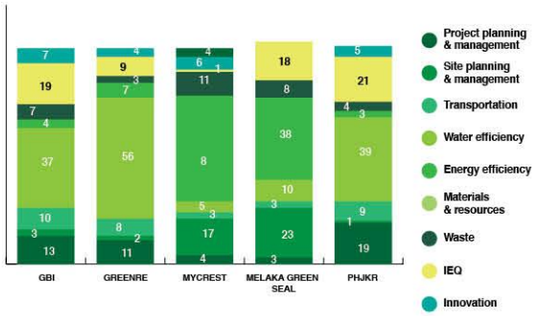


FIGURE 12: WEIGHTAGE FOR MAJOR SUSTAINABILITY THEME AMONG MALAYSIAN RATING TOOLS

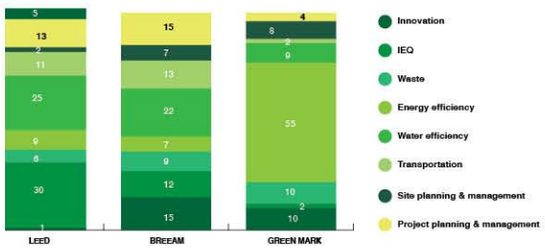


FIGURE 13: WEIGHTAGE FOR MAJOR SUSTAINABILITY THEME OF LEED AND BREEAM

Often, a rating tool can be linked back to common aspects with other systems. Depending largely on the particular influences on each property market. Many rating tools have been modified and adopted from earlier models that were originally developed in other countries. For example, it is possible to trace many systems back to LEED and BREEAM. The benefits of having a common foundation with LEED and BREEAAM may assist with moving towards an internationally-accepted rating tool, especially when there are recent signs of change and compromise. Among these tools, GBI and PHJKR share the highest similarity. The logic behind is that PHJKR is developed based on GBI, which in turn is influenced by LEED. In fact, all the Malaysian developed sustainable rating tools are influenced by GBI – the first Malaysian Green Building Rating Tool which is somehow can be linked back to LEED. This explained why the weighting for criteria of these tools are similar. GreenRE, on the other hand, is a direct adoption from Green Mark with minimum amendment.

As shown in Figure 13, BREEAM has a more balanced distribution among all categories compared to LEED and Green Mark. However, "Energy Efficiency" is still the highest weighted theme of these three international rating tools. Except for Green Mark which assigns 55% of the total score to "Energy Efficiency", the allocations of score in both LEED and BREEAM for such primary sustainability theme are 25% and 22%, respectively. Even when comparing to the five Malaysian developed green building rating tools shown in Figure 12, one can observe that weights assigned to "Energy Efficiency" are still higher than the one in LEED and BREEAM. This leads to the interpretation that "Energy Efficiency" is highly weighted due to the design specifications of these rating tools, in which they are established based on the tropical climate and geographical identities that is hot and humid for the whole year.

In fact, Malaysia is situated in a maritime equatorial area, where the climate is generally the same throughout the year, with uniform temperatures, high humidity, light winds, and

heavy rainfall (Hyde, 2008). The very nature of the Malaysian climate necessitates mechanically ventilated or air-conditional interiors, especially in urban areas. A study on the reformulation of the Malaysian Standard (MS) 1525, Overall Thermal Transfer Value (OTTV) in 2005 by Danida, produced a simple chart on the energy breakdown in typical buildings (Figure 14). This chart is important because it provides a clear understanding of the typical energy distribution in typical office buildings in Malaysia, thereby allowing a clear strategy to be developed to address the energy efficiency priorities in buildings.

The typical energy breakdown in Malaysian office buildings is 50% for air-conditioning, 25% for electrical lighting and 25% for small power (equipment). In addition, air-conditioning energy consumption is not only due to heat from solar gain in the building, but also due to heat from electrical lighting, electrical equipment, conduction (through the building fabric), the provision of fresh air in the building and human occupancy. Each of these items contribute a significant part to the air-conditioning energy used. As, such, energy efficiency in office buildings in this climate has to be addressed holistically by addressing every available opportunity.

Perhaps, a better understanding of the weighting allocation among these eight green building rating tools (covering five Malaysian developed and three international rating tools) can be achieved through correlation analysis. In statistics, the correlation coefficient (r) measures the strength and direction of a linear relationship between two variables. The value of r is always between +1 and –1. The interpretation of this value is shown in Table 5.

In the present study, correlations of weights as well as correlations of ranks of weights (1 = highest rank of weight; 9 = lowest rank of weight) assigned in each pair of rating tools to the nine primary sustainability themes were analysed using the bivariate correlation feature in SPSS, which helped unveil the similarity between the compared rating tools in weights and ranks of weights given to various themes. The correlation coefficients (r) for both the weights and rank of weights are shown in Table 6 and Table 7, respectively. The statistical analysis reveals that there is a high degree of agreement (more than 0.70) amongst the five Malaysian developed rating tools on weights. While in terms of ranks of weights, the correlations among the five Malaysian developed rating tools are generally strong and moderate.

FIGURE 20: TYPICAL ENERGY BREAKDOWN IN A COMMERCIAL BUILDING IN MALAYSIA

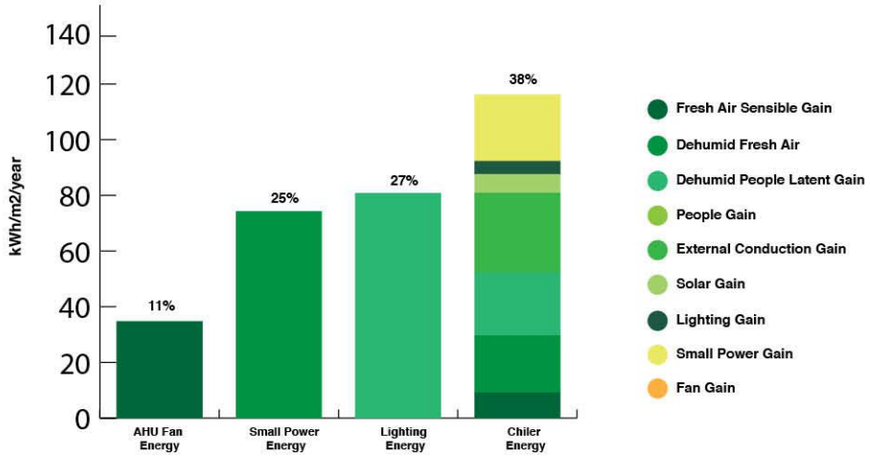


TABLE 5: INTERPRETATION OF CORRELATION COEFFICIENT

Value of r	Interpretation
Exactly –1	A perfect downhill (negative) linear relationship
–0.70	A strong downhill (negative) linear relationship
–0.50	A moderate downhill (negative) relationship
–0.30	A weak downhill (negative) linear relationship
0	No linear relationship
+0.30	A weak uphill (positive) linear relationship
+0.50	A moderate uphill (positive) relationship
+0.70	A strong uphill (positive) linear relationship
Exactly +1	A perfect uphill (positive) linear relationship

TABLE 6: BIVARIATE CORRELATION ANALYSIS ON WEIGHTS

	GBI	GreenRE	MyCREST	Melaka Green Seal	PHJKR	LEED	BREEAM	Green Mark
GBI	1							
GreenRE	0.908	1						
MyCREST	0.586	0.839	1					
Melaka Green Seal	0.662	0.844	0.862	1				
PHJKR	0.993	0.933	0.650	0.715	1			
LEED	0.757	0.933	0.856	0.899	0.800	1		
BREEAM	0.211	0.322	0.582	0.637	0.251	0.430	1	
Green Mark	0.756	0.920	0.786	0.783	0.786	0.870	0.132	1

TABLE 7: BIVARIATE CORRELATION ANALYSIS ON RANKS OF WEIGHTS

	GBI	GreenRE	MyCREST	Melaka Green Seal	PHJKR	LEED	BREEAM	Green Mark
GBI	1							
GreenRE	0.929	1						
MyCREST	0.870	0.975	1					
Melaka Green Seal	0.910	0.884	0.904	1				
PHJKR	0.982	0.897	0.870	0.958	1			
LEED	0.712	0.667	0.750	0.891	0.812	1		
BREEAM	0.606	0.664	0.707	0.757	0.648	0.528	1	
Green Mark	0.915	0.998	0.973	0.876	0.880	0.658	0.658	1

To further understand how the three selected international rating tools influence the Malaysian developed rating tools, the absolute value of the proximity correlation coefficient ($\overline{R_i^2}$) of each Malaysian developed rating tools to the three selected international rating tools are calculated by adopting Equation 1, where r is the correlation coefficient of one rating tool with other rating tools, X is the rating tools number (= 1 to 5), and m is the number of rating tools (5 in this study).

$$\overline{R_X^2} = \sum \frac{r^2}{(m-1)} \quad \text{Equation1}$$

The aim of the proximity correlation coefficient ($\overline{R_i^2}$) is to indicate the proximity of one rating tool and other rating tools – the higher the value; the closer the link. It is noted that the computed ($\overline{R_i^2}$) both for weights and ranks of weights for LEED and Green Mark are higher than the one applied to BREEAM (Table 15 and Table 16). This indicates that the Malaysian developed rating tools are closely linked to both LEED and Green Mark rather than to BREEAM. In terms of weights allocation, Malaysian developed rating tools are more similar to Green Mark; while in terms of rank of weights, they possess more similarity to LEED.

A more detailed discussion on how each of this tool tackles the major sustainability themes, especially on energy efficiency, site planning & management, IEQ, water efficiency, and materials & resources, is given in the following sections:

4.1.1 Energy Efficiency

Table 10 summarizes the strategies adopted by GBI, GreenRE, MyCREST, Melaka Green Seal, and PHJKR in achieving energy efficiency. For assessment of building energy efficiency, scopes of all the five Malaysian developed rating tools are fairly comprehensive; from outdoor environment to indoor environment, from global aspects to local aspects, and from design aspects to operational aspects. All the five schemes have explicitly spelt out assessment of commissioning of building energy systems, which, according to studies, is considered a good practice to ensure more marketable, and sustainable buildings. In general, strategies adopted for achieving building energy efficiency include: (i) building design, (ii) lighting control, (iii) air conditioning system control, (iv) energy consumption control, (v) effective maintenance, (vi) use of renewable energy, (vii) implementation of building energy management system.

TABLE 8: PROXIMITY CORRELATION COEFFICIENT OF WEIGHTS

Correlation Coefficients (r)						$\overline{R_X^2}$
	GBI	GreenRE	MyCREST	Melaka Green Seal	PHJKR	
Green Mark	0.120	0.142	0.135	0.110	0.111	0.617
BREEAM	0.052	0.063	0.071	0.082	0.060	0.329
LEED	0.072	0.064	0.080	0.113	0.094	0.525

TABLE 9: PROXIMITY CORRELATION COEFFICIENT OF RANKS OF WEIGHTS

Correlation Coefficients (r)						$\overline{R_X^2}$
	GBI	GreenRE	MyCREST	Melaka Green Seal	PHJKR	
Green Mark	0.082	0.121	0.088	0.088	0.088	0.467
BREEAM	0.006	0.015	0.048	0.058	0.009	0.137
LEED	0.082	0.124	0.105	0.115	0.091	0.518

TABLE 10: SUMMARY OF ENERGY EFFICIENCY STRATEGIES

Energy Efficiency Strategy	GBI	GreenRE	MyCREST	Melaka Green Seal	PHJKR
Building Energy Index	✓	✓	✓	✓	✓
Building envelope performance	✓	✓	✓	✓	✓
Roof thermal performance	✓	✓	✓	-	✓
Building Orientation	✓	✓	✓	-	✓
Artificial lighting	✓	✓	✓	-	-
Lighting zoning	✓	✓	✓	✓	✓
Sub-metering	✓	✓	✓	✓	✓
Auto-sensor	✓	✓	✓	-	-
Air conditioning system	✓	✓	✓	-	-
Natural ventilation	✓	✓	✓	-	-
Ventilation in common area	✓	✓	✓	-	-
Air infiltration	-	-	✓	-	✓
Renewable energy	✓	✓	✓	✓	✓
Commissioning/Recommissioning	✓	-	✓	✓	✓
Sustainable maintenance	✓	-	✓	✓	✓
Building energy management system	✓	-	✓	✓	-

However, each tool has different emphasis on energy efficiency strategies. As one can observe, MyCREST is the only tool that covers all aspect of energy efficiency strategy. GreenRE, on the other hand, gives more focus on building design, especially in increasing natural ventilation through passive design. GBI, Melaka Green Seal, and PHJKR focus more on lighting control. The commonality is that all these tools emphasize the importance of energy consumption control, effective maintenance, use of renewable energy, and the implementation of building energy management system.

4.1.2 Site Planning & Management

As shown in Table 11, both GBI and MyCREST cover a wide range of "Site Planning & Management" strategies. Among the common strategies are conservation of existing trees, provision of greenery, storm water management, environmental management, green roof/wall, solar reflectance index, and the provision of building user manual. However, there are also some specific strategies which are only covered by certain rating tools. For example, GBI emphasizes on workers' site amenities; MyCREST stresses on the control in external light spill; and PHJKR alone gives point for design for disable group.

4.1.3 Indoor Environment Quality (IEQ)

Table 12 shows the summary of IEQ strategies adopted by each green building rating tool. To note, most of the time, these strategies are sorted under the category of energy efficiency, especially for daylighting, artificial lighting, thermal comfort, and space arrangement, which are both active and passive strategies for enhancing thermal performance of the building. Common strategies are

daylighting, artificial lighting, acoustic comfort, thermal comfort, indoor air quality performance, ETS control, and low VOC materials. Among these tools, both GreenRE and Melaka Green Seal cover relatively lesser range of strategies. On the other hand, both GBI and PHJKR cover almost all the available aspects.

TABLE 11: SUMMARY OF SITE PLANNING & MANAGEMENT STRATEGIES

Site Planning & Management Strategy	GBI	GreenRE	MyCREST	Melaka Green Seal	PHJKR
Compliance with local planning	✓	✓	✓	✓	-
Conservation of existing trees	✓	✓	✓	-	✓
Site inventory of greenery	✓	✓	✓	-	-
Provision of greenery	✓	✓	✓	✓	✓
Community connectivity	✓	✓	✓	-	-
Brownfield development	✓	✓	✓	-	-
Storm water management	✓	✓	✓	-	✓
Environmental management	✓	✓	✓	-	✓
Green roof/wall	✓	-	✓	✓	✓
Solar reflectance index (SRI)	✓	-	✓	✓	✓
Building user manual	✓	✓	✓	✓	✓
Control in External Light Spill	-	-	✓	-	-
Workers' site amenities	✓	-	-	-	-
Design for disable group	-	-	-	-	✓

TABLE 12: SUMMARY OF IEQ STRATEGIES

IEQ Strategy	GBI	GreenRE	MyCREST	Melaka Green Seal	PHJKR
Daylighting	✓	✓	✓	✓	✓
Artificial lighting	✓	✓	✓	-	✓
Visual comfort	✓	-	✓	-	✓
Acoustic comfort	✓	✓	✓	✓	✓
Thermal comfort	✓	✓	✓	-	✓
Indoor Air quality performance	✓	✓	✓	-	✓
Environmental Tobacco Smoke (ETS) Control	✓	-	✓	✓	-
Control of CO2 level	✓	✓	✓	-	✓
Survey on Occupant's comfort	✓	-	✓	-	
Mould control	✓	-	✓	-	✓
Space arrangement	✓	✓	✓	-	✓
Low VOC materials	✓	✓	✓	✓	✓

4.1.4 Water Efficiency

Common water efficiency strategies are water efficiency, water sub metering, water leakage detection, and landscape irrigation (Table 13). However, some tools did offer points for specific strategies which are not shown by others. For example, MyCREST requires water conservation strategy to be established for more effective management purposes, while GreenRE specifically mentions water consumption of cooling tower. Among these tools, only GBI and Melaka Green Seal offer points for rainwater harvesting.

TABLE 13: SUMMARY OF WATER EFFICIENCY STRATEGIES

Water Efficiency Strategy	GBI	GreenRE	MyCREST	Melaka Green Seal	PHJKR
Rainwater Harvesting	✓	-	✓	✓	-
Water Recycling	✓	✓	✓	-	✓
Water Efficient Fittings	✓	✓	✓	-	✓
Water sub metering	✓	✓	✓	✓	✓
Water leakage detection	✓	✓	✓	✓	✓
Landscape irrigation	✓	✓	✓	✓	-
Water consumption of cooling tower	-	✓	✓	-	-
Water conservation strategy	-	-	✓	-	-

TABLE 14: SUMMARY OF MATERIALS & RESOURCES STRATEGY

Materials & Resources Strategy	GBI	GreenRE	MyCREST	Melaka Green Seal	PHJKR
Local materials	✓	-	✓	✓	✓
IBS	-	-	✓	-	-
Refrigerant & clean agent	✓	-	✓	✓	-
Sustainable resources	✓	✓	✓	-	✓
Reused & recycled materials	✓	-	✓	-	✓
Sustainable policy	-	-	✓	✓	-
Life cycle analysis	-	-	✓	-	-

4.1.5 Materials & Resources

In terms of scoring, MyCREST offers more points for this category than others, and thus the requirements are also relatively more as compared to other tools. Common strategies adopted by tools are such as refrigerant & clean agent, and sustainable resources (Table 14). To note, MyCREST places the strategy of refrigerant & clean agent under energy efficiency, which is in contrast to other tools.

4.2 MEASUREMENT-BASED RATING TOOL

Among the Malaysian developed rating tools, only MyCREST (part of it) and Green PASS are performance based green building rating tool that involve carbon calculation. However, only Green PASS is being assessed in this section because, as described above, MyCREST is developed by merging both PHJKR and Green PASS. Thus, analysis on Green PASS is deemed sufficient as it also reflects the characteristics of performance based rating of MyCREST. In general, Green PASS is an assessment system for building construction. The assessment areas encompass site and land use; material; energy; water; waste, and IEQ; while the phases to be covered are construction phase and operation phase.

Green PASS is not merely a rating system. The Assessment of metrics provide information on performance with regards to carbon reduction measures. Green PASS is a carbon-based tool which connects building performance with the environment through carbon reduction measures to minimise the impacts on climate change, currently not addressed by existing assessment methods. In contrast, existing prescriptive methods like GBI and GreenRE are merely design scoring methods to predict the notional performance of buildings. Similar to LCCF, Green PASS also emphasizes on carbon calculation which only including criteria that can be quantitatively measured. Scores are achieved through points gained from building design features present within the system check list, therefore does not measure real building performance and makes no real connection to the environment. In addition to the 'notional performance' derived from theoretical predictions, prescriptive systems also give opportunities point chasers, to score points through credits which are easier or cheaper to implement, rather than consideration of factors that would contribute significantly to building performance.

In these prescriptive schemes, buildings are assumed to perform according to the design and most rating schemes do not assess the real performance of buildings after the completion of the project.

Recent reports worldwide highlighted that existing certified green buildings failed to perform accordingly because the certification does not include monitoring of building performance at post construction. Financially, the prescriptive system also imposed high premiums to users therefore limiting its application to affordable stakeholders only. For mainstreaming green buildings, there is a real need for governments to establish assessment tools that measures actual building performance for climate mitigation and one that could be used and affordable by all levels of stakeholders.

REVIEW ON METRICS OF MALAYSIAN CRITERIA-BASED GREEN BUILDING RATING TOOLS

05

Review on Metrics of Malaysian Criteria-based Green Building Rating Tools

Different rating systems with different formats of assessment outcomes are used by all the five Malaysian developed green building rating tools, as well as the three international rating tools (BREEAM, LEEDS, and CASBEE). MyCREST and PHJKR are similar to BREEAM, in which these rating tools adopt the credits scoring system, where credits are awarded for all issues according to the pre-set performance or feature specific criteria. These credits are summed to yield a total score for each category and then an overall score, as well as percentage of the maximum achievable score for all categories. The latter is used to determine the overall grade of assessment. On the other hand, both GBI and GreenRE are similar to LEED and Green Mark, in which the point scoring system is used, where the awarded points for individual aspects of assessment are summed and compared against a rating scale to yield an overall grade. Melaka Green Seal is different from the rest in the sense that this rating tools, divides all the feature specific criteria into two groups: compulsory and optional. In other to obtain the certification, all compulsory feature specific criteria needed to be met, together with certain number of optional criteria.

Irrespective of whether the outcome format is numeric score, overall grade, or environmental impact approach (from passed to outstanding; and from bronze to platinum), the certified building will still be classified into different rating levels according to the percentage of score earned. To enable an evaluation, the score for different performance levels (Sx) were normalized as a percentage of the maximum achievable value (SMAX) to become scoring (Sy) and the corresponding rating (Ry) levels. Sy and Ry are shown mathematically by Equation 2 and Equation 3 bellow:

$$S_y = \frac{S_X}{S_{MAX}} x100\% \quad \text{---------- Equation 2}$$

$$R_y = \frac{100\%}{N} x\, Y \quad \text{---------- Equation 3}$$

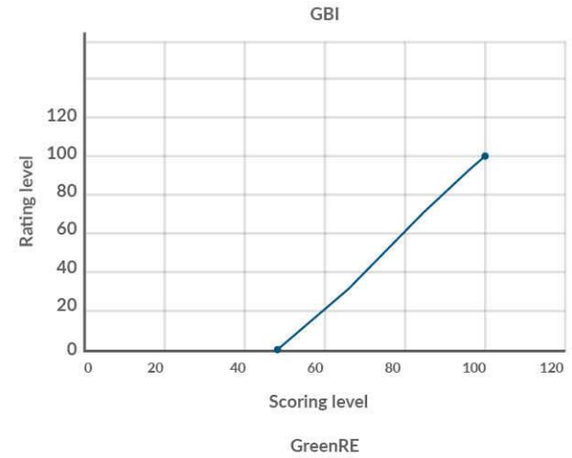
Where Sx is the required number of final score (S) for achieving the yth rating level (y = 1 to N); while N is the number of performance levels.

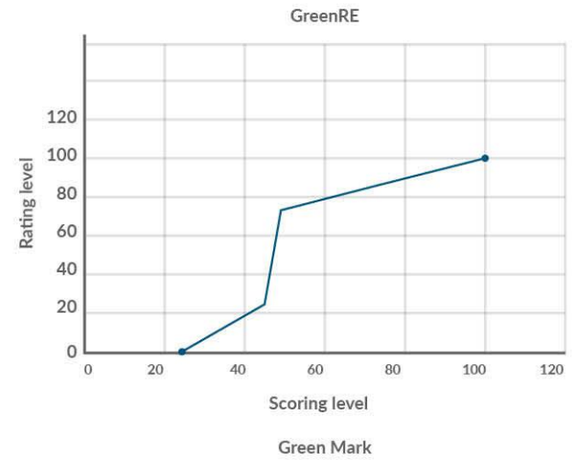
The normalized rating and scoring level for all the rating tools (except for Melaka Green Seal) are summarized in Table 22. For example, in MyCREST, one star (which is equivalent to 40% score) is given as the minimum performance level, which is then set as 0% in the renewed rating level; while four stars of performance level (which is equivalent to 70% score) is being set as a percentage level of 60% in the rating level. With regard to the renewed rating level, one can observe that GreenRE is the most relaxed as it requires the lowest scoring level for achieving the minimum performance level (bronze certification). GBI is the most stringent as it requires the highest scoring level to achieve the minimum performance level (certified). Also, for the same scoring level, GreenRE constantly awards higher overall rating levels than other rating tools. BREEAM appears to be the toughest in awarding the highest performance level among the others; whilst GBI is the toughest in awarding the highest performance level among all

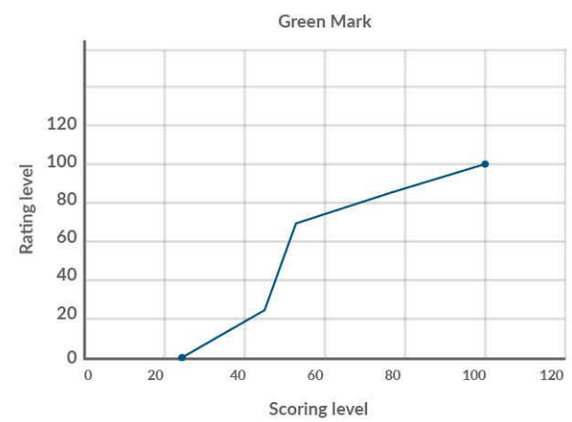
TABLE 22: SUMMARY OF RATING AND SCORING LEVEL

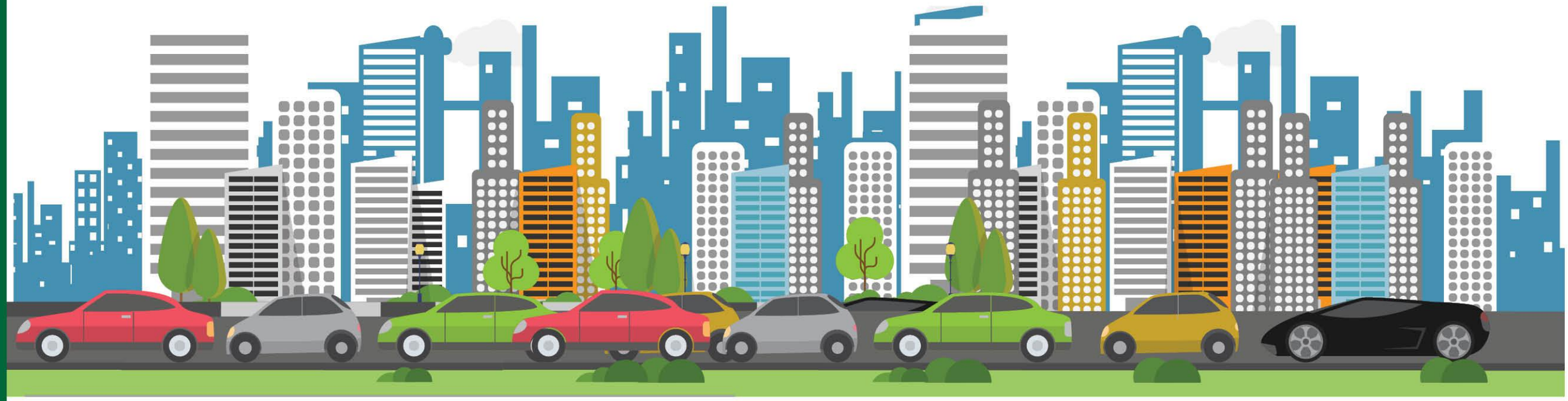
Rating level (%)	Scoring level (%)						
	GBI	GreenRE	MyCREST	PHJKR	LEED	BREEAM	Green Mark
0	50	27	40	40	31	30	31
20			50			45	
25	66	41		50	39		47
40			60			55	
50	76	46		70	47		53
60			70			70	
75	86	49		85	63		56
80			80			85	
100	100	100	100	100	100	100	100

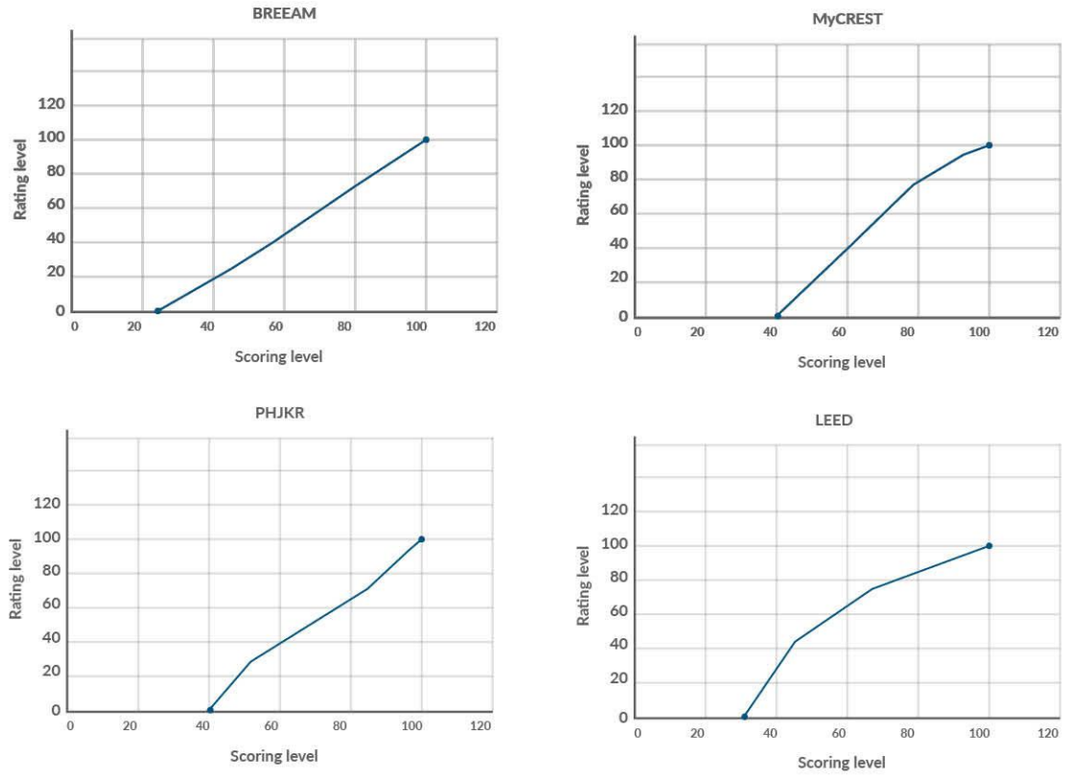
FIGURE 21: RATING SCALE COMPARISON











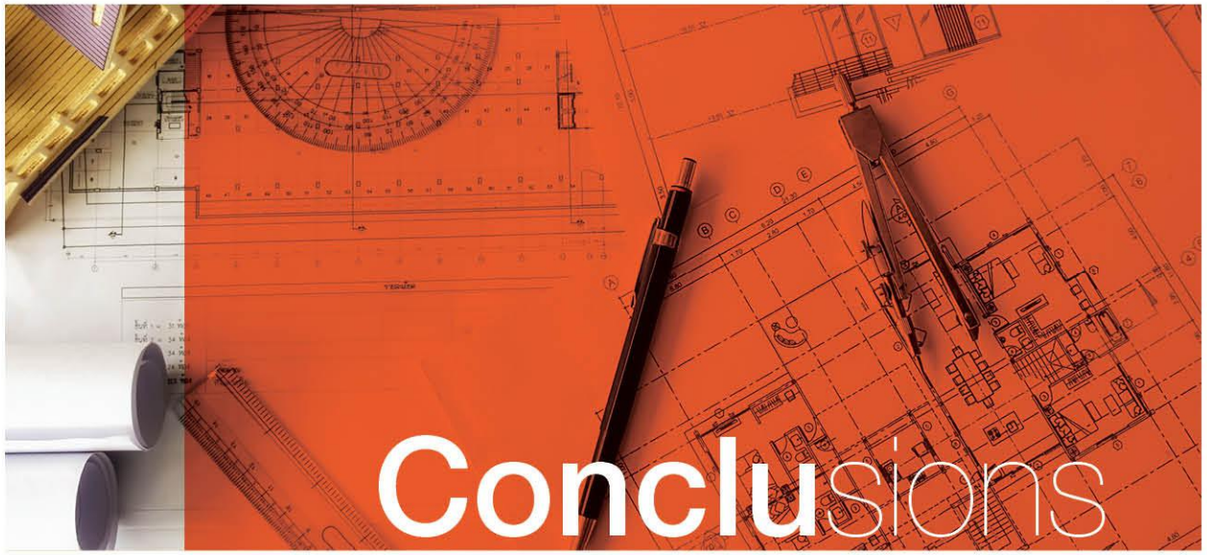
Malaysian developed rating tools. PHJKR is applying a similar scoring level like the GBI, while MyCREST adopts a rather moderate rating scale.

Figure 21 was plotted to investigate the nature of the scoring levels adopted by each rating tool. There are two types of non-linear rating scales – concave and convex. A convex scale indicates that the marginal rate of increase in the rating level increases with unit increase in the scoring level, whereas for a concave scale, the marginal rate of increase in the rating level decreases with unit increase in the scoring level. It is noted that for GBI, PHJKR, MyCREST, and BREEAM the rating level is in generally linearly related to the scoring level, whilst a non-liner rating scale is adopted by GreenRE, Green Mark, and LEED. With regard to use of linear and non-linear rating scales, it was found that convex non-linear rating scale is more suitable for awarding proportionally higher rating for efforts made by investors to achieve a higher level of performance.

There is at present little discussion in the public domain on requirements of a satisfactory rating system. However, it has been widely accepted that the success of a voluntary scheme depends mainly on how well the scheme is received by the profit maximizing building owners and developers. Also, there is an emerging notion that the rating scale should be used to acknowledge implementation cost and difficulties. The underlying premise is that investors would like to be rewarded in proportion to the effort made in achieving a higher level of environmental performance. According to the law of diminishing marginal returns in economics, it is logical to award proportionally higher ratings to encourage investors to aspire for a higher level of environmental performance under the voluntary scheme. In this connection, a convex scale is considered a better rating system. It can be seen in the above that only GreenRe and Green Mark take into consideration such a phenomenon in their development. Despite non-linear rating scales having been adopted by LEED, it is concavely-curved.

CONCLUSIONS

06



Conclusions

Buildings are key target of policies that aim at promoting environmentally sustainable development. Amongst policy instruments that address environmental burdens incurred by buildings, labelling and certification schemes are arguably the most cost-effective. Since the first building environmental assessment scheme was launched in the 1990's, similar schemes have emerged in about 30 countries. These are mainly domestic schemes tailored to suit local contexts. Whilst most of these schemes take a voluntary, market driven approach, some have become a part of mandatory building approval requirements, though different certification schemes may co-exist in some regimes. Benchmarking the strengths and characteristics of different schemes has been advocated.

Being desirous of using building environmental assessment schemes as a vehicle to reduce environmental impacts of buildings, many countries have either developed or are in the process of developing their own assessment schemes. Most new schemes are developed with reference to first generation assessment schemes that originated from developed countries. However, the reference schemes were themselves developed to address specific regional concerns, and were often structured into practical frameworks, which make their reconfiguration for application to another regime a difficult proposition. Hence, whilst there is a growing number of building environmental assessment schemes all over the world, the schemes differ to a great extent in various aspects. It is also common to see different types of schemes coexisting in the same market.

Furthermore, assessment results from different schemes cannot be directly benchmarked and compared, and should there be large differences in outcomes of different assessments, suspicion may arise on the credibility of either or both schemes. Thus, systematic benchmarking the strengths and characteristics of different schemes for reference of policy makers in developing domestic schemes for individual regimes has been advocated. Furthermore, instead of making isolated efforts for developing and enhancing individual schemes, it will be desirable for policy makers to familiar with the strengths of different building environmental assessment schemes, which may entail coordination and sharing of research efforts for enhancing the efficacy of schemes of individual regimes.

In this connection, this study provides a comprehensive review and comparison of the issues and metrics of the Malaysian developed rating tools. Comparison of Malaysian rating tools shows that GBI, GreenRE, and MyCREST are the most comprehensive. Statistical analysis also reveals that there is a moderate degree of agreement amongst the compared rating tools on weights and ranks of weights allocated to nine primary sustainability themes. Through comparison, strengths and characteristics of the five schemes have been identified for reference of policy makers in developing their domestic schemes.

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APPENDIX

07

LEED

Criteria	Maximum Points	Alternative Sorting
Integrative Process	1	Project planning
Location and Transportation		
Neighbourhood Development Location	16	Site planning
Sensitive Land Protection	1	Site planning
High-Priority Site	2	Site planning
Surrounding Density and Diverse Uses	5	Site planning
Access to Quality Transit	5	Transportation
Bicycle Facilities	1	Transportation
Reduced Parking Footprint	1	Transportation
Green Vehicles	1	Transportation
Sustainable Sites		
Construction Activity Pollution Prevention	Required	Site planning
Site Assessment	1	Site planning
Site Development – Protect or Restore Habitat	2	Site planning
Open Space	1	Site planning
Rainwater Management	3	Site planning
Heat Island Reduction	2	Site planning
Light Pollution Reduction	1	Site planning
Water Efficiency		
Outdoor Water Use Reduction	Required	Water efficiency
Indoor Water Use Reduction	Required	Water efficiency
Building-Level Water Metering	Required	Water efficiency
Outdoor Water Use Reduction	2	Water efficiency
Indoor Water Use Reduction	6	Water efficiency
Cooling Tower Water Use	2	Water efficiency
Water Metering	1	Water efficiency
Energy and Atmosphere		
Fundamental Commissioning and Verification	Required	Energy efficiency

Criteria	Maximum Points	Alternative Sorting
Minimum Energy Performance	Required	Energy efficiency
Building-Level Energy Metering	Required	Energy efficiency
Fundamental Refrigerant Management	Required	Materials & resources
Enhanced Commissioning	6	Energy efficiency
Optimize Energy Performance	18	Energy efficiency
Advanced Energy Metering	1	Energy efficiency
Demand Response	2	Energy efficiency
Renewable Energy Production	3	Energy efficiency
Enhanced Refrigerant Management	1	Materials & resources
Green Power and Carbon Offsets	2	Energy efficiency
Materials and Resources		
Storage and Collection of Recyclables	Required	Waste
Construction and Demolition Waste Management Planning	Required	Waste
Building Life-Cycle Impact Reduction	5	Materials & Resources
Building Product Disclosure and Optimization – Environmental Product Declarations	2	Materials & Resources
Building Product Disclosure and Optimization – Sourcing of Raw Materials	2	Materials & Resources
Building Product Disclosure and Optimization – Material Ingredients	2	Materials & Resources
Construction and Demolition Waste Management	2	Waste
Indoor Environmental Quality		
Minimum indoor Air Quality Performance	Required	IEQ
Environmental Tobacco Smoke Control	Required	IEQ
Enhanced Indoor Air Quality Strategies	2	IEQ
Low-emitting Materials	3	IEQ
Construction Indoor Air Quality Management Plan	1	IEQ
Indoor Air Quality Assessment	2	IEQ
Thermal Comfort	1	IEQ
Interior Lighting	2	IEQ
Daylight	3	IEQ
Quality Views	1	IEQ
Acoustic Performance	1	IEQ
Innovation		
Innovation	5	Innovation
LEED Accredited Professional	1	Innovation
Regional Priority	4	Site planning

Sustainable Element	Number of allocation	Percentage
Project planning & management	1	1
Site planning & management	38	30
Transportation	8	6
Water efficiency	11	9
Energy efficiency	32	25
Materials & resources	14	11
Waste	2	2
IEQ	16	13
Innovation	6	5

BREEAM

Criteria	Maximum Points	Alternative Sorting
Management		
Project brief and design	4	Project planning
Life cycle cost ad service life planning	4	Project planning
Responsible construction practices	6	Project planning
Commissioning and handover	4	Project planning
Aftercare	3	Project planning
Health and Wellbeing		
Visual comfort	6	IEQ
Indoor air quality	5	IEQ
Thermal comfort	3	IEQ
Acoustic performance	4	IEQ
Safety and security	2	IEQ
Energy		
Reduction of energy use and carbon emissions	15	Energy efficiency
Energy monitoring	4	Energy efficiency
External lighting	1	Energy efficiency
Low carbon design	3	Energy efficiency
Energy efficient cold storage	2	Energy efficiency
Energy efficiency transportation systems	3	Energy efficiency
Energy efficient equipment	2	Energy efficiency
Transport		
Public transport accessibility	5	Transportation
Proximity to amenities	2	Transportation
Cyclist facilities	2	Transportation
Maximum car parking capacity	2	Transportation
Travel plan	1	Transportation
Water		
Water consumption	5	Water efficiency
Water monitoring	1	Water efficiency
Water leak detection	3	Water efficiency
Water efficient equipment	1	Water efficiency

Criteria	Maximum Points	Alternative Sorting
Materials life cycle impacts		
Life cycle impacts	6	Materials & resources
Responsible sourcing of materials	4	Materials & resources
Designing for durability and resilience	1	Materials & resources
Material efficiency	1	Materials & resources
Waste		
Construction waste management	4	Waste
Recycled aggregates	1	Waste
Operational waste	1	Waste
Speculative floor and ceiling finishes	1	Waste
Adaption to climate change	1	Waste
Functional adaptability	1	Waste
Land Use and Ecology		
Site selection	3	Site planning
Ecological value of site and protection of ecological features	2	Site planning
Enhancing site ecology	3	Site planning
Long term impact on biodiversity	2	Site planning
Pollution		
Impact of refrigerants	4	Materials & resources
NOx emissions	2	Materials & resources
Surface water run-off	5	Site planning
Reduction of night time light pollution	1	Site planning
Reduction of noise pollution	1	Site planning

Sustainable Element	Number of allocation	Percentage
Project planning & management	21	15
Site planning & management	17	12
Transportation	12	9
Water efficiency	10	7
Energy efficiency	30	22
Materials & resources	18	13
Waste	9	7
IEQ	20	15
Innovation	-	-

GREEN MARK

Criteria	Maximum Points	Alternative Sorting
Energy Efficiency		
Thermal Performance of Building Envelope – ETTV	12	Energy efficiency
Air-Conditioning System	30	Energy efficiency
Building Envelope – Design/Thermal Parameter	35	Energy efficiency
Natural Ventilation/Mechanical Ventilation	20	Energy efficiency
Daylighting	6	IEQ
Artificial Lighting	12	Energy efficiency
Ventilation in Carparks	4	Energy efficiency
Ventilation in Common Areas	5	Energy efficiency
Lifts and Escalators	2	Energy efficiency
Energy Efficient Practices & Features	12	Energy efficiency
Renewable Energy	20	Energy efficiency
Water Efficiency		
Water Efficient Fittings	10	Water efficiency
Water Usage and Leak Detection	2	Water efficiency
Irrigation System and Landscaping	3	Water efficiency
Water Consumption of Cooling Tower	2	Water efficiency
Environmental Protection		
Sustainable Construction	10	Materials & resources
Sustainable Products	8	Materials & resources
Greenery Provision	8	Site planning
Environmental Management Practice	7	Site planning
Green Transport	4	Transportation
Refrigerants	2	Materials & resources
Stormwater Management	3	Site planning
Indoor Environmental Quality		
Thermal Comfort	1	IEQ
Noise Level	1	IEQ
Indoor Air Pollutants	2	IEQ

Criteria	Maximum Points	Alternative Sorting
Indoor Air Quality (IAQ) Management	2	IEQ
High Frequency Ballasts	2	IEQ
Other Green Features		
Green Features & Innovations	7	Innovation
Carbon Emission of Development	4	Environmental

Sustainable Element	Number of allocation	Percentage
Project planning & management	-	-
Site planning & management	18	10
Transportation	4	2
Water efficiency	17	10
Energy efficiency	97	55
Materials & resources	16	9
Waste	4	2
IEQ	14	8
Innovation	7	4

MYCREST

Criteria	Maximum Points	Alternative Sorting
Pre-Design		
MyCREST Sustainable and Carbon Reduction Target in Needs Statement	1	Project planning
Initial Target of MyCREST Level and Estimation MyCREST Green Budget	1	Project planning
Green Eco-Charrette	1	Project planning
Use of Integrated Design Process	1	Project planning
Potential Environmental Impact of Development or Redevelopment	1	Project planning
Facilities Manager in Design Team	1	Project planning
Infrastructure and Sequestration		
Site Inventory Analysis on Greenery	Required	Site planning
Compliance with Landscape Requirement from Local Authority	Required	Site planning
Low Carbon City Characteristics and Factors		
- Development within Defined Urban Footprint	3	Site planning
- Urban Connectivity	2	Site planning
- Brownfield Development	1	Site planning
Carbon Accounting on Site (For Greenfield or Graded Land)		

Criteria	Maximum Points	Alternative Sorting
- Carbon Sequestration – Preservation (for Mature Trees)	2	Site planning
- Carbon Sequestration – Preservation/Restoration/ New Planting	7	Site planning
Environmental Management Plan (EMP)	1	Site planning
Factors in Stormwater Management		
- Control of Stormwater Run-off on Site	1	Site planning
- Stormwater Design – Quality	1	Site planning
- Intergration of Carbon Sequester Strategies	1	Site planning
Low-Carbon Transport Factors		
- Covered pedestrian Walkway	3	Transportation
- Low-emission vehicle designated parking	1	Transportation
- Busline & LRT Station	1	Transportation
Urban Heat Island Mitigation		
- Heat island Mitigation – Roof/Wall	2	Site planning
- Heat Island Mitigation – Noon-Roof	2	Site planning
Control in External Light Spill and Brightness	1	Site planning
Energy Performance Impacts		
Building Envelope Performance	Required	Energy efficiency
Roof Thermal Performance	Required	Energy efficiency
Building Energy Efficiency Performance	Required	Energy efficiency
Fundamental Refrigerant Management	Required	Materials & resources
Building Envelope Performance – Thermal Performance	3	Energy efficiency
Decentralization of Lighting Systems Control		
- Lighting Zoning	1	Energy efficiency
- Motion sensor use in all toilets and staircase	1	Energy efficiency
Admission of Daylight Zone and Provision of Automatic Controls		
- Automatic daylight – Photo-sensors	1	IEQ
- Natural Lighting	2	IEQ
Artificial Lighting		
- Design Lighting Power Density (LPD)	4	Energy efficiency
- LED Lighting for 24 Hour Area & Carpark	1	Energy efficiency
Individual Metering		
- Sub-meters on switchboards for each service system	1	Energy efficiency
Renewable Energy	4	Energy efficiency
Energy Efficient Unitary Air-conditioning Systems	1	Energy efficiency
Main Commissioning of Building Energy Systems	Required	Energy efficiency
Improved Commissioning during Design Stage	3	Energy efficiency
Air Penetration		
- Division of air-conditioned and non air-conditioned areas	1	Energy efficiency

Criteria	Maximum Points	Alternative Sorting
- Infiltration rate does not exceed 0.5 ACH or equivalent	1	Energy efficiency
Building Energy Management System	1	Energy efficiency
Building Energy Efficiency Performance	40	Energy efficiency
- Energy reduction derived from the integration of shaded trees within 5 meters from the building perimeter	1	Energy efficiency
Energy Efficiency – Performance and Assessment	Required	Energy efficiency
Heat Gain Control and Comfort through Natural Ventilation		
- Open plan	2	Energy efficiency
- Orientation of building layout and major openings	2	Energy efficiency
- Design for cross ventilation	2	Energy efficiency
- Provide operable windows	2	Energy efficiency
- Allow for adequate internal airflow	2	Energy efficiency
- Design clerestories or vented skylights	2	Energy efficiency
- Provide attic ventilation	2	Energy efficiency
- Provision of the use of fan-assisted cooling strategies	2	Energy efficiency
- Recesses and deep shading of facades/solar heat gain reduction	2	Energy efficiency
- Predict comfort in buildings	2	IEQ
Occupant & Health		
Air Quality Performance	Required	IEQ
Indoor Smoking Restriction	Required	IEQ
Control & Strategies to Reduce Mould Occurrence	1	IEQ
Indoor Air Quality Pollutants		
- Low VOC Materials – for paints and coatings	1	IEQ
- Low VOC Materials – for adhesives and sealants	1	IEQ
Carbon Dioxide Level Control	1	IEQ
Lowering the Embodied Carbon		
Recycling Facility	Required	Waste
Green Products	2	Materials & Resources
Sustainable Sources Materials & Product		
- Sustainable timber source	1	Materials & Resources
- Recycled Content	2	Materials & Resources
Industrial Building System	3	Materials & Resources
Solid Waste Management – Route and Recyclers	1	Waste

Criteria	Maximum Points	Alternative Sorting
Life Cycle Analysis (LCA) – Building Works	6	Materials & resources
Salvaged and Reused Materials	1	Waste
Water Efficiency Factors		
Reduce Portable Water – 10% Reduction	Required	Water efficiency
Water Conservation Strategies	2	Water efficiency
Reduced portable Water for Landscape	2	Water efficiency
Water Sub-Metering and Leak Detection		
- Install individual sub-meters to monitor the major water usage	1	Water efficiency
- Linking all private meters to the EMS for leak detection	1	Water efficiency
Recycled Grey Water	2	Water efficiency
Social and Cultural Sustainability		
Design for Social Responsibility	1	Site planning
Access to Views from Work Areas	1	IEQ
Compatibility of Urban and Façade Design to Cultural Values	2	Site planning
Maintenance of Heritage Value of Existing Facilities	1	Site planning
Demolition & Disposal Factors		
Responsible Sourcing of Materials	1	Materials & resources
Design for Dis-Assembly	1	Waste
Existing Structural Material Reused	1	Waste
Sustainable and Carbon Initiatives		
Certified MyCREST Qualified Professional	1	Innovation
Innovation: Carbon Reduction/Impact Points	6	Innovation

Sustainable Element	Number of allocation	Percentage
Project planning & management	6	4
Site planning & management	28	17
Transportation	5	3
Water efficiency	8	5
Energy efficiency	83	49
Materials & resources	19	11
Waste	2	1
IEQ	10	6
Innovation	7	4

GREENRE

Criteria	Maximum Points	Alternative Sorting
Energy Efficiency		
Thermal Performance of Building Envelope – OTTV	15	Energy efficiency
Air-Conditioning System	27	Energy efficiency
Building Envelope – Design/Thermal Parameters	29	Energy efficiency
Natural Ventilation (exclude carparks)	13	Energy efficiency
Daylighting	6	IEQ
Artificial Lighting	12	Energy efficiency
Ventilation in Carparks	5	Energy efficiency
Ventilation in Common Areas	5	Energy efficiency
Lifts and Escalators	3	Energy efficiency
Energy Efficient Practices & Features	13	Energy efficiency
Renewable Energy	20	Energy efficiency
Water Efficiency		
Water Efficient Fittings	8	Water efficiency
Water Usage and Leak Detection	2	Water efficiency
Irrigation System and Landscaping	3	Water efficiency
Water Consumption of Cooling Tower	2	Water efficiency
Environmental Protection		
Sustainable Construction	10	Materials & resources
Sustainable Products	8	Materials & resources
Greenery Provision	8	Site planning
Environmental Management Practice	8	Site planning
Green Transport	4	Transportation
Stormwater management	1	Site planning
Community Connectivity	2	Site planning
Indoor Environmental Quality		
Thermal Comfort	2	IEQ
Noise Level	2	IEQ
Indoor Air Pollutants	2	IEQ
Indoor Air Quality (IAQ) Management	2	IEQ
High Frequency Ballasts	2	IEQ
Other Green Features		
Green Features & Innovations	7	Innovation
Carbon Emission of Development	4	Environmental

Sustainable Element	Number of allocation	Percentage
Project planning & management	-	-
Site planning & management	19	11
Transportation	4	2
Water efficiency	15	8
Energy efficiency	100	56
Materials & resources	13	7
Waste	5	3
IEQ	16	9
Innovation	7	4

GBI

Criteria	Maximum Points	Alternative Sorting
Energy Efficiency		
Design		
- Minimum EE Performance	1	Energy efficiency
- Lighting Zoning	3	Energy efficiency
- Electrical Sub-metering	1	Energy efficiency
- Renewable Energy	5	Energy efficiency
- Advanced EE Performance – BEI	15	Energy efficiency
Commissioning		
- Enhanced Commissioning	3	Energy efficiency
- Post Occupancy Commissioning	2	Energy efficiency
Verification & Maintenance		
EE Verification	2	Energy efficiency
Sustainable Maintenance	3	Energy efficiency
Indoor Environmental Quality		
Air Quality		
- Minimum IAQ Performance	1	IEQ
- Environmental Tobacco Smoke (ETS) Control	1	IEQ
- Carbon Dioxide Monitoring and Control	1	IEQ
- Indoor Air Pollutants	2	IEQ
- Mould Prevention	1	IEQ
Thermal Comfort		
- Thermal Comfort: Design & Controllability of Systems	2	IEQ
- Air Change Effectiveness	1	IEQ
Lighting, Visual & Acoustic Comfort		
- Daylighting	2	IEQ
- Daylight Glare Control	1	IEQ

Criteria	Maximum Points	Alternative Sorting
- Electric Lighting Levels	1	Energy efficiency
- High Frequency Ballasts	1	Energy efficiency
- External Views	2	IEQ
- Internal Noise Levels	1	IEQ
Verification		
- IAQ Before & During Occupancy	2	IEQ
- Post Occupancy Comfort Survey: Verification	2	IEQ
Sustainable Site Planning & Management		
Site Planning		
- Site Selection	1	Site Planning
- Brownfield Redevelopment	1	Site Planning
- Development Density & Community Connectivity	2	Site Planning
- Environment Management	2	Site Planning
Construction Management		
- Earthworks – Construction Activity Pollution Control	1	Site Planning
- QLASSIC	1	Site Planning
- Workers' Site Amenities	1	Site Planning
Transportation		
- Public Transportation Access	1	Transportation
- Green Vehicle Priority	1	Transportation
- Parking Capacity	1	Transportation
Design		
- Stormwater Design – Quantity & Quality Control	1	Site Planning
- Greenery & Roof	2	Site Planning
- Building User Manual	1	Site planning
Materials & Resources		
Reused & Recycled Materials		
- Materials reuse and selection	2	Waste
- Recycled content materials	2	Waste
Sustainable Resources		
- Regional Materials	1	Materials & resources
- Sustainable Timber	1	Materials & resources
Waste Management		
- Storage & Collection of Recyclables	1	Waste
- Construction Waste Management	2	Waste
Green Products		
- Refrigerants & Clean Agents	2	Materials & resources
Water Efficiency		
Water Harvesting & Recycling		

Criteria	Maximum Points	Alternative Sorting
- Rainwater Harvesting	2	Water efficiency
- Water Recycling	2	Water efficiency
Increased Efficiency		
- Water Efficient – Irrigation/ Landscaping	2	Water efficiency
- Water Efficient Fittings	2	Water efficiency
- Metering & Leak Detection System	2	Water efficiency
Innovation		
Innovation in Design & Environmental Design Initiatives	6	Innovation
Green Building Index Accredited Facilitator	1	Innovation

Sustainable Element	Number of allocation	Percentage
Project planning & management	-	-
Site planning & management	13	13
Transportation	3	3
Water efficiency	10	10
Energy efficiency	37	37
Materials & resources	4	4
Waste	7	7
IEQ	19	19
Innovation	7	7

MELAKA GREEN SEAL

Criteria	Maximum Points	Alternative Sorting
Energy Efficiency		
External Building Thermal Envelope	1 Compulsory	Energy efficiency
Energy Management Control System	2 Optional	Energy efficiency
Lighting Zoning		
- Lighting zooming, level, power density	3 Compulsory	Energy efficiency
- Auto & motion sensors	2 Optional	Energy efficiency
Submetering	1 Optional	Energy efficiency
Renewable Energy	1 Optional	Energy efficiency
Building Energy Index	1 Compulsory	Energy efficiency
Enhanced Commissioning/Recommissioning	2 Compulsory	Energy efficiency
Sustainable Maintenance	2 Optional	Energy efficiency
Internal Environment Quality		
ASHRAE 62.1-2007/Local Building Code	1 Compulsory	IEQ
Sound Insulation	1 Compulsory	IEQ
Quality Daylighting	1 Optional	IEQ
Low Emission Paints/Materials	1 Optional	IEQ

Criteria	Maximum Points	Alternative Sorting
Environmental Tobacco Smoke (ETS) Control	2 Compulsory	IEQ
Pre-Occupancy Flushing	1 Compulsory	IEQ
Sustainable Site Planning & Management		
Building Exterior Management	1 Optional	Site planning
Green Vehicle Priority	1 Optional	Transportation
Site Planning	1 Compulsory	Site planning
Greenery & Roof		
- Hardscape & Greenery Application	1 Compulsory	Site planning
- Shade (within 5 years of occupancy)	1 Optional	Site planning
- Paving Materials with SRI of at least 29	1 Optional	Site planning
- Open Grid Pavement System	1 Optional	Site planning
- SRI for Roof	1 Optional	Site planning
- Vegetated Roof/ High Albedo	1 Optional	Site planning
Building User Manual	1 Compulsory	Site planning
Material & Resources		
Sustainable Policy	1 Compulsory	Project planning
Local Materials	1 Compulsory	Materials & resources
Refrigerant & Clean Agent		
- Use zero ozone depleting potential (ODP) products	1 Compulsory	Materials & resources
- Use non-synthetic (natural) refrigerant & clean agents with zero ODP	1 Optional	Materials & resources
Water Efficiency		
Rainwater Harvesting	1 Compulsory	Water efficiency
Landscape Irrigation	1 Optional	Water efficiency
Water Use Index		
- Residential (15m3), Commercial (1m3)	1 Compulsory	Water efficiency
- Metering & leak detection system	1 Optional	Water efficiency

Sustainable Element	Number of allocation	Percentage
Project planning & management	1	3
Site planning & management	9	23
Transportation	1	3
Water efficiency	4	10
Energy efficiency	15	38
Materials & resources	3	8
Waste	-	-
IEQ	7	18
Innovation	-	-

PHJKR

Criteria	Maximum Points	Alternative Sorting
Sustainable Site Planning & Management		
Site Planning	1	Site planning
Sustainable Ground Work	3	Site planning
Environmental Management System	3	Site planning
Soil Erosion Control	1	Site planning
Stormwater Management	2	Site planning
Strategic Landscape		
- Conservation of mature trees	1	Site planning
- Green Area in Development	1	Site planning
- Trees Planting for Shading	1	Site planning
- Selection of construction materials for walkway with high heat reflection	1	Site planning
- Grass pavement system	1	Site planning
Green Roof/Wall		
- SRI with various roof types and slopes	1	Site planning
- Encouraging green roof/wall design	3	Site planning
Car Park	1	Transportation
Manual for Building User	1	Site planning
Design for Disable Group	1	Site planning
Energy Efficiency Management		
Building Orientation		
- Main façade facing North-South	2	Energy efficiency
- Minimise façade opening facing East-West	1	Energy efficiency
Façade Design		
- Selection of window glass	2	Energy efficiency
- OTTV	1	Energy efficiency
- Sunlight block in east-west façade	1	Energy efficiency
Roof Design		
- U-value	1	Energy efficiency
- RTTV	1	Energy efficiency
- Roof insulation	1	Energy efficiency
Lighting Zoning		
- Dividing spaces with lighting zone	4	Energy efficiency
- Lighting Power density (LPD)	1	Energy efficiency
- Automatic sensor	2	Energy efficiency
- Light control in general places	2	Energy efficiency
- Light control areas	1	Energy efficiency
Sub-Metering	1	Energy efficiency

Criteria	Maximum Points	Alternative Sorting
Renewable Energy	6	Energy efficiency
Air Infiltration	3	Energy efficiency
Building Energy Index	7	Energy efficiency
Testing and Monitoring	1	Energy efficiency
Verification	1	Energy efficiency
Sustainable Maintenance		
- Maintenance team office	1	Energy efficiency
- Maintenance contractor	1	Energy efficiency
- Maintenance plan	1	Energy efficiency
- Energy control management system	1	Energy efficiency
Indoor Environmental Quality Management		
Space Planning		
- Arrangement of office space along façade	1	IEQ
- Partition wall with light penetration	1	IEQ
- Maximising external view	1	IEQ
- No deep planning	1	IEQ
- Effective ceiling height	1	IEQ
- Bright colour for wall and ceiling	1	IEQ
Daylighting		
- Design window with daylighting factor	1	IEQ
- Light shelves	2	IEQ
Natural Ventilation	1	Energy efficiency
Thermal Comfort	3	IEQ
Visual Comfort		
- Space arrangement without barrier	1	IEQ
- Glare control	1	IEQ
- Lighting in room	1	Energy efficiency
- Acoustic Comfort	1	IEQ
Indoor Air Quality		
- Use of low VOC materials	1	IEQ
- Prohibition of smoking	1	IEQ
- Indoor air quality performance	1	IEQ
Control of Carbon Dioxide Level	1	IEQ
Mould Control	2	IEQ
Survey on Occupant's Comfort	3	IEQ
Materials and Resources Management		
Green Product	1	Materials & resources
IBS	1	
Materials & resources		
3R	3	Waste
Local Materials	1	Materials & resources

Criteria	Maximum Points	Alternative Sorting
Waste Management	2	Waste
Water Efficiency Management		
SPAH	3	Water efficiency
Recycled Waste Water	2	Water efficiency
Water Efficient Product	2	Water efficiency
Water Submetering	2	Water efficiency
Water Leakage Detection System	1	Water efficiency
Innovation		
Innovative Design	6	Innovation

Sustainable Element	Number of allocation	Percentage
Project planning & management	-	-
Site planning & management	22	19
Transportation	1	1
Water efficiency	10	9
Energy efficiency	45	39
Materials & resources	3	3
Waste	5	4
IEQ	24	21
Innovation	6	5

MYGHI

Criteria	Maximum Points	Alternative Sorting
Sustainable design & construction activities		
Construction management plan		
- Waste management	13	Environment
- Air pollutant control	4	Environment
- Innovation	2	Environment
Noise mitigation control		
- Techniques	6	Environment
- Mitigation at the source	2	Environment
Equipment and machineries efficiency		
- Natural sources and emission reduction	6	Environment
Quality management		
- Management plan and training	13	Others
Context sensitive design		
- Design flexibility	9	Others
Erosion and sedimentation control		
- Erosion and sedimentation plan	7	Water quality
Alignment selection		

Criteria	Maximum Points	Alternative Sorting
- Environmental impact reduction	6	Environment
Energy efficiency		
Management policies		
- Renewable energy policies	6	Energy
- Enhanced commissioning of building energy systems	10	Energy
- Energy plan for maintenance	4	Energy
Rest & service area		
- Reduced electrical consumption	3	Energy
- Sustainable infrastructures	9	Energy
Toll plaza		
- Toll booth	6	Energy
- Lighting zone	8	Energy
- Administration and supervision building	5	Energy
Compound and car park		
- Energy efficiency performance	6	Energy
Interchange		
- Reduced energy consumption	5	Energy
- Stray light/Light pollution reduction	2	Energy
Environmental & water management		
Environmental management system		
- EMS certification	6	Environment
Stormwater runoff quantity		
- Runoff flow control	10	Water quality
- Disaster cost analysis	3	Water quality
- Drainage system	2	Water quality
Stormwater runoff quantity		
- Water pollution reduction	6	Water quality
- Runoff treatment and water bodies protection	11	Water quality
Ecosystem protected and preservation		
- Habitat restoration and protection	5	Environment
- Site vegetation	5	Environment
- Tree and plants communities	3	Environment
- Ecological connectivity	9	Environment
Material & technology		
Innovation technology		
- Usage of industrial by-product	4	Materials
- Sub-grade improvement /soil stabilization	4	Materials

Criteria	Maximum Points	Alternative Sorting
- Cool pavement	4	Materials
Reduce, reuse and recycle		
- Reuse of top soil	4	Materials
- Reuse and/or recycled of non-hazardous materials	4	Materials
- Earthwork balance	4	Materials
Economical materials and pavement		
- Regional materials	4	Materials
- Pavement design life	3	Materials
- Recycle pavement or new sustainable techniques	4	Materials
- Permeable pavement	4	Materials
- Quiet pavement	4	Materials
Erosion control		
- Soil biotechnical engineering treatments	4	Water quality
- Green techniques	4	Water quality
Social and Safety		
Services and facilities		
- Intelligent traffic system	23	Others
- Provision of basic facilities	10	Others
- Provision of additional facilities	2	Others
Economy		
- Business enhancement	4	Others
- Number of job creation	2	Others
- New development	2	Others
- Tourism	2	Others
Pollution reduction		
- Air and noise pollution	3	Environment
Public acceptance		
- Perception	7	Others
Environment		
- Environmental friendly	2	Environment
- Landscaping	2	Environment
Safety management		
- Road safety audit	2	Others
Innovation		
- Technology	3	Others
- Research and development	3	Others

Sustainable Element	Number of allocation	Percentage
Environment	74	24
Water quality	47	15
Energy	64	21
Materials	43	14
Others	82	26