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# **Sustainability Rating Tools and Measurement: A Pilot Study**

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## **Abstract**

Sustainability is the most sought after topic in the contemporary built environment, however, different countries established their own green building organizations and created different sustainability rating systems. The BRE Environmental Assessment Method (BREEAM) in UK and part of Europe, Leadership in Energy and Environmental Design (LEED) in the US and Canada, and the Green Star in Australia and South Africa, are the most commonly used rating system in the global coverage. When comparing BREEAM, LEED and Green Star, there are similarities that sustainability issues are breakdown into a number of categories and assigned weightings, such as management, energy, transport, health and wellbeing, water, materials, land use and ecology, pollution, and sustainable sites, etc.

LEED is the leading green assessment rating organisation using score checklist to assess sustainable projects. Different levels of certification, from Silver, Gold to Platinum are achieved based on the scored points from the checklist. However, the potential problem is the scoring point system creates negative incentives to design around the checklist rather than to build the greenest building. This paper present a case study is the first high rise hotel project in the world that achieved triple platinum awards from three different green assessment rating organisations, including LEED of USA, BEAM Plus of Hong Kong and Green Mark of Singapore. This paper aims to investigate the approach of this project to different sustainability rating systems and how it achieved the highest level of sustainability.

**Keywords:** sustainability rating system, LEED, BEAM Plus, Green Mark, hotel

## **Introduction**

U.S Green Building Council, a nonprofit organization formed in 1993 created a voluntary program called “Leadership in Environment and Energy Design (LEED)” and released its first version in 2000. The program was aimed to support sustainability and help to develop buildings which will be efficient and cheaper to maintain. The first version of LEED rating system was created for new construction and it guided standards and benchmarks which were comparatively easy to achieve. After its initial success, LEED programs were developed creating guidelines for existing buildings and commercial interiors and existing buildings. Architects, land use planners and civil engineers realized the value the standards brought to the community, and hence the industry transformed. LEED certification provides independent, third-party verification that a building was designed and built using strategies aimed at achieving high performance in key areas of human and environmental health: Sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality. Building projects satisfy prerequisites and earn points to achieve different levels of certification, from Silver, Gold to Platinum level. However, a successful sustainable development is more than just counting the score points of the rating system. It is important for a sustainable project to create integrated solutions across not only engineering but planning, architecture, interior and construction management aspects and also take the life time operation and maintenance aspects into

account in the early stages of the project. This paper will first review the development of green assessment rating systems. Hence a case study of an outstanding sustainable hotel project in Hong Kong is used to demonstrate how to achieve the triple platinum awards from three different green assessment rating organisations, including LEED of USA, BEAM Plus of Hong Kong and Green Mark of Singapore. Finally, discussion on the holistic approach of this hotel project that how it achieved the highest level of sustainability.

## **Sustainability Assessment Rating Systems**

Over the past decade, various green building rating systems or certification schemes were promoted across the globe. However, there are three most commonly used sustainability rating systems in the global coverage, they are LEED, BREEAM and GREEN STAR. LEED is the most recognized rating system mainly used in USA and Canada, and now extended to include Mexico, India, Brazil, Emirates, etc. BREEAM is the BRE Environmental Assessment Method that mainly operated in UK and part of Europe including Netherlands, France, Spain, Germany, Sweden, Poland, Norway, Russia, etc. GREEN STAR is the environmental rating system to evaluate the environmental design and construction of buildings and communities that operated in Australia and New Zealand. When comparing BREEAM, LEED and Green Star, there are similarities that sustainability issues are breakdown into a number of categories and assigned weightings, such as management, energy, transport, health and wellbeing, water, materials, land use and ecology, pollution, and sustainable sites, etc.

The success of the LEED rating systems in USA lead to the rise of similar green building councils in many other countries such as, Singapore, Hong Kong, India, Canada, etc, which in turn created their own rating systems (Talwar, 2013). In Asia, the sustainability rating systems are more diversified and most of the countries have established their own rating systems, including:

- CASBEE is the Comprehensive Assessment System for Building Environmental Efficiency owned and operated in Japan by the Japan Sustainable Building Consortium,
- BEAM Plus is the environmental assessment scheme for new buildings and existing buildings, which is owned by BEAM Society Limited, recognized by the Hong Kong Green Building Council and operated in Hong Kong.
- Green Mark is a benchmarking scheme for environmental design and performance, operated by Building and Construction Authority in Singapore.
- EEWH is the green building certification system in Taiwan, stands for the evaluation of four categories -Ecology, Energy saving, Waste reduction, and Health
- ESGB is the Evaluation Standard For Green Buildings in PRC China

Reed and Krajcinovic-Bilos (2013) recognised that the individual characteristics of each country, such as the climate and type of building stock that lead to the development of an individual sustainability rating tool for each country.

Internationally, LEED is a globally recognized symbol of excellence in green buildings. The LEED rating systems generally have 100 base points plus six Innovation in Design points and four Regional Priority points, for a total of 110 points. Each credit is allocated points based on the environmental impacts and human benefits of the building-related impacts that it addresses. Projects achieve certification if they earn points according to the following levels:

- Certified: 40–49 points
- Silver: 50–59 points
- Gold: 60–79 points
- Platinum: 80+ points

However, some criticisms on LEED rating system is that its “Rating System Checklist” to evaluate a building’s water and energy efficiency, land use, choice of materials, and indoor environmental quality. Based on the checklist scoring results, it certifies buildings on a scale from simply “LEED certified” up through Silver, Gold and Platinum. Stein and Reiss (2004) pointed out that “*buildings that earn more LEED credits do not necessarily provide more environmental benefits than buildings that earn fewer credits*”, and Frangos (2005) recognized that “point mongering” is a common phenomenon under the LEED rating checklist scoring system. In addition, Leu (2012) pointed out that further potential problem is the scoring point system creates negative incentives to design around the checklist rather than to build the greenest building.

## **Holistic Approach**

Since the first version of LEED released in 2000, The LEED system is gaining popularity in the international green building marketplace. Over the years, the rating systems became more stringent; with the recent Version 4 released in November 2013. The new rating systems may be a challenge to achieve, however building owners and developers are motivated to design and build buildings which conform to the highest certification levels and are still able to compete in the real estate market. As a result of this, at present there are better and more efficient buildings in the market. Lam et al. (2013) recognized that one of the key aspects on innovative design strategies allowed building performance to go beyond the checklist-based scoring systems.

It is important to create integrated solutions across not only engineering but planning, architecture, interior and construction management aspects and also take the life time operation and maintenance aspects into account in the early stages of the project. This holistic approach has resulted in providing a clear direction for the projects to reach the highest sustainability targets. Some examples have been presented in the Sustainable Building 2013 Hong Kong Regional Conference, for instance, the research & development campus in Shanghai (Laverick, 2013), Hysan Place in Causeway Bay Hong Kong (Chan, 2013) and public rental housing developments at the old Kai Tak Airport site in Kowloon (Yim, 2013). The following is a case study analysis of an outstanding sustainable hotel project in Hong Kong using holistic approach to sustainability that achieved triple platinum awards from three different green assessment rating organisations.

## **Pilot Study: A Hotel Project in Hong Kong**

The Holiday Inn Express Hong Kong SoHo hotel is situated in Sheung Wan, the heart of the commercial centre in Hong Kong. The project commenced in 2009 and opened in September 2013. The project site area is 612 square metres with a total Gross Floor Area of 9,496 square metres. It consists of 37 storeys and 274 guest rooms.

This hotel project sets out as an integrated green and sustainable building design participated by the developer, architect, engineers, special consultants and construction team. The hotel’s design and construction is "Green" concerned and oriented on sustainability, carbon emission reduction, water & energy efficiency, atmosphere optimization, material and resources consideration, indoor environmental quality performance with a number of innovative ideas on energy optimization solution and sustainable practices (Ngan et al., 2013). The result is an overall energy saving of 58.5% over EMSD HK hotel energy consumption benchmark (EMSD, 2000). The key green features of the hotel project can be classified in a number of categories, including:

### **(A) Architecture**

- Building orientation: Guest rooms located at North-South directions and minimized Window area in the West direction.
- 5D Building Information Modelling is adopted during design development.
- Provide podium garden, roof garden and Green wall from 2/F to 6/F, increased landscaping area to 47.5% of the site area.
- Extensive use of standardized prefabricated elements up to 50% major building components

(B) Heating, Ventilation and Air-conditioning System

- “Energy Optimization Solution” to Chiller Plant is adopted to optimize overall system energy efficiency and control performance. High CoP (5.48) Variable Speed Drive (VSD) water-cooled chiller system.
- CO<sub>2</sub> sensors installed to control air handling units.
- Centralized control by Building Management System (BMS)

(C) Electrical System

- Light-Emitting Diode (LED) lights and T5 light tubes installed.
- Daylight sensors installed at the lift lobbies and Great Room.
- Solar lawn lights installed to store solar energy in nickel cadmium batteries.

(D) Lift System

- Lifts’ motors driven under Variable Voltage Variable Frequency (VVVF).

(E) Plumbing and Hot Water Supply System

- Heat pump to reclaim heat from HVAC system and solar energy from roof top solar hot water panel and solar reclaimed cladding.
- Rainwater and AC condensation recycling tanks (total volume 10,000L) collected water from air-conditioning system and treated using carbon filter and ultraviolet lamp to remove suspended solids.

(F) Innovative Design and Techniques

- Intelligent lift optimization counterweight reduced counterweight from 50% to 35% heavier than the lift car.
- Intelligent fan coil unit (iFCU) used permanent magnet motor through magnetic forces to operate.
- Peltier Headboard - personalized air-conditioner embedded into the headboard of the beds.
- Pattern recognition technology, closed-circuit television (CCTV) cameras and motion sensors to observe the occupancy status of the corridors.

It is the first high rise hotel project in the world that achieved triple platinum awards from three different green assessment rating organisations, including LEED-NC of USA (USGBC, 2013), BEAM Plus New Building of Hong Kong (HKGBC, 2013) and Green Mark’s Provisional of Singapore (Building Construction Authority, 2013). The score cards from these three green assessment rating systems are listed in Table 1 to 3.

Table 1: LEED - New Construction Score Card for the Hotel Project

<b>Category</b>	<b>Achieved Scores</b>	<b>Max Points</b>	<b>Percentage Achieved</b>
Sustainable Site	23	26	88.5%
Water Efficiency	13	14	92.9%
Energy and Atmosphere	28	35	80.0%
Material and Resources	1	14	7.1%
Indoor Environment Quality	13	15	86.7%
Innovation and Design Process	4	6	66.7%
<b>OVERALL SCORE</b>	<b>82</b>	<b>110</b>	<b>74.5%</b>

Table 2: BEAM Plus for New Building Score Card for the Hotel Project

Category	Achieved Credits	Applicable Credits	Achieved Percentage	Weighting Factor
Site Aspects (SA)	14	19	73.7%	25%
Material Aspects (MA)	6	20	30.0%	8%
Energy Use (EU)	31	37	83.8%	35%
Water Use (WU)	6	8	75.0%	12%
Indoor Environmental Quality (IEQ)	22	28	78.0%	20%
Innovations and Additions (IA)	5	1+5 Bonus	500.0%	100%
<b>OVERALL RATING</b>	<b>84</b>	<b>118</b>	<b>79.8</b>	

Table 3: Green Mark Score Card for the Hotel Project

Category	Achieved Scores	Max Points	Percentage Achieved
Energy Efficiency	63.5	72	88.2%
Water Efficiency	9.93	14	70.9%
Environmental Protection	17.00	27	63.0%
Indoor Environmental Quality	4.00	4	100.0%
Other Green Features	1.50	7	21.4%
<b>OVERALL SCORE</b>	<b>95.93</b>	<b>124</b>	<b>77.4%</b>

As indicated in the score cards of the three different green assessing rating systems, the top three categories of percentage achieved from each of the Platinum awarded rating system are very consistent, namely water efficiency, energy efficiency, and indoor environmental quality.

This hotel project adopted numerous innovative features and technologies in energy savings and environmental friendly features in its design, including automatic curtain system, photo sensors, energy efficient lighting, HVAC system optimization, counterweight optimization, Peltier headboard, etc. The building's entire life cycle has been thoroughly considered prior to construction in creating a comfortable and sustainable building for guests and visitors (Mak et al., 2014). These innovative features and technologies are the excellent achievement of sustainability for the hotel project. For example, the Peltier Headboard is the first hotel to develop and patent the technology on headboards. This smart technology ensure that when guests are sleeping cool air is only circulated to where it is needed rather than the entire guest room in order to save energy. However, LEED has only awarded one single point for this true innovation. On the whole, the category of innovative design and technologies only accounted for a very small proportion of the overall score, and a very small percentage achieved in the innovation category. For instance, percentage achieved for the innovation category in LEED is 4.8% (4/82), BEAM plus is 5.9% (5/84), and even lower in Green Mark is 1.6% (1.5/95.93). This indicated that the scored points in innovative category did not totally reflect the efforts input into the hotel project. The achievements of the hotel project are more than just the scored points at platinum level, it demonstrates a holistic approach that emphasis on the innovative design strategies to acquire the highest commitment to sustainability.

## Conclusion

The commonly used green assessment rating tools are based on scored points. They provided a basic check list to various categories under sustainability topics, the higher the score, represent the better the level of achievement in sustainability. The three common top categories are energy efficiency, water efficiency and indoor environmental quality. However, there is very small proportion of the score checklist assigned to the innovation category of which will make a great different to achieve the highest level of sustainability, This indicated that the scored points in innovative category did not totally reflect the efforts input into the hotel project. Sustainability projects need to achieve beyond the scored points and should use holistic approach on innovative design strategies towards sustainability.

This hotel project considered all aspects of energy savings and environmental friendly features during the preliminary stage, from architectural design and building services engineering, to construction and operation. With the integrated effort of highly energy efficient components, environmental friendly features and in particular many innovative design and techniques, this hotel project has become an iconic landmark in the green building industry and demonstrated that its achievement is go beyond the scored points at platinum level.

## References

- Building Construction Authority (2013) Available from: <http://www.greenmark.sg/> [Accessed 30 May 2013].
- Chan, L.K. (2013) Hysan Place – Innovative Environmental Solutions to Urban Density. Proceedings of the Sustainable Building 2013 Hong Kong Regional Conference, Hong Kong.
- Electrical and Mechanical Services Department (2000) Guidelines on Energy Efficiency of Lift and Escalator Installations. Available from: [www.emsd.gov.hk/](http://www.emsd.gov.hk/) [Accessed 30 May 2013].
- Frangos, Alex (2005) Is it Too Easy Being Green? Wall Street Journal, 19 October 2005, page B1.
- Hong Kong Green Building Council, 2013, Available from: <http://www.hkgbc.org.hk/eng/BeamPlusDirectory.aspx> [Accessed 29 May 2013].
- Lam T.N.T., Wan, K.K.W, Ng, T.S.K., Cheng, V.S.Y, Schepers, H. (2013) Built Environment Modelling and High Performance Envelope Design. Proceedings of the Sustainable Building 2013 Hong Kong Regional Conference, Hong Kong.
- Laverick, M. (2013) Sustainable Buildings and use of Advanced Technology in Current Practice in PRC. Proceedings of the Sustainable Building 2013 Hong Kong Regional Conference, Hong Kong.
- Leu, C. Y. (2012) A Critical Analysis on the Effectiveness of Energy Performance Assessment for Green Building Labelling Scheme in Hong Kong. Unpublished Degree of Engineering Doctorate Dissertation, City University of Hong Kong, Hong Kong.
- Mak, M.Y., Wong, C.T.C., So, A.T.P., Chan, A.C.M. (2014) Beyond Platinum: A Green Hotel Project in Hong Kong. *Proceedings of the International Conference on Intelligent Systems, Structures and Facilities ISSF 2014 – Sustainable Green Intelligent Buildings*, Asian Institute of Intelligent Buildings, Hong Kong.
- Ngan, E.S.K., Chan, S.W.P. and Leung, E.Y.W. (2013) Green Travelling – Staying in Sustainable Hotel. Proceedings of the Sustainable Building 2013 Hong Kong Regional Conference, Hong Kong.
- Reed, R., Krajnovic-Bilos, A. (2013) An Examination of International Sustainability Rating Tools: an Update. *19<sup>th</sup> PRRES Pacific Rim Real Estate Society Conference*, Adelaide, Australia.
- Stein, J. and Reiss, R. (2004) Ensuring the Sustainability of Sustainable Design: What Designers Need to know about LEED. E Source. Paper AED-04-01, September.
- Talwar, M. (2013) Sustainable Plans for an Urban City. Proceedings of the Sustainable Building 2013 Hong Kong Regional Conference, Hong Kong.
- U.S. Green Building Council (2013) Available from: <http://new.usgbc.org/projects>. [Accessed 30 May 2013].
- Yim, S. (2013) Homes in the Park – A Sustainable Public Housing Estate Conserved from an Old Airport at Kai Tak in Hong Kong. Proceedings of the Sustainable Building 2013 Hong Kong Regional Conference, Hong Kong.