The Cream of BEAM Plus

A General Case Review of Platinum Green Buildings

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Abstract: BEAM (Building Environmental Assessment Method) Plus is Hong Kong's green building assessment system. This study investigates the assessment results of 23 projects that achieved a Platinum rating at the 'Provisional' or 'Final' stage of assessment. The success factors common to these projects are good-quality indoor environments, low sewage discharge, the reduction of peak electricity demand, good pollution management and the careful selection of materials. Nevertheless, there is room for improvement in areas such as mitigating the urban heat island effect, material/waste recycling, water recycling, passive design, reducing car use and increasing the use of renewable energy. The results of the study demonstrate that BEAM Plus has driven the creation of more healthy, efficient and sustainable buildings in Hong Kong. As the rating tool is continuously upgraded to promote market transformation, the green building movement will continue to thrive.

INTRODUCTION

Initiated in 1996, the Building Environmental Assessment Method (BEAM) is a voluntary green building certification scheme tailored to the sub-tropical, high-density urban environment of Hong Kong. The scheme has evolved over time. In 2009, a major overhaul was made with the production of an enhanced rating tool known as 'BEAM Plus' [1]. This enhancement was developed in response to global concerns about climate change, and was designed to meet higher expectations of carbon emission reduction, site utilisation and passive design. The rating tool provides building users with a single label that represents a wide range of building performance issues. A BEAM Plus certified building is healthier, more comfortable and more energy efficient than a building that lacks BEAM Plus certification, and has fewer adverse environmental effects. The awards available under the scheme are Platinum, Gold, Silver, Bronze and Unclassified. This paper reviews the key attributes of the first 23 Platinum-rated projects, comprising 20 Provisional Platinum projects and 3 Final Platinum projects certified between the commencement of registration in August 2010 and 31 December 2013.

BACKGROUND

From the commencement of registration to the end of 2013, 442 projects were registered for BEAM Plus assessment [2]. Analysis reveals that a substantial percentage (43%) of the projects registered for assessment were residential. The next two major categories were commercial (25%) and government, institution or community (GIC) sites (19%). This indicates that a wide spectrum of buildings have been registered for green building certification. Further statistical details are provided in Figure 1.

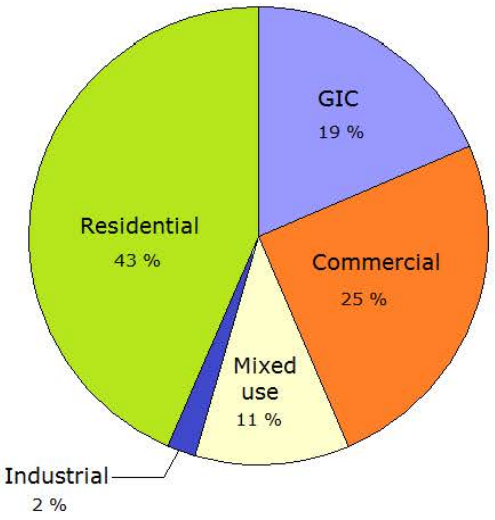

Figure 1 Profile of 442 registered projects

As of 31 December 2013, 107 projects had been assessed at the design stage, i.e. 'Provisional Assessment', and 3 had received post-construction stage assessment, i.e. 'Final Assessment'. The profile of the assessed projects is illustrated in Figure 2.

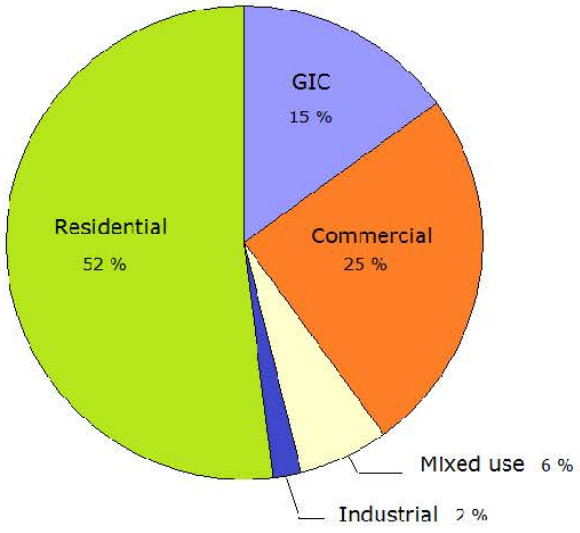

Figure 2 Profile of 110 assessed projects

Platinum, Gold and Bronze ratings were fairly evenly distributed among the 110 assessed projects, with each grade awarded to approximately one fifth of the buildings. A quarter of the projects received an Unclassified rating. The Silver rating was least well represented, with the smallest proportion of projects (14%) receiving this grade. A pie chart illustrating these statistics is provided in Figure 3. All three of the projects that underwent Final Assessment were in the Platinum group.

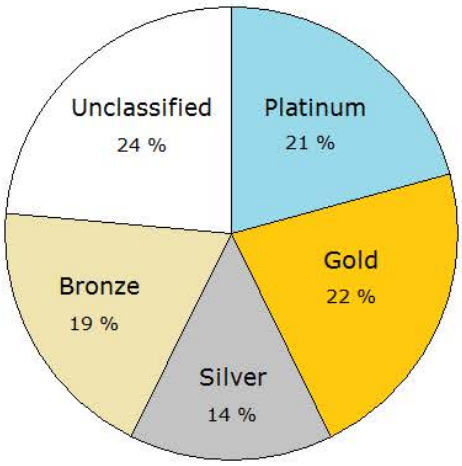

Figure 3 Distribution of ratings among 110 assessed projects

This study investigates 20 Provisional Platinum projects and 3 Final Platinum projects. A breakdown of these projects by building category is provided in Figure 4. GIC projects make up the highest percentage (44%) of Platinum-rated projects, and the residential category has the second highest percentage (35%) of Platinum projects.

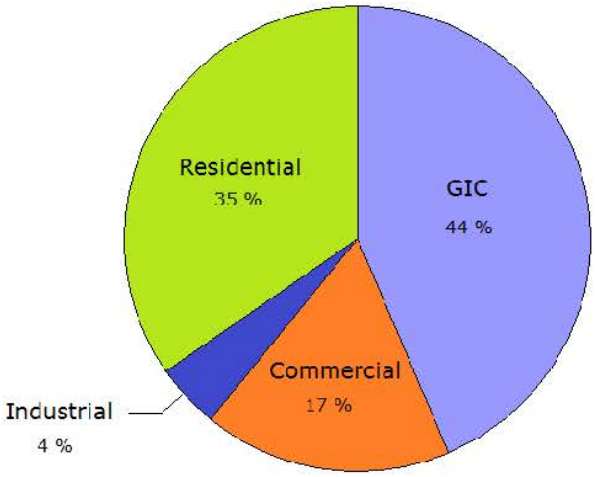

Figure 4 Profile of 23 Platinum projects

ANALYSIS

The results of analysing the Assessment Reports [3] for the 20 Provisional Platinum and 3 Final Platinum projects are presented below.

Project Scores

Figure 5 illustrates the individual scores for each project, and the breakdown of these scores. The projects are denoted by building type to avoid disclosing their identities. The minimum score required to achieve a Platinum rating is 75, but more than half (12) of the projects received scores higher than 80, reflecting their substantial efforts to promote greener building design and reduce adverse environmental effects.

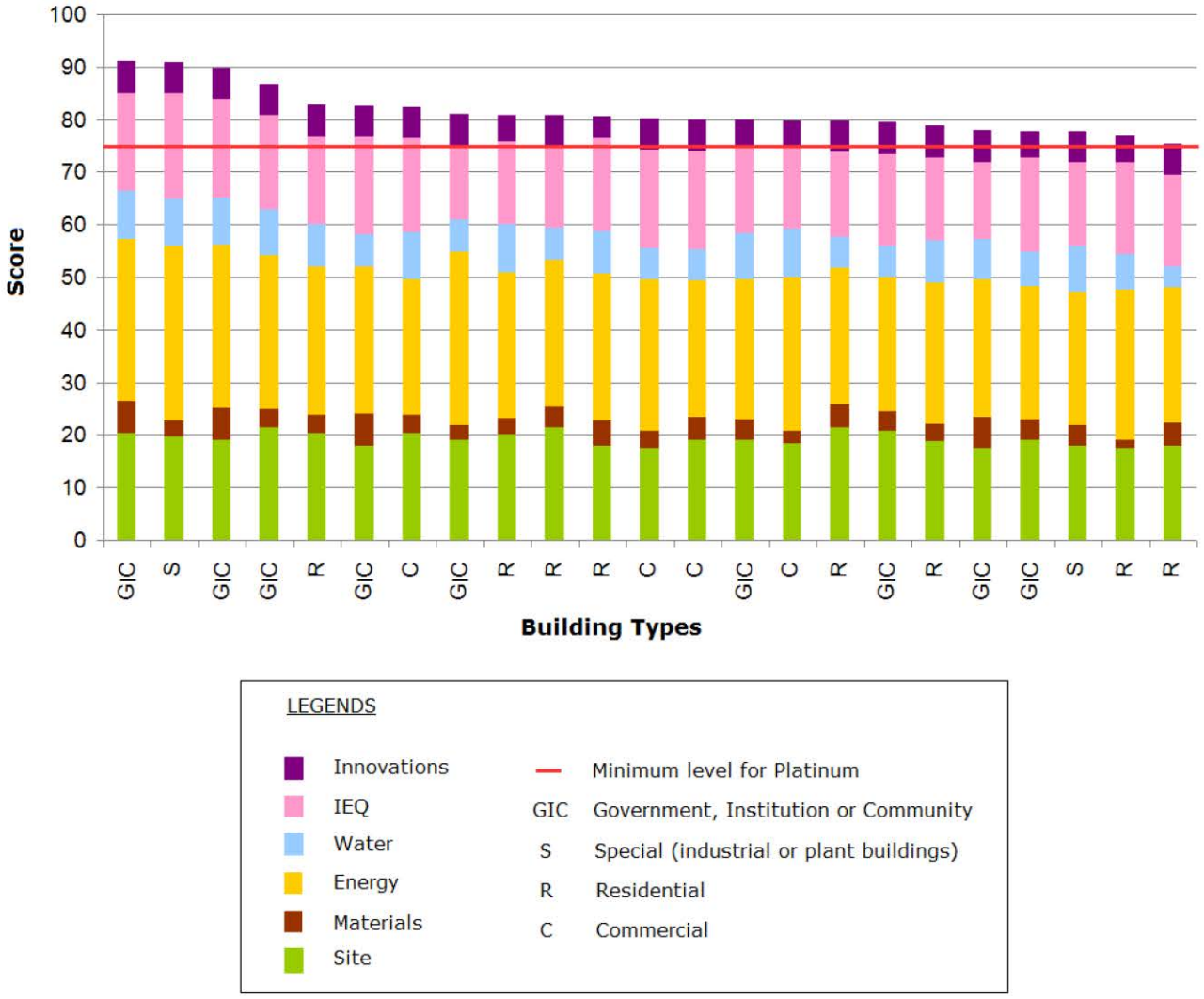

Figure 5 Individual scores received by the 23 Platinum projects

Most of the highest-scoring projects are GIC projects, indicating that government and government-owned statutory bodies are active in pursuing outstanding performance in green building. Interestingly, the project with the second highest score is a 'Special' building, i.e. an industrial or plant building. This shows that the green rating tool can also be used effectively to assess non-conventional buildings.

Ten of the 23 projects are owned by private companies or non-governmental bodies. This indicates that non-governmental clients (including some smaller companies) are also enthusiastic in promoting good performance in green building.

Category Scores

BEAM Plus scores are calculated in five performance categories, namely Site Aspects, Materials Aspects, Energy Use, Water Use and Indoor Environmental Quality (IEQ). The number of credits received in each category is divided by the number of applicable credits to obtain a percentage score for that category. The average scores of the 23 projects in each category, and their average total marks, are illustrated in Figure 6.

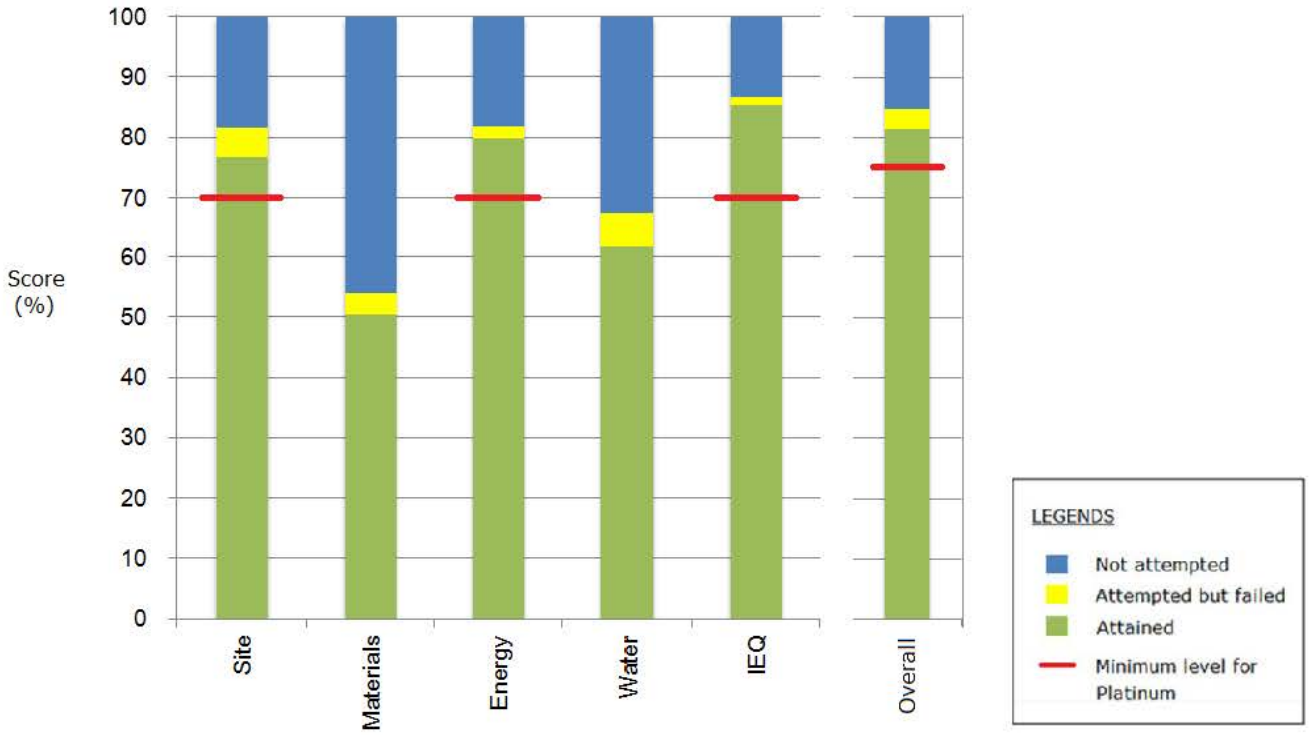

Figure 6 Average category scores and overall scores achieved by the Platinum projects

In the graph shown in Figure 6, the green segment of each bar represents the average score achieved by the 23 projects in the given category, and the yellow segments represent the scores that were attempted but not achieved. The red lines represent the minimum requirements for a Platinum rating. These minimum requirements are imposed in three categories, namely Site Aspects, Energy Use and IEQ, and applied to each project's total score.

The Platinum projects noticeably exceeded the minimum levels for a Platinum rating in the aforementioned three categories, especially IEQ and Energy Use. However, the average scores for Materials and Water are only 51% and 62%, respectively. First, BEAM Plus does not demand a minimum score for Materials or Water. Second, the weighting factors for scores in these categories are also low, with Materials weighted at 8% and Water weighted at 12%. These weighting factors are applied before summing up the category scores to obtain an overall mark.

The 23 projects achieved an average overall score of 81.5, which is well above the minimum level (75) required for a Platinum rating.

The largest proportion of scores attempted but not achieved (represented by the yellow section of each bar) is found in the Water Use category, with the second and third largest in Materials and Site Aspects. The smallest proportion is found in the IEQ category. This implies that there is room for improvement in the clarity of the submission criteria or project applicants' submission skills in the categories of Water Use, Materials and Site Aspects.

On average, the projects set an overall target score of 84.7, and achieved 81.5. The difference of 3.2 is a timely reminder that project applicants should always set a higher target for credits than the minimum required.

Individual Credit Analysis

The results of analysing the percentage of projects achieving each credit are provided in the bar chart in Figure 7. In the following sections, the strengths and weaknesses shared by the Platinum projects are assessed by examining the areas that frequent score highly and those that are less commonly achieved.

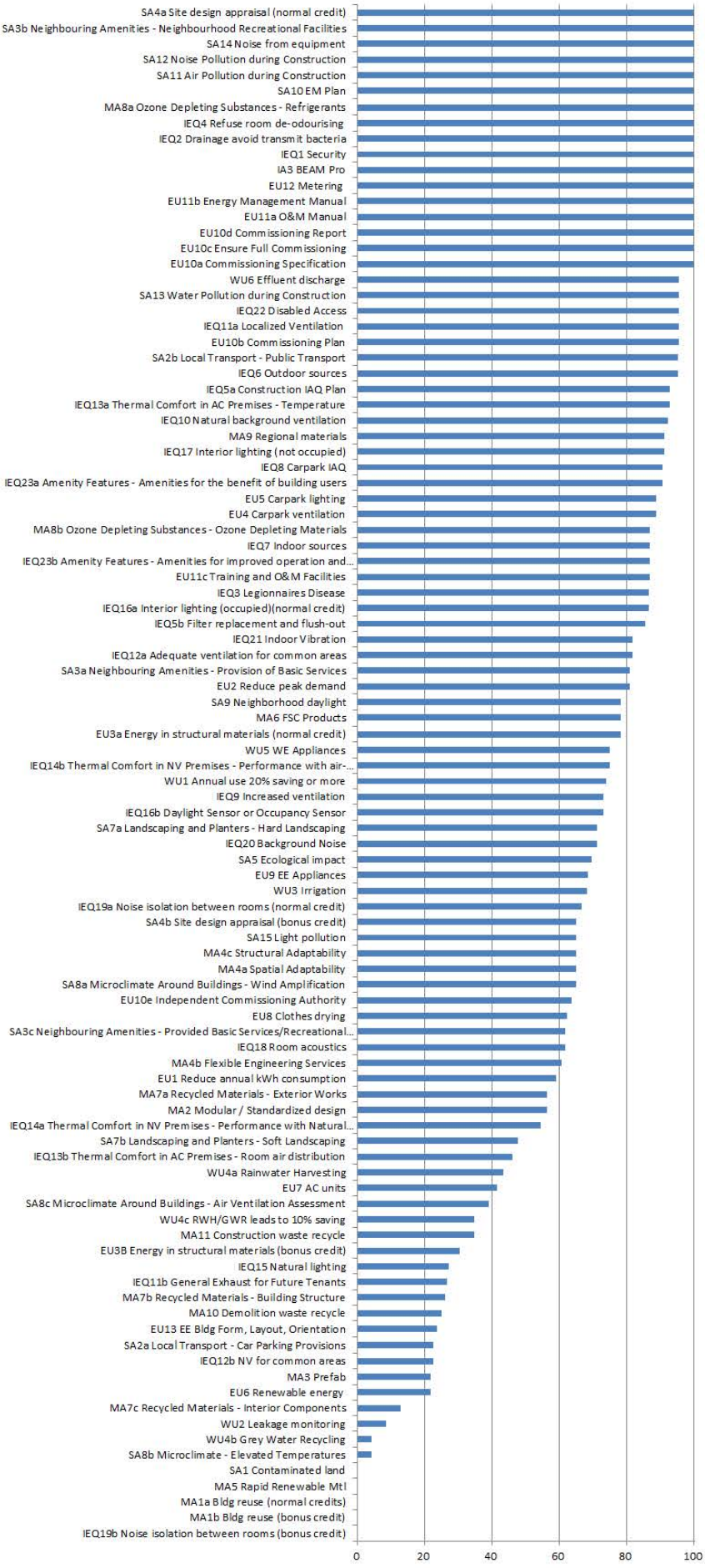

Figure 7
Percentage of Platinum projects achieving each credit

High-scoring Areas

The areas in which more than 75% of the projects received full marks are summarised in Table 1.

Table 1 Areas in which more than 75% of the projects received full marks

Item		% of Platinum projects achieved full scores
1.	**Site Aspects**	
1.1	Meet 50% of Urban Design Guidelines (SA4a)	100
1.2	Noise from building equipment (SA14)	100
1.3	Pollution management during construction (SA10-SA13)	96 – 100
1.4	Availability of public transport (SA2b)	95
1.5	Neighbourhood basic & recreational services (SA3a, 3b)	81 – 100
1.6	Neighbourhood daylight access (SA9)	78
2.	**Materials Aspects**	
2.1	Ozone depleting substances (MA8a, 8b)	87 – 100
2.2	Regionally manufactured materials (MA9)	91
2.3	Sustainable forest products (MA6)	78
3.	**Energy Use**	
3.1	Installation of adequate metering (EU12)	100
3.2	Maintenance manuals / Energy management manuals (EU11a, 11b)	100
3.3	Testing and commissioning (EU10a to d), excluding engagement of independent commissioning authority	96 – 100
3.4	Car park lighting and ventilation (EU4, EU5)	89
3.5	Operator training and maintenance facilities (EU11c)	87
3.6	Peak electricity demand reduction (EU2)	81
3.7	Embodied energy study for structural materials (EU3a)	78
4.	**Water Use**	
4.1	Low volume sewage discharge (WU6)	96
4.2	Use of water-efficient appliances (WU5)	75
5.	**Indoor Environmental Quality**	
5.1	Security measures (IEQ1)	100
5.2	Hygienic drainage system design (IEQ2)	100
5.3	Refuse room de-odorising (IEQ4)	100
5.4	Localised ventilation for contaminant sources (IEQ11a)	96
5.5	Barrier-free access (IEQ22)	96
5.6	Achieving IAQ (Indoor Air Quality) Good Class (IEQ6, 7)	87 – 95
5.7	Construction IAQ management (IEQ5a, 5b)	86 – 93
5.8	Temperature control with air-conditioning (IEQ13a, 14b)	75 – 93

Item		% of Platinum projects with full marks
5.9	Adequate air change rate for buildings designed to use natural ventilation (IEQ10)	92
5.10	Carpark IAQ (IEQ8)	91
5.11	Performance of artificial lighting (IEQ16a, 17)	87 – 91
5.12	Amenity features in buildings (IEQ23a, 23b)	87 – 91
5.13	Prevention of Legionnaires' Disease (IEQ3)	87
5.14	Adequate ventilation in common areas (IEQ12a)	82
5.15	Mitigation of indoor vibration (IEQ21)	82

Based on the summary provided in Table 1, the projects have the following strengths in common:

- the effective minimisation of adverse environmental effects during construction and operation;
- appropriate site selection to ensure that surrounding services and utilities are adequate;
- appropriate selection of materials such as refrigerants and timber;
- the use of regionally manufactured materials;
- a reduction in peak electricity demand;
- the implementation of adequate measures to ensure proper T&C and proper operation and maintenance;
- the performance of advanced studies in areas such as embodied energy and the use of computational fluid dynamics for natural ventilation;
- the provision of adequate security measures and facilities for the disabled;
- a high-quality and healthy indoor environment; and
- the use of water-efficient appliances and a reduction in sewage discharge.

Further statistics on the Platinum projects are provided as follows.

Site Aspects

- Greenery as a percentage of site area ranges from 11% to 65%, with an average of 38%.
- 78% of the Platinum projects benefit from green roof design. Greenery as a percentage of roof area (excluding areas occupied by mechanical equipment) ranges from 23% to 100%, with an average of 61%.

Materials Aspects

- 65% of the Platinum projects received credits for the use of recycled materials in exterior paving works. The percentage of recycled content ranges from 28% to 97%, with an average of 52%.
- 65% of the Platinum projects received credits for construction waste recycling. The percentage of waste recycled ranges from 30% to 89%, with an average of 54%.

Energy Use

- For the projects with energy simulation data, the annual reduction in energy use ranges from 12% to 60%, with an average of 30%. The reduction in peak electricity demand ranges from 8% to 41%, with an average of 31%.
- Renewable energy was adopted in 61% of the Platinum projects and 36% of the renewable energy projects attained full marks in the relevant credit area (EU6). It is encouraging to note that two of the projects that received full marks are high-rise buildings, with heights between 19 and 22 storeys.
- Among the energy saving techniques frequently used in the Platinum projects are the following: daylight/occupancy sensors (10 projects), demand control ventilation (9 projects), hybrid ventilation (9 projects), low-emissivity glass (12 projects), shading devices (10 projects) and orientation design to reduce energy use (15 projects).

Water Use

- Low-flow water fixtures were widely adopted to reduce water use. The annual reduction in water use ranges from 22% to 64%, with an average of 39%.
- Dual-flush toilets and low-flow urinals were widely adopted to reduce sewage discharge. Annual effluent reduction ranges from 20% to 63%, with an average of 44%.
- Rainwater harvesting was adopted in 61% of the Platinum projects. The resulting reduction in fresh water use ranges from 5% to 99%, with an average of 39%.
- Grey-water recycling was adopted in 4% of the Platinum projects. The resulting reduction in fresh water use is around 8%.
- 57% of the Platinum projects received full marks in water-efficient irrigation. The reduction in water use for irrigation ranges from 50% to 100%, with an average of 73%. In the majority of these projects, water reduction was achieved through rainwater harvesting.

Innovations

Among the innovative features of the Platinum projects are the following.

Site Aspects

- Openings in the body of the building to enhance urban ventilation. (These openings are also integrated with sky gardens.)
- Use of bio-retention systems to reduce storm-water runoff and treat water pollutants.
- Use of vertical green hoarding panels on site.

Material Aspects

- Separate refuse chutes for general waste and recyclable waste.

Energy Use

- Use of tri-generation or the flexibility to implement tri-generation in the future.
- Use of bio-diesel for power generation.
- Feedback to the public grid of excess electricity generated on site.
- Innovative cooling devices such as Peltier bed coolers and chilled beams.
- Intelligent fan coil units with brushless DC motors and innovative controls.
- Reclamation of solar energy from external wall panels for hot water heating.

Other Aspects

- Innovative educational signage within buildings.
- Use of innovative building information modelling (BIM) to optimise resource use and improve the predictability of building performance.
- Use of innovative online project collaboration platforms to save paper.
- Use of innovative building management systems (BMS) to save paper.

It should be noted that some of the above features (e.g. BIM and online collaboration platforms) will be adopted increasingly over time in the building industry. It is thus likely that these features will no longer be counted in the category of Innovations and Additions in the future.

Performance Enhancements

BEAM Plus allows project designers to achieve bonus credits not only through innovation, but by demonstrating that the performance of a project greatly exceeds the requirements of the existing credit areas. Among the performance-enhancing features of the 23 Platinum projects are the following.

Site Aspects

- Hard-paved construction, i.e. re-usable precast concrete panels used to reduce dust on main haul roads and in storage areas.
- Provision of electric vehicle charging points for 100% of carparking spaces.

Materials Aspects

- Extensive (more than 95%) use of regionally manufactured building materials.
- Extensive (more than 90%) recycling of demolition waste.
- Extensive (more than 70%) use of paving blocks and plastic timber made from recycled materials.
- Extensive (more than 80%) use of sustainable sources or recycled timber.
- Use of food waste composters to reduce organic waste.

Energy Use

- Extensive generation of energy from renewable sources (>100% of demand) and considerable reduction in electricity consumption.
- More than 10% of annual building energy demand met by the use of a bio-diesel generator to supply power to a chiller plant.
- Two-stage lighting in common corridors (with override switches accessible via door telephones) to save energy while simultaneously meeting universal access requirements.

Water Use

- Use of root-zone irrigation system to minimise water use in irrigation.
- Implementation of twin-tank system to enhance reliability and avoid water wastage during tank cleaning.

Indoor Environmental Quality

- Use of operable louvre façades in offices to enable the amount of natural ventilation to be varied according to the time of day, and to facilitate IAQ management during renovation/construction.
- Implementation of de-odorising system using biological agents to remove ammonia, VOC and sulphurous compounds at refuse collection points.
- Multi-sensory maps for persons with disabilities.

Community Aspects

- Provision of an eco-park cum community farm for residents' enjoyment.

Pinch Points

Analysis of the 23 projects also reveals that some of the BEAM Plus criteria are less commonly achieved. Table 2 lists the areas in which fewer than 35% of the projects attained full marks. The 35% threshold (instead of the lower quartile) was chosen to give a broader view of the pinch points.

Table 2 Credits not commonly achieved by the 23 Platinum projects

Item		% of Platinum projects with full marks
1.	**Site Aspects**	
1.1	Contaminated land assessment and rehabilitation (SA1) (bonus)	0
1.2	Shading of non-roof areas and use of cool/green roofs to mitigate urban heat island effect (SA8b)	4
1.3	Elimination of private car parking (SA2a)	23
2.	**Materials Aspects**	
2.1	Building reuse (MA1) (bonus)	0
2.2	Use of rapidly renewable materials (MA5)	0
2.3	Use of recycled materials in interior and structural components (MA7b, 7c)	13 – 26
2.4	Prefabrication (MA3)	22
2.5	Demolition waste recycling (MA10)	25
2.6	Construction waste recycling (MA11)	35
3.	**Energy Use**	
3.1	Use of renewable energy (EU6)	22
3.2	Energy-efficient building layout (passive design) (EU13)	24
3.3	Use of materials with low embodied energy in major elements (EU3b) (bonus)	30
4.	**Water Use**	
4.1	Grey-water recycling (WU4b)	4
4.2	Installation of leakage monitoring devices (WU2)	9
4.3	Use of reclaimed water to save 10% of water (WU4c) (bonus)	35
5.	**Indoor Environmental Quality**	
5.1	Impact noise isolation between residential floors (IEQ19b) (bonus)	0
5.2	Use of natural ventilation in common areas (passive design) (IEQ12b) (bonus)	23
5.3	Provision of a general exhaust for future tenants (IEQ11b)	27
5.4	Average daylight factor of 2% or more (passive design) (IEQ15)	27

As indicated above, some of the items listed in the table receive bonus credits. Examples of such items are contaminated land assessment and rehabilitation, the minimisation of embodied energy in structural materials, and 10% water saving through additional water recycling. As achieving these outcomes typically requires substantial effort, the scores received in these areas tend to be lower.

Contested credits are another reason for the low scores in the areas listed above. Credits may be contested due to insufficient supporting materials, calculation errors, inconsistent information or a lack of justification, among other factors. A notable example is provided by the applicants' attempts to install leakage monitoring devices in water supply systems. The applicants failed to achieve the relevant credit due to insufficient coverage of the leakage monitoring systems. Another commonly contested credit area is the shading of non-roof areas and the use of cool/green roofs. The applicants submitted insufficient documentation to verify the characteristics of the shading or roofing materials used.

The low achievement rates in certain other credit areas (e.g. the elimination of private carparking spaces, building reuse, the use of rapidly renewable materials, prefabrication, and the provision of adequate daylight to the interior of buildings) are probably due to inherent site, neighbourhood or building design constraints. This result is unsurprising, because the BEAM Plus rating tool is performance-based. Designers are thus free to pursue development in the most suitable credit areas without compromising their ability to achieve a good final rating.

Finally, technological immaturity also reduces the frequency with which certain credits are achieved. It is likely that as technologies continue to advance and become more popular, credits that are currently challenging will become more achievable (through, for example, the use of more cost-effective renewable energy technologies and the enhanced performance of products containing recycled materials). The BEAM Plus rating tool is subject to regular revision. Its assessment criteria are regularly fine-tuned and upgraded to ensure its relevance and to reflect the latest leadership practices in high-performance building.

Future Developments

The Hong Kong Green Building Council (HKGBC) has already established future directions for upgrading the BEAM Plus assessment tool for new buildings. The enhancements made to the tool are expected to reflect experience gained in past assessments. The coverage of the tool will continue to increase with the incorporation of social sustainability elements such as pay-for-safety schemes, measures to protect workers' wages, and health and safety design considerations. The required standards will be raised to keep pace with industry advancement. Other recently developed green material labelling tools such as Construction Industry Council Carbon Labelling and HKGBC Green Building Product Labelling will be incorporated where appropriate. Crucially, the tool will continue to be consensus-based, and a high degree of transparency and inclusiveness will be maintained throughout the revision process. Accordingly, working groups composed of representatives of a range of trades will be formed to lead and monitor the revision process. Stakeholder engagement exercises will also be organised to solicit the views of developers, building design professionals and other relevant stakeholders.

CONCLUSIONS

Statistical analysis of the BEAM Plus projects reveals that a great variety of buildings are achieving Provisional/Final Platinum status, such as GIC, commercial, residential and industrial projects. Together, GIC and residential projects constitute the largest proportion of Platinum-rated projects. More than half of the projects examined in this study obtained scores higher than 80, exceeding the minimum score of 75 for a Platinum rating.

Among the success factors shared by these projects are good-quality indoor environments, low sewage discharge, a reduction in peak electricity demand, careful pollution management and a good choice of materials. A large number of innovative and performance enhancement techniques have been adopted by the project designers, although there is still room for improvement in various areas, such as mitigating the urban heat island effect, material/waste recycling, water recycling, eliminating private carparking spaces, passive design and widening the use of renewable energy.

The results of this study demonstrate that BEAM Plus has driven the creation of more healthy, efficient and sustainable buildings in Hong Kong. The best-practice industry standards set by the BEAM Plus rating tool have been enthusiastically pursued and achieved by the participating project designers. Their efforts are expected to reduce greenhouse gas emissions and improve our quality of life. As the rating tool is continuously upgraded and more innovative initiatives are implemented, the green building movement will continue to thrive.

REFERENCES

[1] BEAM Plus Manuals, available on the HKGBC website (http://www.hkgbc.org.hk/eng/BEAMPlus_NBEB.aspx)

[2] BEAM Plus Project Directory, available on the HKGBC website (http://www.hkgbc.org.hk/eng/BeamPlusDirectory.aspx)

[3] Assessment Reports and Project Information relating to BEAM Plus Projects, obtained from the internal database of BEAM Society Limited

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