

HK-BEAM: THE BUILDING ENVIRONMENTAL PERFORMANCE STANDARD FOR BENCHMARKING AND ENHANCING SUSTAINABLE HOUSING

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Abstract

HK-BEAM, the Hong Kong Building Environmental Assessment Method, is the private sector initiative to assist developers, designers, builders and managers in designing and managing local buildings in a sustainable manner. HK-BEAM sets out over 100 “best practice environmental criteria” for a range of issues – from energy efficiency and building materials, to construction pollution and indoor environmental quality – against which building performance can be measured and environmental enhancements will be encouraged.

As of October 2003, almost 100 of Hong Kong’s most prestigious private and public sector premises (consisting of over 33,000 residential units and 3.8 million m² of commercial space) have been submitted for voluntary, independent certification against HK-BEAM, gaining recognition for their environmental achievements in building planning, design, construction, operation and management whilst enhancing the sustainability and environmental performance of their properties. These account for more than 25% of commercial space, and approximately 10 % of dwellings, completed in 2002. Most recently, the scope of the HK-BEAM certification has been expanded to cover all types of local buildings, including office, residential and commercial premises, institutional, hotel and complex premises. With specific focus upon residential premises, this paper will :

- introduce HK-BEAM’s “life-cycle” approach to the evaluation of overall building environmental performance;
- present the levels of environmental achievement in design and management, reached by developments so far submitted for certification ; and
- introduce the latest HK-BEAM standards and highlight areas in which the assessment scheme continues to stimulate demand for innovative products, services and technologies from the building industry.

Whilst every assessment has resulted in real environmental improvements, HK-BEAM has also revealed gaps in local knowledge, information, products and services needed to build greener buildings, and allowing potential cost savings to be realised .

Keywords : Sustainable Housing, Building Environmental Performance and Continual Improvement.

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Introduction

Hong Kong's current economic climate has led to recent repressions in the building industry, and this coupled with increasing awareness amongst building professionals and expectations from occupants (particularly after the recent outbreak of the SARS infection) has stimulated the demand for "green" housing properties which offers "added-value" environmental features to attract and satisfy potential buyers and tenants. As stipulated by recent government policies, the promotion of sustainable development within the community is an essential part in making Hong Kong a world class city and thus returning her to economical prosperity. To this end, the adoption of environment friendly building designs and facility management would be of paramount significance in the replacement of Hong Kong's glut of aging housing stocks with more sustainable and financially rewarding premises.

The Hong Kong Building Environment Assessment Method (HK-BEAM) is an independent certification scheme which encourages collaboration between stakeholders in the building industry towards common environmental goals in terms of premises design and management. The performance appraisal scheme allows developers to put their buildings on the path to sustainable development, and offers recognition for environmental accomplishments. HK-BEAM encourages the use of "best environmental practices" for the life cycle of a building which includes, planning, design, construction, use and maintenance, and eventual demolition or de-construction.

There is a need for this holistic approach as current legislation only investigates environmental issues at the "cradle" and construction stage of the building's life cycle. The Hong Kong Planning Standards and Guidelines (HKPSG) and the Environmental Impact Assessment (EIOA) Ordinance address issues such as land use, infrastructure compatibility and the migration of local problems during construction and building operation. However, currently there is little guidance and bench marking for building design and management practices, which will help to reduce a building's environmental impact throughout its lifetime.

This paper will focus on this life cycle approach with highlights of up-to-date achievements that have been accomplished and areas where HK-BEAM has encouraged alternative thinking and innovation within the building industry.

HK-BEAM: In More Detail

HK-BEAM is owned and operated by the HK-BEAM Society¹ which is a non profit making organisation, consisting of building professionals to oversee the on-going development and implementation of the assessment scheme. HK-BEAM was initiated by the Real Estate Developers Association of Hong Kong (REDA) in 1996 and premises are assessed by a team of

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buildings and environmental specialists at the Business Environment Council (BEC), on behalf of the Society. The Department of Building Services Engineering at Hong Kong Polytechnic University (HKPU) undertakes technical research of the standard under the direction of the Society Steering Committee. The Committee consists of representatives from REDA, BEC, HKPU, Swire Properties, Hong Kong Land, the Housing Department, the Environmental Protection Department and the Buildings Department.

The recently revised HK-BEAM standards defines over 100 best practice criteria to address environmental issues for all local high rise building types (including commercial buildings, residential premises, institutional buildings, hotels and mixed used complexes), either air conditioned (centrally/ decentralised) or naturally ventilated. One feature of the revised HK-BEAM assessment framework is to embrace codes of practice already developed by the government² and encourage the uptake of internationally recognised environmental tools³.

Two standards have been developed to appraise the environmental performance of buildings at distinctive life cycle stages :

- *HK-BEAM for New Building Developments*: Aims to introduce cost effective improvements during the planning and design stage of the development. Construction practices and commissioning issues upon building completion are also assessed.
- *HK-BEAM for Existing Building Premises* : Can be carried out at any stage of a completed building's life with the objectives of providing management with a statement of current performance and improvement measures to enhance the overall operational efficiency of the premises. In summary, further to the review of inherent design, other lifecycle stages of the premises, including maintenance and repair, and building operation and management are evaluated for enhancement.

In line with overseas assessment schemes, and to give environmental context to the assessment, HK-BEAM covers environmental issues under the following impact categories at each stage of the building's life cycle :

- Site Aspects (location, planning and emissions);
- Material aspects (selection, usage and waste management);
- Energy use (system designs and management);
- Water consumption (quality and conservation);

² For example, Works Bureau's *Technical Circulars on Waste Management*, Electrical and Mechanical Services Department's *Energy Efficiency Design Codes* and *Legionnaires Disease Prevention Design Codes and Practices*, and Environmental Protection Department's *Practice Notes for Professional Persons* and *IAQ Objectives*.

³ For example the adoption of a ISO 14001 environmental management system by the main contractor during building construction.

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- Indoor environmental quality (thermal comfort, indoor air quality, lighting, noise and vibrations); and
- Innovations (innovative techniques and performance enhancements)

Buildings are submitted for assessment on a voluntary basis and the results of the assessment are presented on the HK-BEAM certificate as Bronze, Silver, Gold or Platinum. The assessment process involves a two-stage procedure (illustrated in *Figure 1*), and in addition to awarding recognition for building environmental excellence, it also encourages collaboration between all stakeholders to accomplish common sustainable development goals, often with the introduction of innovative technologies and techniques which may not otherwise be implemented in Hong Kong.

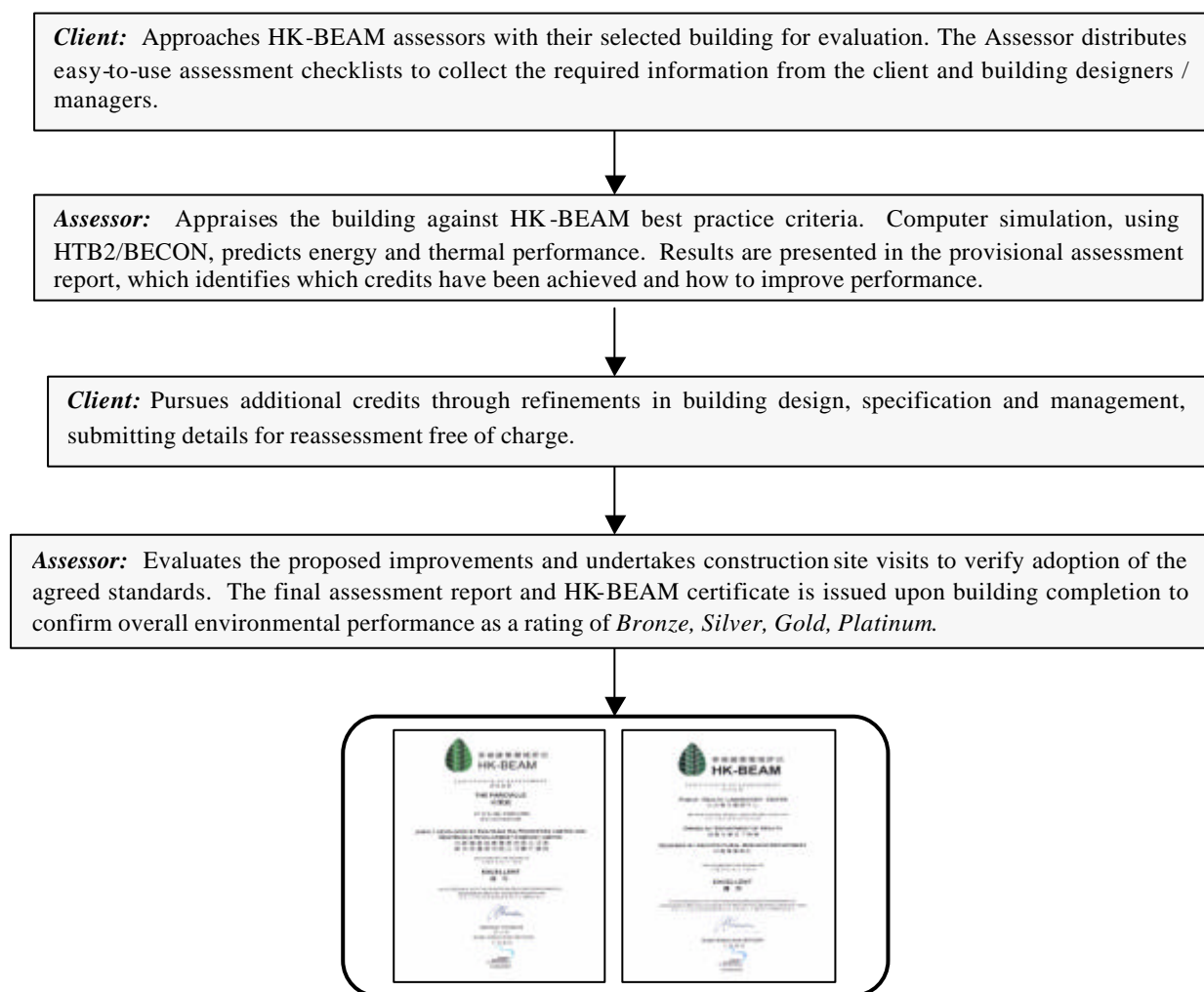


Figure 1: The HK-BEAM Assessment Process

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The Coverage of HK-BEAM through The Life-Cycle Approach

The following section highlights some of the most significant environmental issues appraised under HK-BEAM at each stage of the building's life cycle.

Planning: This is a critical period of the life cycle as it can dictate the environmental impact over the remaining life cycle stages. The Environmental Impact Assessment (EIA) Ordinance requires that the environmental impacts of projects be assessed during this stage, however many new building developments (these include premises not situated on "sensitive" locations, and residential developments served by public sewers, with less than 2000 units) are exempted from undertaking this under current legislation.

This is where HK-BEAM comes into action by allowing developers and designers to earn credits by consideration of potential environmental impacts arising from the development at this early stage. Assessments of potential noise, air quality, water and ecological problems arising from the development are required, following the principals of an EIA, with measures identified to mitigate and enhance the local environment. Such forward thinking should prove to be a popular approach – avoiding retrospective costs and perhaps increasing premiums in the future.

Design: In Hong Kong, the majority of our time is spent indoors (over 70 %), and therefore building design shape the standard of our living and working environment. The HK-BEAM assessment criteria focuses on how the building structure and engineering systems create a comfortable, healthy and efficient living and working space for its occupants.

Compared to practices overseas, the use of "virtual" design tools (such as the simulation of solar gains and wind movement for residential premises) to harness the building's micro-climate remains quite limited in Hong Kong. HK-BEAM encourages the undertaking of such studies to provide an invaluable insight into how the building could perform, providing the opportunity to test infinite ideas and innovations in massing, envelope and engineering systems even before foundations have been laid.

Hong Kong also falls behind when it comes to assessing the "life cycle impacts" and "life cycle costs" of building materials. At present, there is no single resource or agreed formula by which designers and clients can compare environmental and financial impacts of building materials, on a life cycle basis. HK-BEAM makes a start, drawing attention to material production (energy content, toxicity and pollution) and disposal (recyclability and waste generation), though currently using research from overseas.

Construction: It is all very well to think through the planning and design of a new development, but often the most visible sign of environmental failures come during the construction stage. Increased legislative requirements upon construction and the environment in

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recent years, and the gradual adoption of environmental management systems (EMS) by some contractors, has often only served to make these failures even more evident.

In this respect, HK-BEAM places the onus on the client to implement a contractual framework with the main contractor during the tendering stage. Credits are awarded where the contractor adopts an environmental management plan (EMP) for the project, which requires the identification of potential environmental impacts, and the means and timing of their mitigation. Such an approach, which includes requirements for regular environmental monitoring and auditing and reporting, has been adopted with some success for infrastructure projects in Hong Kong, though requires the full commitment of the client in ensuring its successful implementation for building developments.

Operation and Maintenance: Even with state-of-the art building designs in place, the environmental performance of a premises could be compromised if effective operation and maintenance procedures are not adopted by the building management. To these ends, assessment criteria which encourages proper and adequate commissioning, energy monitoring and maintenance provisions are included with the objective of ultimately improving building operational efficiency.

In order to maximise the benefits of building designs, and enable occupants to undertake sustainable operation of the premises, HK-BEAM encourages the provision of informative guidelines which details environmental design features and operational practices. This should be provided in the form of a *Tenant Hand Book* for housing premises. For existing premises, policy related assessment criteria such as environmental purchasing requirements and waste recycling initiatives are in place to encourage the building management to enhance the operational efficiency of the premises.

Deconstruction: Whilst the assessment at this stage of the building's life cycle does not fully lie within the scope of *HK-BEAM*, clients and designers are encouraged to look ahead to how they can contribute to more sustainable decommissioning. This remains a relentless challenge in Hong Kong, where many consider that the "deconstruction" of a building is not feasible given current construction techniques, market demand for recyclable and reusable fixtures, and the lack of time and space availability. HK-BEAM, at least, seeks to encourage flexibility in design to reduce resource consumption and waste generation by future occupants.

HK-BEAM Achievements

Since the introduction of HK-BEAM to the building industry in 1996, almost 100 landmark properties in Hong Kong have been provided with recognition for improved building performance (see *Figure 2* below), comprising over 3.6 million m² of office space and 33,000 residential units. These accounted for more than 25% of commercial space, and approximately 10 % of dwellings, completed in 2002. In fact, for *Grade A* offices completed in 2002, 80% of

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these (in terms of gross floor areas for Chater House and Cyberport Commercial Development) have been submitted for HK-BEAM certification. With the recent introduction of the revised standards for all building types, it is envisaged that the number of premise assessed under HK-BEAM will significantly grow, with enhanced environmental performance and financial benefits.

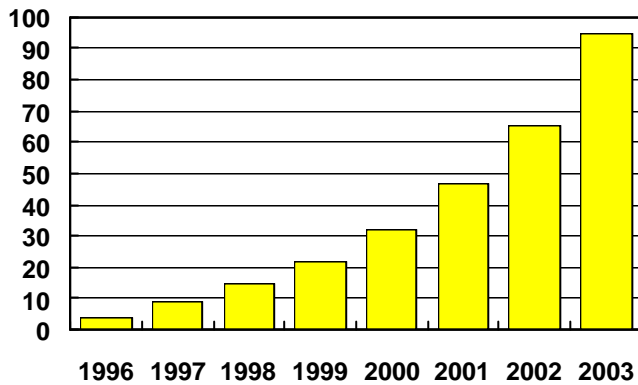


Figure 2: Growth of Buildings Assessed under HK-BEAM

Organisations which have so far submitted properties for assessment include Swire Properties, Sun Hung Kai Properties, HongKong Land, Cyberport Management, AIG Global Real Estate, IFC Development, Glorious Sun Holding, Man Hing Hong Land Investment, Central Plaza, Bank of China, the Housing Department, HSBS Property Management, the Architectural Services Department, Hang Lung Real Estate Agency, the Hong Kong Electric Company, the Urban Renewal Authority, Kowloon Motor Bus Co..

Henderson Land, Hong Kong Housing Society, the Emperor Group, the Great Eagle Company, Hong Kong & China Gas, the Open University of Hong Kong, City University of Hong Kong, and the Government Property Agency.

As indicated by organisations whom have submitted their buildings for certification, in addition to gaining third party recognition for their environmental achievements, the assessment has also yielded improvements in building environmental performance, economical gains and enhanced their corporate image for the sustainable development of Hong Kong. In terms of financial benefit, for example, under the guidance of HK-BEAM, a private developer adopted a series of environmental features (including sky and podium gardens, prefabricated construction and solar shading devices) for an urban residential development (*The Orchards*) and was rewarded with two additional saleable floors (of approximately 1000 m² in GFA) by the government's GFA exemption incentive scheme. To enhance operational efficiency, a client adopted HK-BEAM for an existing office premises (and achieved the highest rating) for which a series of energy improvement measures were implemented and reported an annual electricity cost saving of \$1 million, with a pay back period of less than 3 years. Another developer employed an improvement measure to enhance the envelope design of their new office premises to achieve the HK-BEAM rating, although the additional capital investment was around \$1million, it was estimated that an annual cost saving of \$0.7 million could be realised, with a payback period of less than 1.5 years.

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Finally, the inherent environmental improvement nature of HK-BEAM has stimulated partnership between stakeholders participating in the scheme and lead to the introduction of innovative technologies and techniques which may not otherwise be adopted by the client. Some of these are highlighted below.

Innovative and Sustainable Building Designs

Solar Powered Landscape Lights These self-contained renewable energy powered exterior lighting systems have been adopted in a number of residential premises assessed under HK-BEAM. The solar lamps consist of either nickel cadmium or lead acid batteries, and are charged during the day via photovoltaic panels and are switched on at night via the use of motion sensors, upon detection of people movement. In addition to environmental benefits, these lighting systems offers reduced operational costs as grid electricity charges and cable maintenance are eliminated.

Electric Shuttle Buses These alternative fuelled vehicles have been introduced as a means of providing shuttle travel services to public mass transport systems for a number of rural residential developments appraised under HK-BEAM. The introduction of these renewable energy transport systems for everyday use in these premises should hopefully stimulate their wider adoption and thus alleviate the well publicised air pollution problems associated with road vehicle emissions. A vehicle used in one development is a natural gas-electric hybrid powered bus (see *Figure 3*) imported from New Zealand and is the first of its kind in Hong Kong. The ability to switch to the natural gas mode in these buses can counteract against potential power inadequacy problems associated with electric vehicles.



Figure 3: Hybrid diesel/electric Shuttle Bus

Rain Water Recycling Systems In areas where high levels of rainfall is expected, the installation of rainwater water collection, treatment and recycling systems would be extremely advantageous in reducing water consumption, with likely cost savings. Several of the residential development assessed under HK-BEAM have installed such a water recycling system which during the rainy season, uses treated rainwater for plant irrigation and cleansing of common areas in the estate.

Wind Turbines Wind power technology still has a long way to go before it is capable of satisfying a large percentage of our energy needs in Hong Kong. However wind turbines have been introduced on a residential development submitted for HK-BEAM certification in which there are highly exposed areas, suitable for their installation. In addition to powering lighting in

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the premises, the installation also serve as an advert for the wider adoption of renewable energy in Hong Kong.



Figure 4 : Wind Tunnel Modelling for enhancing Pedestrian Comfort

installation of appropriately positioned sensors (see *Figure 4*). Pedestrian areas predicted to be experiencing high wind velocities were landscaped in such a way to reduce high wind impacts (e.g. planting of trees) and stagnant areas of “dead air” were ventilated using strategically positioned deflectors.

Computational Fluid Dynamics (CFD). With recent advances in computer technology, empirical scientific principles have been applied for the development of powerful and multifunctional predictive design tools such as CFD. Based on the principles of conservation of mass, energy and momentum, CFD have been used by many HK-BEAM clients (as an alternative to wind tunnel testing) to forecast exterior wind velocities and effective cross ventilation in naturally ventilated areas for their residential premises (see *Figure 5*). If correctly applied, CFD is advantageous over physical modelling in that, with adequate data and operator competency, reliable results and alternative design solutions (if required) can be rapidly generated, at a lower cost.

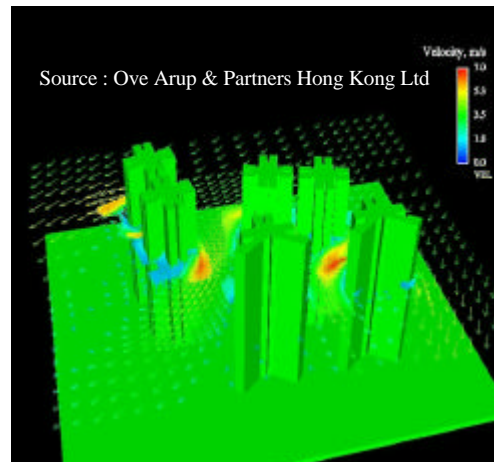


Figure 5: CFD to appraise size and location of openings (windows) for cross ventilation optimisation

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Educational Children's Play Area One excellent idea has been to incorporate environmental education into a children's play area for a residential premises assessed under HK-BEAM. Educational games revolve around the themes of recycling, water treatment, noise and air pollution, environmental building design, renewable energy, waste reduction and alternative uses for recyclable materials.

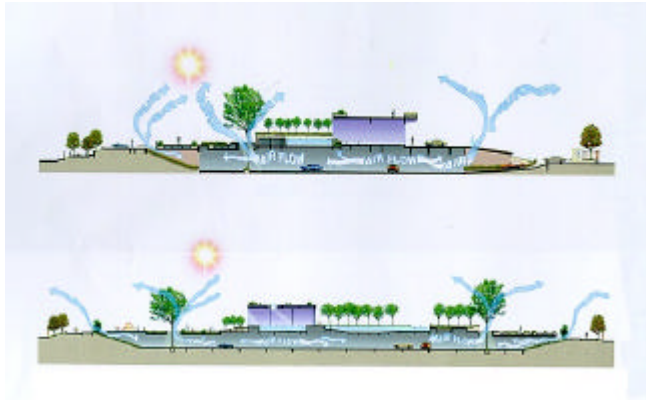


Figure 5 : Naturally ventilated car park, landscaped with trees to enhance cross ventilation

structure and creation of ventilation openings enhances natural airflow within the car park. In addition, trees are planted in the basement and stretch through and beyond the podium structure. This generates a three dimensional perspective to the landscaping and tree openings improve cross ventilation of the basement car park.

“Green” Building Products Many building products with well known environmental merits whilst readily available overseas have not found a market place in Hong Kong. This has been principally due to the lack of tangible incentives for adopting these products, and thus clients and designers are reluctant to consider these alternatives due to their higher cost. However, HK-BEAM's stipulation of “green” building materials has stimulated market demand for some of these products resulting in their local availability. Examples of environment friendly building products which have been adopted by HK-BEAM assessed premises include timber products originating from sustainable sources, low toxicity and volatile organic compound (VOC) free natural painting systems and extruded polystyrene roof insulation materials adopting carbon dioxide blowing agents (rather than ozone depleting halochlorofluorocarbons which was the norm in Hong Kong).

Conclusion

In order for Hong Kong to maintain its present position as the leading business centre in the region and recent government declarations for it to become a world class city, the embracement of sustainable development within the community is vital to enhance competitiveness and accomplish these goals.

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As a community we continue to grapple with the concept of Sustainable Development - *meeting the needs of the present without compromising the means of the future* - and what it means for Hong Kong. The design, construction and use of our buildings consumes enormous quantities of resources; creates untold environmental pollution and generates much of our waste. Building design and management shape our urban environment and control our overall quality of life. In short, as a large sector of the economy, the construction industry can make a significant contribution to a more sustainable environment in Hong Kong.

Since HK-BEAM's introduction in 1996, it has provided a unique stepping-stone towards embracing such sustainability issues, through partnership of stakeholders in the building industry. The inherent comprehensive nature of the life cycle approach adopted in HK-BEAM has led to the adoption of many building designs and management measures, which are environmentally beneficial, and often financially rewarding, which might otherwise have been overlooked. Therefore, in brief, further to having social impacts (for example through shaping buildings for occupant health and comfort), HK-BEAM also provides both environmental and economical merits to the community, which constitutes to the three core elements of sustainable housing in Hong Kong.

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