VOL 40
JUN 2012
www.hkie.org.hk

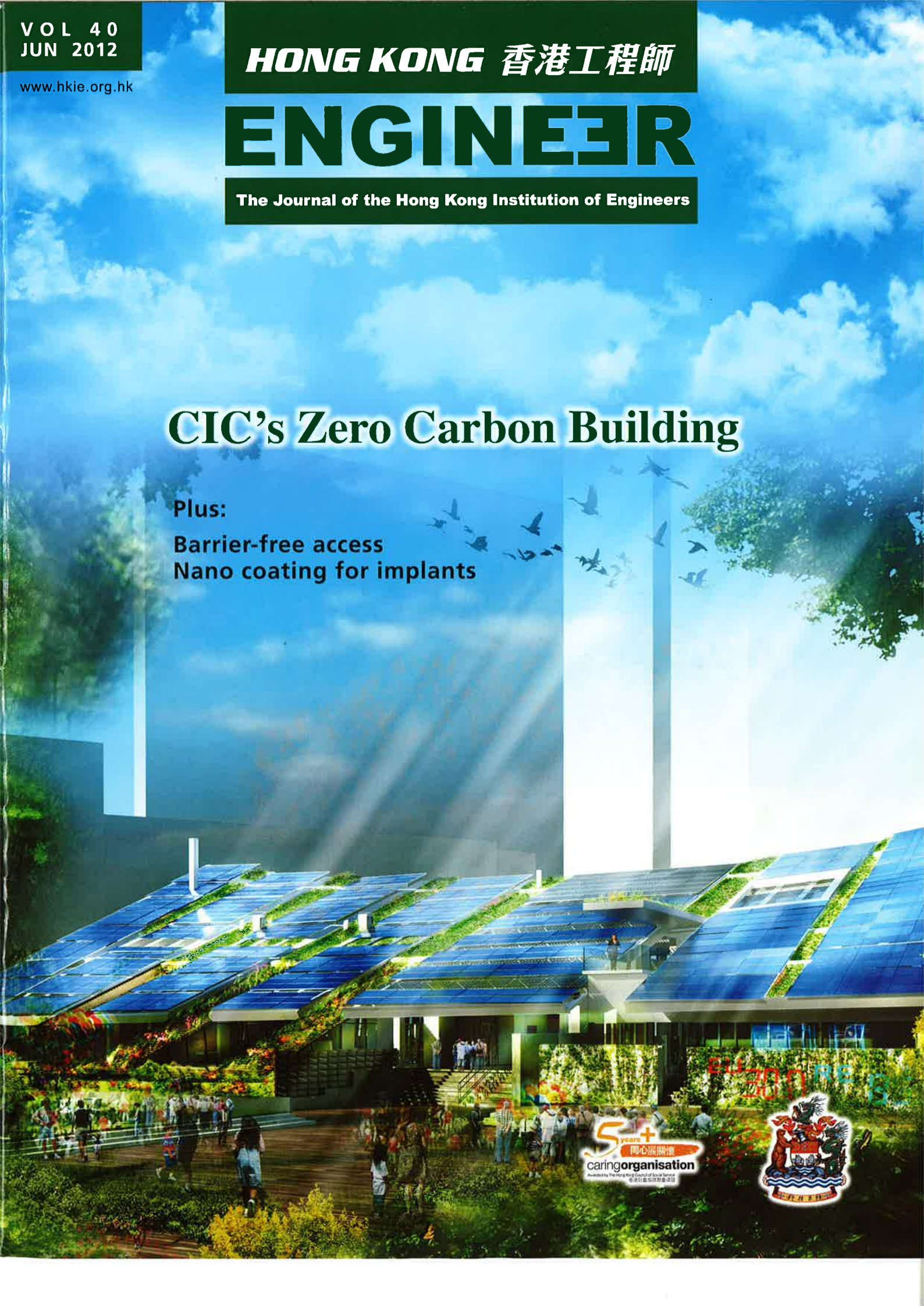
HONG KONG 香港工程師 ENGINEER

The Journal of the Hong Kong Institution of Engineers

CIC's Zero Carbon Building

Plus:

Barrier-free access
Nano coating for implants



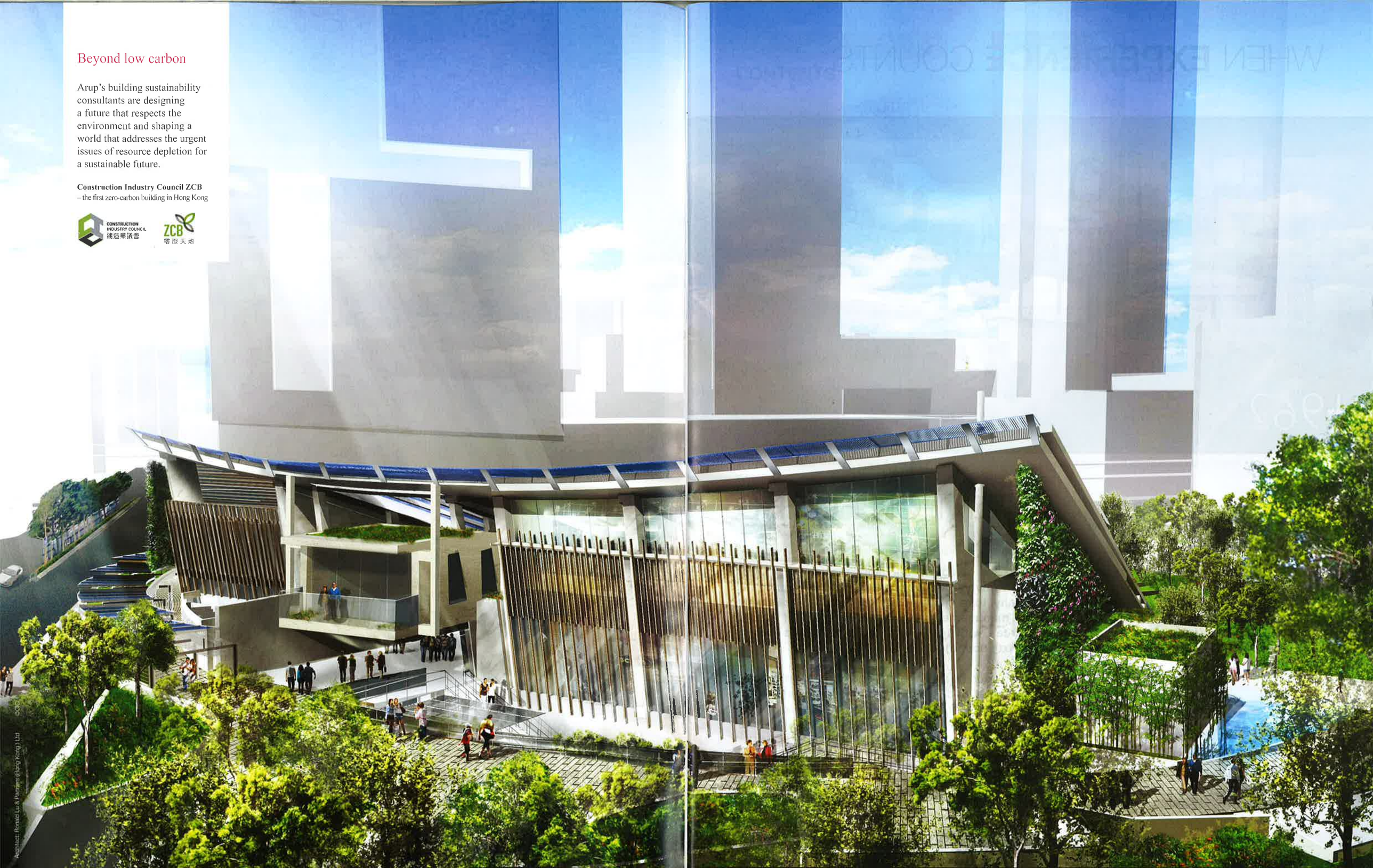
Beyond low carbon

Arup's building sustainability consultants are designing a future that respects the environment and shaping a world that addresses the urgent issues of resource depletion for a sustainable future.

Construction Industry Council ZCB
– the first zero-carbon building in Hong Kong

CONSTRUCTION INDUSTRY COUNCIL 建造業議會

ZCB 零碳天地



Architect: Ronald Lu & Partners (Hong Kong) Ltd

We shape a better world | www.arup.com

ARUP

By Angela TAM

CIC bids to pioneer **zero-carbon** in the urban jungle

Artist's impression of CIC's zero-carbon building. Images: CIC

With world energy prices going up and governments struggling to reach agreement over reduction in carbon emissions sufficient to avert catastrophic climate change, drastic measures are needed to cut energy consumption. So imagine a building that is so energy-efficient that it can operate on only half the amount of electricity needed by a typical building of a similar size, in a city where buildings account for close to 90% of energy use.

We do not yet know whether this amount of energy savings can be achieved for a typical Hong Kong high-rise, but the Construction Industry Council (CIC) has offered a tantalising glimpse of the possibilities that integrated architectural and engineering design can achieve for an enlightened client.

In collaboration with the Development Bureau, CIC has turned a 14,700 sq m site at Sheung Yuet Road, Kowloon Bay, into a three-storey (including basement), 1,400 sq m "zero-carbon building" and a green open space seeded with native vegetation.

The architect, Ronald Lu & Partners (HK) Ltd, and engineering consultant, Ove Arup & Partners (HK) Ltd, have worked together to deliver a project that combine renewable energy use with energy-efficiency features to prevent the emission of 8,250 tons of greenhouse gases over a period of 50 years.

Renewable energy

Although not a high-rise, the project is a good case study of the challenges that must be overcome to achieve "zero-carbon" in the Hong Kong context.

Surrounded by high-rises on a site not far from the runway of the former Kai Tak airport, the building was carefully shaped and oriented to make the most of prevailing winds and natural light.

The building was set in the northwest portion of the site, which is the brightest. Photovoltaic (PV) panels facing due south sweep down the roof of the structure to capture as much solar energy as possible. According to Arup director Ir Dr Raymond Yau, three types of PV panels were installed to generate renewable energy. Polycrystalline PV panels cover about 1,000 sq m while building-integrated PV (BIPV) and thin-film CIGS (copper indium gallium selenide) solar cells are used in small amounts, the latter largely as a demo as it is currently too expensive to be commercially viable.

Although thin-film CIGS solar cells are currently quite expensive, researchers at the Chinese University of Hong Kong have developed a cheaper alternative that can be manufactured by depositing multiple layers of thin-film material on low-cost substrates such as glass, plastic and metal foil to make it much more price-competitive with crystalline silicon solar cells. According to the researchers, their innovation can also generate electricity under cloudy or poor light conditions, which makes it particularly suitable for use on densely packed high-rise buildings.

The building is positioned to capture as much sunlight as possible

The solar array on the CIC building, which resembles a contemporary take on the traditional tiled roof, is as much an architectural expression as a source of renewable energy. The PV installations will provide 30% of the electricity; biodiesel will account for the other 70%. Electricity will be produced by equipment about the size of an emergency power generator.

"Since Hong Kong has a large food and beverage industry we decided to choose waste cooking oil as a source of energy," Ir Dr Yau said.

Trigeneration

The project is expected to consume 50 tonnes of waste cooking oil a year - about 2.5% of the B100 biodiesel, or pure waste cooking oil, currently produced by two companies in Hong Kong. A third plant is under construction and production capacity is certain to rise, offering more buildings the opportunity to cut their emissions by turning waste into energy.

The biodiesel will be used mainly to provide air-conditioning for the building, which will be required for only four to five months of the year. The trigeneration system will use an absorption chiller to recover waste heat to dehumidify the building, after which any extra electricity will be fed into the grid.

"Air-conditioning use will be based on temperature and humidity," Ir Dr Yau said. "It will be a closed-loop system so electricity will be fed into the grid mainly in the summer."

To minimise the need for air-conditioning, which is the chief energy hog in buildings, the CIC building has a range of active and passive systems to facilitate ventilation. Large fans running at low speed will circulate air in an open-plan interior while a combination of floor ventilation and radiant cooling through the ceiling will remove heat through radiation rather than convection.

The passive approach also includes an orientation designed to capture southeasterly winds and a cladding that has an OTTV (overall thermal transfer value) of only 15 W/sq m, compared with 20 W/sq m as required under the official OTTV standard that was revised in 2001.

Sustainable materials were used for the project's construction as much as possible. For example, recycled materials were used as pavers and construction and demolition waste was broken up into smaller pieces and wrapped in iron cages to form the gabion planter wall. The project team also opted to build a reinforced concrete structure using pulverised fuel ash instead of a steel-framed structure. To offset the embodied energy arising from the project's construction, some electricity will be put back into the grid every year to make this what CIC chairman Yu Wai-wai called an "energy plus" project.

Large fans will facilitate ventilation

Rhodoleia and scarlet sterculia are among the native species selected for the CIC project due to their visual appeal

The site as it stood in May 2012

The energy performance of the building will be continuously monitored over its estimated 50-year lifespan by 3,000 sensors. The data collected is sure to be a boon for anyone keen to develop a new generation of energy-efficient buildings.

Native woodland

In addition to showcasing renewable energy and energy efficiency technologies, the project will also demonstrate how individual developments can help mitigate the urban heat island effect. Research has shown that greening the heat-absorbent hard surfaces of urban areas could lower the temperature by a few degrees. The allocation of more than 50% of the site to vegetation therefore will have a significant cooling effect on the whole area surrounding the CIC project.

What's more, CIC has taken the opportunity to introduce native species that will not only cool the neighbourhood and provide visual amenity, but also enhance biodiversity, act as a carbon sink and kickstart demand for native plant species.

"Most native woodland in Hong Kong was destroyed a thousand years ago," said Prof C Y Jim, the University of Hong Kong's chair professor of geography and respected ecologist, who was engaged as the project's greening consultant. "Foreign species were then introduced because they grow quickly and can adapt to dry conditions and exposed areas, but native wildlife of course prefer native plant species."

To prepare for the native woodland, the sand and construction waste that covered the site were removed. Soil excavated from the site was used as fill for the native woodland and a 1 m deep layer of superior topsoil was then added for the planting of 135 native trees as well as a variety of shrubs over a 3,000 sq m area. According to Prof Jim, the species were selected based on their mature sizes, their attractiveness to native wildlife and the ornamental flowers and fruits they will produce, which will be pleasing to visitors and wildlife alike. They have been planted randomly, as they would be in nature, and are expected to provide a dense canopy eventually.

"Right now local nurseries mainly supply seeds for foreign species. They don't make the effort to go out and collect the seeds of native species because there is no demand for them. Hopefully with this project we will start to create a demand for native species and change their mindset," Prof Jim said.

Apart from the man-made woodland, the project will also feature rooftop and vertical greening. Many experiments in vertical greening in Hong Kong to date have suffered from maintenance issues and poor species selection. Both potential problems have been addressed by Prof Jim through the choice of easy-to-maintain species that reach an appropriate height when fully grown - which means they will not expose walls upon reaching maturity or run out of space to climb. These are mainly vines that only need soil on the ground rather than soil in pots suspended on the external wall that requires elaborate irrigation systems.

The native species are expected to take between ten and 20 years to reach maturity. Some may even take 100 years. CIC, however, is happy to be patient: local birds are already visiting and tweeting their joy at finding a native woodland in the midst of the urban jungle. More visitors - of the human as well as avian variety - are expected when the HK$240 million project is up and running. It will feature an exhibition and education centre, a showcase eco-home and an outdoor exhibition area which will play host to public tours as well as visits by building professionals. The target is more than 40,000 visitors per year.

Extensive greening will help mitigate the urban heat island effect