- Case Study -
Green buildings: Hong Kong Science Park / Zero Carbon Building / Towngas Headquarters

Sustainable development goals (SDGs)

Goal 9: Industry, innovation and infrastructure

Goal 11: Sustainable cities and communities

Goal 7: Affordable and clean energy

Relevant concept/ issues

Green technology

Relevant sector

Construction

— THE CASES —

Case 1: Hong Kong Science Park

Hong Kong Science Park is an outstanding local example of the application of green building initiatives. The 'Green 18' in the park's phase II, which opened in 2011, incorporated many green features, including the utilization of natural daylight. Remember the special outer wall of the Beijing National Aquatics Center, (also known as the Beijing Water Cube)? Well, 'Green 18' used the same material on its roof. This environmentally friendly roof has **high transparency properties, which can effectively introduce natural daylight to different areas of the building**.

Fig. 1. Exterior of 'Green 18'

In addition, **a glass fin panel was installed on the louvres on the outside of 'Green 18'. This glass fin panel closes in summer to become solar shading and reduce solar radiation.** It helps to prevent increases in the inside temperature and reduces the need for the air-conditioning system, thereby lowering the consumption of electricity. In winter, the glass fin panel opens to allow natural ventilation and sunlight, making 'Green 18' a building that is warm in winter and cool in summer. Vertical axis wind turbines were also installed on the roof to introduce wind power as a source of renewable energy for the establishment (WWF Hong Kong, 2012).

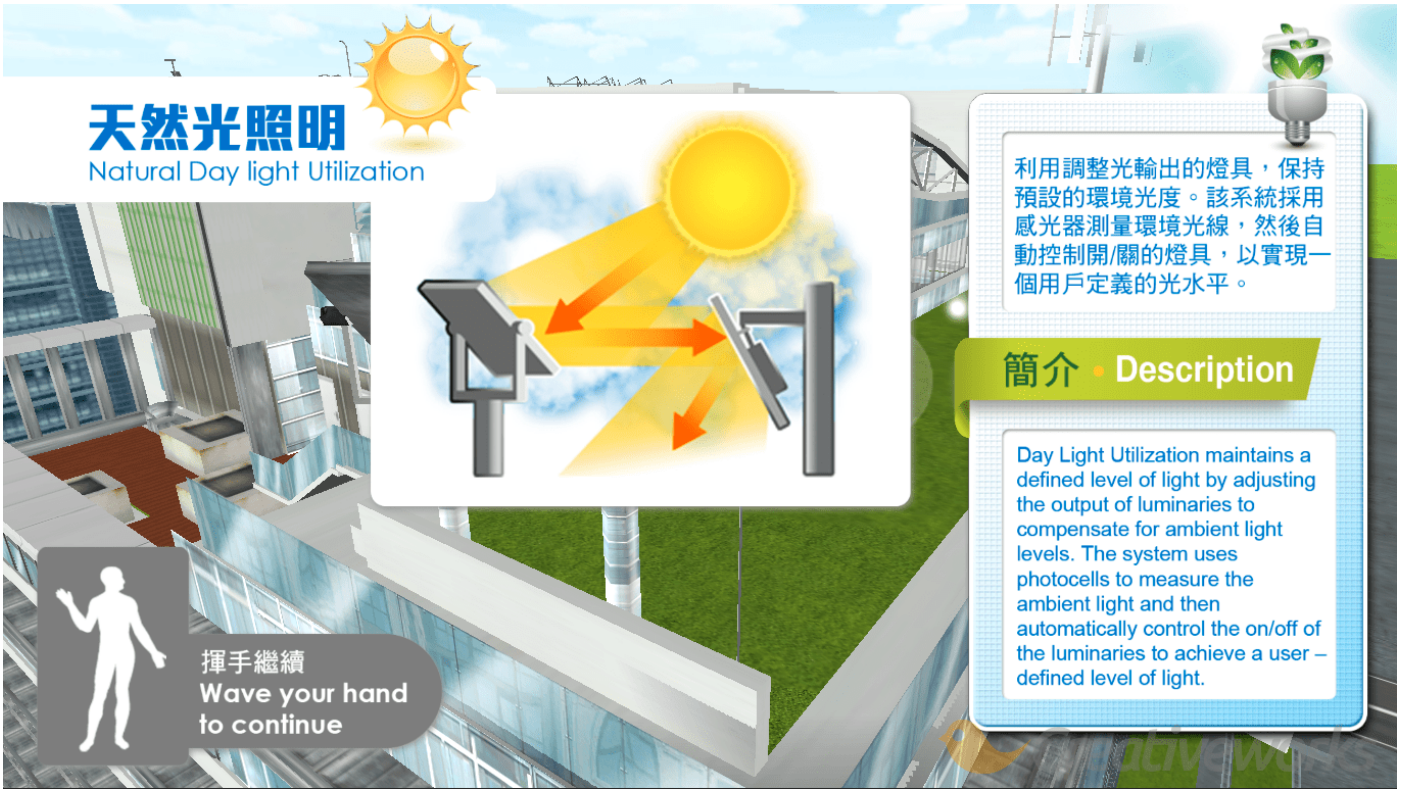

Fig. 2. Description of 'Green 18' Building

Source: Green Buildings and the City (2012).

Case 2: Hong Kong Zero Carbon Building

A zero carbon building (ZCB) in Hong Kong is a building with **zero net energy consumption or zero net carbon emissions** over a whole year. In recent years, low/zero carbon buildings have attracted much attention in many countries, because they are considered to be an important means for conserving energy and reducing greenhouse gases emissions. Some examples of existing zero carbon buildings around the world include:

- Self-sufficient solar house, Freiburg, Germany
- Plus Energy House, Ministry of Federal Ministry for Transport, Building and Town Planning, Germany
- Beddington Zero Energy Development, London
- Pusat Tenaga Malaysia's ZEO Building, Malaysia
- BCA Academy, Singapore
- The Samsung Green Tomorrow House, South Korea

1. Renewable energy

Renewable energy is natural energy, which does not have a limited supply. Renewable energy can be used again and again and will never run out. Examples of renewable energy sources include: biomass, hydro energy, geothermal energy, solar energy, tidal energy, wave energy and wind energy.

In the ZCB, **renewable energy** is generated on site from solar energy by **photovoltaic (PV) panels** and from **biofuel** (a type of biomass) made from waste cooking oil.

- **Photovoltaic Panels**

  A photovoltaic (PV) panel is a device that generates electricity from sunlight.

  Solar irradiance of the whole ZCB site was achieved by studying the surrounding context and neighboring buildings to determine the best location for the building in order to collect the solar energy. Three different types of PV panels are used: multi-crystalline on the inclined roof, building integrated photovoltaics (BIPV)-thin film covering the viewing platform, and cylindrical CIGS (copper-indium-gallium-selenide **thin-film solar cells**) thin film integrated in the Air-Tree installation.

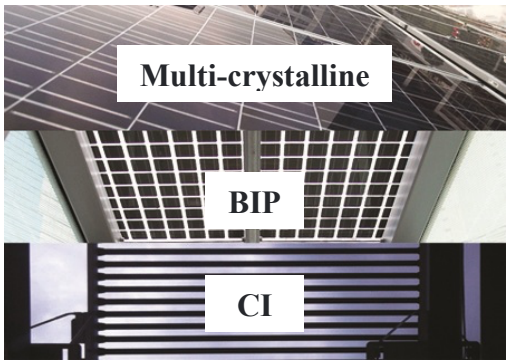

Fig. 3. Types of photovoltaic panels

  The ZCB's cylindrical CIGS, as the first installation in Hong Kong, are particularly interesting because they are relatively efficient and capture both light reflected from the ground as well as light directly from the sun.

  Solar thermal energy is also utilized in the Eco-café to generate hot water. The total of 1,015m^2 photovoltaic cells can generate 87MWh electricity per year.

- **Biofuel**

  Biofuel is a type of fuel derived from organic matter (obtained directly from plants, or indirectly from agricultural, commercial, domestic, and/or industrial waste) as opposed to fossil products.

  The ZCB uses a combined cooling, heating and power (CCHP) system, also called a 'tri-generation system', to generate electricity from biofuel made from waste cooking oil. The waste heat from the electricity generation process is harvested for cooling and dehumidification. This system is renewable, as the biofuel used is produced in Hong Kong from used cooking oil, thereby turning waste to energy. **It increases energy utilization to 75 percent, compared to 40 percent in a conventional power plant.**


Fig. 4. ZCB

  Generating over 143MWh electricity per year this system, together with the PV panels, delivers more energy than is needed to power the building.

2. Active systems

Active systems refer to the electrical and mechanical systems, such as the HVAC (heating, ventilation and air conditioning) systems and lighting systems.

- **High-volume, low-speed fans**

  High-volume, low-speed fans can generate a high volume of airflow at a low speed. The noise associated with the circulation of the fan blades is minimal. These huge ceiling fans move large volumes of air effectively by using a patented blade design, which enhances evaporation for comfort. The fan can effectively reduce the length of time air-conditioning is use.

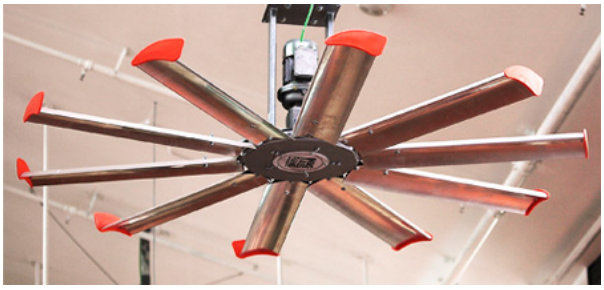

Fig. 5. High-volume low-speed fans

- **High-temperature cooling system**

  A high-temperature cooling system does not need to overcool the air to achieve a comfortable humidity level, thus saving the energy used for air-conditioning. This is mainly achieved through a separate cooling and humidity removal system.

  The high-temperature cooling system in the ZCB is comprised of chilled beams, underfloor displacement cooling and desiccant dehumidification. In conventional systems, cooling and dehumidification are performed at the same time. At the ZCB, desiccant dehumidification is a separate process and so it improves efficiency compared to the combined cooling and dehumidification system.

  Cool and dry air is supplied from the floor up – it gathers heat from occupants of the building and starts to rise. A vertical flow is generated near each occupant, creating a healthier environment as germs are less likely to spread and stale air is exhausted near the ceiling.

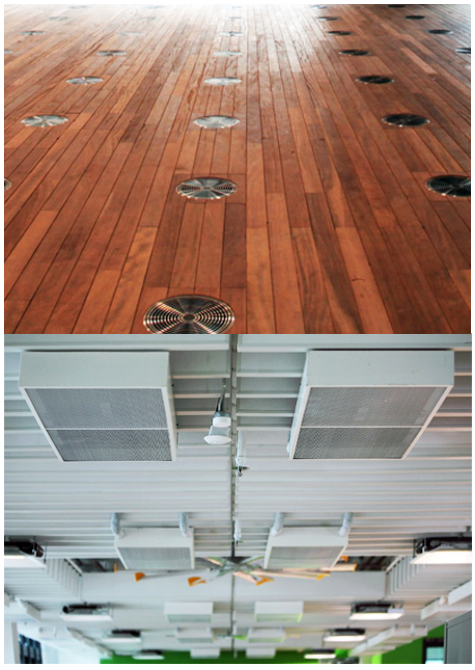

Fig. 6. High-temperature cooling system

- **Intelligent lighting management**

  Intelligent lighting management refers to the automatic control of the lighting based on occupancy, individual needs and the natural lighting level. The ZCB is divided into zones according to their natural lighting potential and use. In each zone, sensors monitor the lighting levels and the occupancy and the lighting is adjusted accordingly.

- **Active skylight**

  The active skylight is a roof window frame with inclined shading fins. The skylights can be shaded if necessary to optimize daylight and solar control. The shading fins are controlled by computer software and sensors by adjusting their shading angles to cut out direct sunlight at different angles as the sun passes over the building. They diffuse daylight into the interior as needed, greatly reducing the heat emitted by direct sunlight.

Fig. 7. Active skylight with shading fins

- **Task lighting**

  Task lighting provides high levels of illumination in an energy efficient and controllable way. Using warm, white-colored LEDs with high luminous efficacy, it puts light where it is needed and reduces the energy use of ambient lighting.

- **Regenerative lift**

  A regenerative lift is a lift equipped with a regenerative converter to provide a feedback path for energy generated arising from the braking mode of the motor. Power is also regenerated when the lift is in up-operation with no/little load or down-operation with full/heavy load. The amount of regenerative power depends on loading condition, travelling distance, starting frequency, and the efficiency of the lift system.

Source: What is Zero Carbon Building? Retrieved from https://zcb.cic.hk/chi/home

Case 3: Towngas Headquarters

As a leading utility provider, Towngas has fully integrated environmental considerations into their business model. With the ultimate aim of protecting the environment, they have achieved numerous building sustainability objectives by adopting **advanced energy efficiency technologies,** as well as best practice on **facilities management** at the Towngas Headquarters. After undergoing BEAM Plus Assessment, Towngas Headquarters achieved the Platinum rating of Final Assessment under the BEAM Plus Existing Buildings (version 1.2) of the Hong Kong Green Building Council. It is the first non-residential building in Hong Kong to gain the highest level of recognition under the BEAM Plus Final Assessment for existing buildings.

Towngas's achievement is mainly attributed to having successfully integrated green management, including electricity conservation, preservation of water resources, improvement of indoor air quality and waste management to enhance the overall building environment.

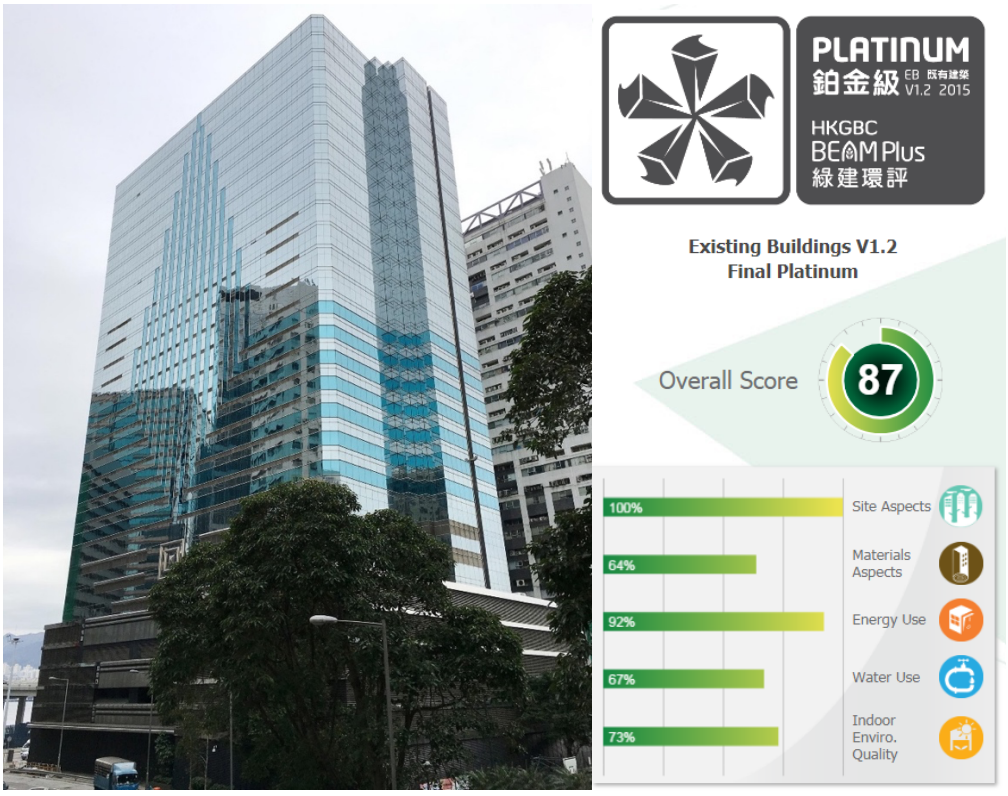

Fig. 8. BEAM Plus Assessment of Towngas Headquarters

1. **Electricity conservation**
   - **Energy saving air-conditioning system:** the rooftop chiller plant system was upgraded to a high-energy efficient oil-free variable speed water-cooled chiller.
   - **Highly efficient energy-saving lighting devices:** lighting devices with motion sensors were installed in the office, which enable automatic switch-off when the premises are unoccupied. LED lighting devices with motion sensors and a dimming function were installed on the staircase, existing lighting was upgraded to T5 light fixtures with nano reflectors and an 'intelligent power meter' was set up for energy management.
   - Achievement: Compared to 2012, there was a **15 percent reduction** in the headquarters' electricity consumption of 1,000,000 kWh in 2015 (that is equivalent to 780 tonnes of greenhouse gas emissions or approximately 33,000 trees), and the savings on electricity expenses for the headquarters was up to **HK$1,220,000**.
   - Rooftop organic farm: Each organic workshop serves 30 staff regularly and 50 catties of vegetables are reaped each harvesting cycle. The farm means Towngas staff can experience the fun of gardening and low-carbon living, and it also effectively reduces the urban heat island effect, improves the ambient air quality and creates a green landscape in the community. To further promote green living in the community, Towngas invites different green organizations and representatives of corporations and district councils to visit the eco-friendly facilities in the headquarters and the rooftop farm.
2. **Preservation of water resources**
   - Water recycling system: set up the rooftop rainwater harvesting system and the condensate water collection system on the carpark level.
   - Installed a one cubic meter rainwater harvesting tank on the rooftop for irrigating the rooftop organic farm and for cleaning. 140 cubic meters of rainwater is collected annually.
   - Installed a two cubic meter condensate water collection tank on the carpark level for irrigating the flower farm on the ground floor and for cleaning the carpark. 355 cubic meters of condensate water is collected annually.
   - Water conservation devices: installed water-saving devices in the shower room, washroom and pantry, including the grade 1 water fixtures, sensor type faucet and urinal and dual flush water closets that reduce the amount of water for flushing. Seven percent of potable water is saved.
3. **Improvement of indoor air quality**
   - **Increased fresh air:** installed a CO2 sensor for controlling the amount of fresh air available inside. A PAU Bag Filter was applied.
   - Achievement: The Indoor Air Quality Certificate (Good Class) was obtained, that maintains the level of CO2 at approximately 700 ppm (parts per million).
4. **Waste management**
   - **Established a waste management strategy**: Implemented the principles of **'5R' waste Management**, including 'reduce', 'replace', 'recover', 'recycle' and 'reuse', and educated staff about it.
   - **Recycled testing tubes**: The amount of solid disposal was reduced.
   - **Whole-year office recycling scheme**: Set up disposal and food waste collection points. Over 18 types of waste are collected for recycling.
   - **Waste management audit**: In 2015, Towngas conducted a waste management audit at its headquarters in Hong Kong to develop a strategic plan for waste reduction.

Source: Towngas Headquarters is the first non-residential building in Hong Kong to achieve Platinum rating under BEAM Plus Existing Buildings v1.2. (2016).

Reference:

Green Buildings and the City. (2012). Retrieved from https://www.wwf.org.hk/en/?6483/green-buildings-and-the-city

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