ARUP

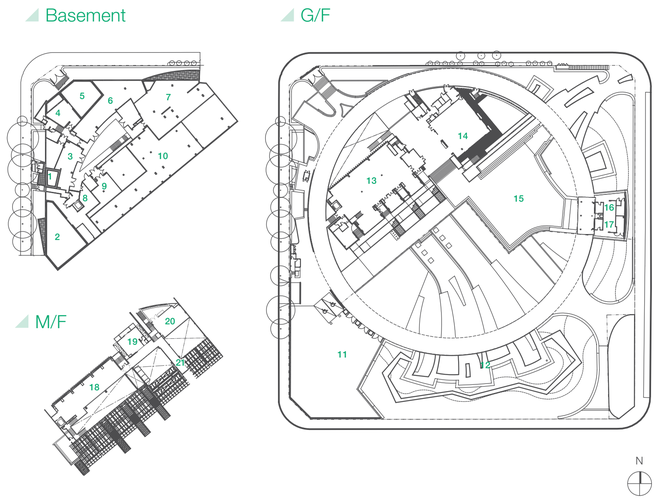
Realising green ambitions

Arup Building Sustainability is the creative force behind the Zero Carbon Building (ZCB), the first of its kind in Hong Kong designed for the city's challenging climate.

Zero Carbon Building

Hong Kong

Floor plan



1 Bio-diesel tank
2 Reclaimed water tank
3 CHP plant
4 F.S. sprinkler pump
5 Sprinkler water tank
6 Air-conditioning chiller plant
7 Grey water system
8 Black and grey water system
9 Future E&M plant
10 E&M trench
11 EV (Electric vehicle) charging station
12 Urban native woodland
13 Eco-office and exhibition gallery
14 Multi-purpose hall
15 Eco-plaza
16 Eco-café
17 Shop
18 Exhibition gallery
19 Eco-home
20 Cooling tower plant
21 Viewing platform

Recycled materials

The gabion wall is made of aggregates from construction waste, while 25% and 35% PFA (Pulverised-fuel Ash) concrete was widely adopted in reinforced concrete structure. Recycled materials such as TiOstone, aggregates, metal, timber and glass are used wherever the design and schedule allowed. Excavated soil during construction is used as fill in the urban native woodland.

Zero VOC sealant and paint

Zero VOC sealant and paint are essential to achieve excellent indoor air quality.

TiO_2 bricks

The paving blocks are manufactured from recycled glass. TIOSTONE helps remove pollutants in the air to mitigate the effects of air pollution.

Low-embodied carbon materials

Low embodied carbon materials are specified for major building components, such as concrete, bricks and timber.

Waste reduction/sorting/recycling

Recycling facilities are provided throughout ZCB to maximise separation at source.

Arup Building Sustainability's zero-carbon design, ranging from structural engineering to sustainability consulting, enabled the realisation of this sustainable showcase for multi-functional use.

ZCB is a pioneer project of future sustainable design which makes use of passive and active design, as well as adopting solar and bio-diesel as renewable energy sources. The concept of combined cooling, heat and power and energy cascade significantly enhances energy efficiency. These are the key elements that enable ZCB to achieve carbon neutrality throughout its building life cycle.

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Fitted out with more than 80 environmental strategies, this smart building is monitored and controlled by over 2,500 sensing points that report on every aspect of performance.

Passive design

A series of thoughtful strategies in site planning, built-form layout and material selection allowed low-energy systems that deliver a high level of environmental comfort.

Active design

Active design measures in electrical / mechanical systems ensure the highest efficiency with seamless integration into the overall architecture of ZCB.

Beyond zero carbon

The remaining energy demand is offset by harvesting every last drop of the available energy and generating clean energy on site.

Energy harvested from the sun and generated by the bio-diesel generator will power the building, equipment and appliances while also generating heat for hot water. When surplus energy is produced, ZCB will be the first building in Hong Kong to export renewable electricity into the grid.

Green spaces, microclimate and water systems

ZCB features Hong Kong's first urban native woodland which occupies 47% of the site area, reducing the urban heat island effect in the highly built-up area of Hong Kong. This serves as an urban oasis for the people of Hong Kong.

Materials, construction and life-cycle energy

The use of low-embodied energy materials, recycled and local materials together with advanced construction technology ensure reduction in carbon emission even before its operation.

Carbon credit available for purchase for large commercial activities in the future can ensure continued carbon offset. This ensures carbon positive aspects of ZCB with minimal life-cycle impact of the project.

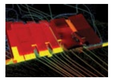
BEAM Plus Platinum

"This project has achieved the Platinum Rating of Provisional Assessment under the BEAM Plus NB V1.1 of the Hong Kong Green Building Council on 5 June 2012."

Green Building Award 2012

ZCB was awarded Green Building Award 2012 Grand Award for New Buildings – Hong Kong.

Ventilation-responsive built form and orientation



The tapered and linear built form designed with reference to CFD (Computational Fluid Dynamic) simulation resulted in a built form that induces natural ventilation.

Solar-responsive built form

The large northern façade and shaded southern façade admit daylight with minimal associated heat gain. Glazing is minimised on the eastern and western façades to reduce glare and improve the visual comfort together with other passive strategies. This creates optimal daylight with minimal heat gain while harnessing solar energy.

Light pipe

Light pipe is a reflective light transmitting tube to lead in natural daylight from the roof into the deep zone of ZCB where daylight alone may not be sufficient.

Wind catcher

This passive device introduces outdoor air to the inner part of ZCB to enhance natural ventilation.

External solar shading

Deep overhangs spanning the southern façade and vertical fins on the northern façade are designed to eliminate direct solar gain during hot summer months.

High-performance glass wall system

Spectrally selective low-E IGUs (Insulated Glass Units) admit solar energy in the visible spectrum (daylight), but reflects energy in the infra-red range (heat).

High-volume low-speed fans

ZCB's open-plan cross-ventilated layout, in conjunction with high-volume-low-speed fans, promotes a gentle and uniform air-velocity throughout the building that can effectively mitigate the often very humid condition during summer.

Earth cooling tube

Metal tubes were placed underground to make use of cooler soil properties to pre-cool outdoor fresh air prior to entering the air handling unit. Initial measurements indicate peak summer temperature is reduced by up to 4.5°C.

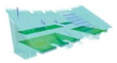
Light shelf

The light shelf introduces diffused daylight into the interior of ZCB.

Ultra-low overall thermal transfer value

The combination of solar shading, high performance cladding and glazing means extremely low solar heat gain and cooling requirements, reducing the demand for air-conditioning. This is reflected in the low OTTV (Overall Thermal Transfer Value) of smaller than 15W/m² [conventional 24W/m²]).

Natural lighting



Daylight, with little associated heat, is allowed to diffuse through the large northern façade and further amplified by the sloped ceiling of the interior. This is supplemented with dimming devices that create the adequate level of artificial lighting to minimise energy consumption.

Controlled ventilation

A number of high-level windows are centrally controlled by the system that coordinates internal and external conditions, air-conditioning strategy and microclimate sensory data to facilitate effective ventilation systems that can reduce the demand for air-conditioning.

Optimised WWR (Window-to-Wall Ratio)

A large WWR is used at southern and northern elevations, while the glazing area at eastern and western elevations is minimised to balance daylight utilisation with solar heat gain.

Smart display and control of appliances

The Eco-home features an intelligent home appliance control system to reduce household energy consumption.

Intelligent high-efficacy lighting system

A combination of LED and fluorescent fixtures delivers an adequate lighting level with minimal electricity consumption at an extremely low lighting power density of 6W/m².

Task lighting

Rather than uniformly lighting the building to a high-level of brightness, most of the interior space is illuminated to approximately 200 lux (appropriate for general usage). Task-lighting (500 lux) supplements lighting demand in areas where fine work occurs (office desk, display etc).

Underfloor air supply

Conditioned air is supplied to the room at low level and low velocity through the floor plenum. The system is inherently energy efficient: the natural stratification of the room ensures that only the occupied zone (0 to 2m from finished floor) is cooled.

Energy efficient appliances

All electrical appliances are certified Class 1 by EMSD (Electrical and Mechanical Services Department) according to Energy Efficient Certification Scheme.

Occupancy sensors

The cooling and dehumidification of fresh air requires large amounts of energy. The CO_2 sensors monitor the air quality within occupied space and adjust the amount of fresh air provided to each space as required.

Intelligent skylight

The intelligent skylight tracks the real-time location and brightness of the sun to adjust its louvers to deliver an appropriate light into the interior.

High temperature/desiccant dehumidification systems

The building uses a high temperature cooling system consisting of underfloor air supply, radiant system and desiccant dehumidification. To achieve the desired room conditions of 26°C with 55% relative humidity, conventional systems overcool the supply air (10 to 14°C). In this design, the humid fresh air is pre-treated through a desiccant dehumidification process, allowing high air and coil temperatures that place less load on chillers.

Microclimate monitoring stations

Four on-site microclimate monitoring stations gather information on solar, wind, temperature and humidity measurements to coordinate microclimate conditions with desired comfort for interior space.

Chilled beams

Radiant cooling technology directs chilled water to passively chilled beams, creating similar experience of "coolness" in caves.

BMS (Building Management System)

More than 2,500 sensors are built to report detailed building performance. The system is a platform for the building operator to directly control and fine-tune operations and efficiency to meet changing needs.

BEPAD (Building Environmental Performance Assessment Dashboard)

The information from the BMS is displayed on a 3D model of the building in real-time in the BEPAD. This user-friendly, interactive graphic interface displays real-time energy and carbon emission performance of ZCB.

Green coverage

Greenery covers 47% of the site and the landscape design improves the cooling effect and is estimated to lower the air temperature by up to 1°C.

Urban native woodland

The planted urban native woodland area of approximately 2,000m² requires minimal maintenance and irrigation. It includes 135 native trees of over 40 different species and a diversity of native shrubs, providing food and shelter to attract native wildlife to the city.

Green walls

Designed based on local climatic conditions, the "creeping green wall" grows quickly in Hong Kong's climate. They and are resistant to strong typhoon winds, and can be easily replaced.

Constructed wetland

Rainwater from sloped roof drips towards the constructed wetland which treats and filters the water through the roots of plants before being introduced into the recycled water system.

Bioretention sub-soil drainage

Rainwater from the landscape area seeps through the porous paving material and vegetation into a series of built-in drainage network and is channelled to a central rainwater tank for later irrigation use.

Drip irrigation

Drip irrigation system supplies irrigation water directly to the soil to minimise evaporative and other losses.

Storm water harvesting

Processed rainwater from the constructed wetland and landscape are stored in a 180m³ rainwater storage tank.

Black water treatment system

Black water from toilets are collected and processed through an MBR (Membrane Bio-Reactor) and recycled for flushing purpose.

Grey water treatment system

Grey water from basins are collected in a grey water filtration process and recycled for flushing purpose.

Water-efficient fixtures

Water-efficient sanitary ware such as low-flow basins, shower heads, dual flow water closets and waterless urinals uses 40% less water than conventional fixtures.

Electric vehicle charger

Two electric vehicle chargers at the ZCB provide renewable energy and promote the use of electric vehicles.

Solar thermal hot water system

A cost-effective solar energy application system is used for hot water demand in the Eco-café.

Bio-diesel from waste cooking oil

A generator system with power generation of 100kW consuming B100 bio-diesel is installed to generate 150MWh electricity per year. The use of near zero-carbon fuel of bio-diesel from waste cooking oil displaces the combustion of fossil fuel and also avoids generation of methane gas.

Adsorption chiller

The adsorption chiller uses water as refrigerant, a silica gel as adsorbent, and hot water as main power source. The evaporator section cools the chilled water through adsorption of the silica gel, while the hot water regenerates ("dries") the silica gel. It produces chilled water temperatures at 9°C with hot water temperatures of 80°C.

Combined Cooling, Heating and Power (CCHP) tri-generation

The ZCB generates electricity, heating and cooling in an energy cascade. Combustion occurs in the IC engine driving the pistons to generate electricity. A water jacket cooling system prevents overheating and also acts as a source of waste heat capture. A high-efficiency chimney economizer further increases waste heat capture through flue gas recovery. The waste heat is utilised for driving an adsorption chiller to generate chilled water (9°C), and the remainder is used for dehumidification.

Grid feed-in

ZCB is the first building in Hong Kong to actively feed renewable electricity into the grid.

PV (Photovoltaic) panels

The building features 1,015m² of crystalline panels that produce a high output. In areas where it is desirable to allow some natural light through the roof, BIPV panels are integrated into the building fabric (25m²). The design also showcases the new ultra-light-weight cylindrical CIGS technology.

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