# REALISING SINGAPORE'S Green Building Dream

**TOWARDS A FUTURE-READY BUILT ENVIRONMENT** 



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Since its launch in 2005, the BCA Green Mark Scheme has carved out a decade of achievements. This book chronicles 10 pivotal years in a nation's journey towards becoming a global paragon of sustainability standards for built environments of the tropics. Showcasing 50 impressive developments and momentous projects, it is a testament to the exceptional foresight, dedication and capabilities of all parties involved.

## Appreciation

#### **Special Thanks**

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### **Realising Singapore's Green Building Dream** Towards a Future-Ready Built Environment

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# Foreword

"Today, 10 years after the launch of the BCA Green Mark Scheme, we have greened 29 per cent of our built environment. The BCA Green Mark was conceived in Singapore. But it has universal application anywhere in the tropical belt. More than 250 projects in 75 cities from 14 countries have adopted the BCA Green Mark Scheme." ur greening efforts as a Garden City are well known. Beyond plants and trees, we have extended our greening efforts to buildings, not just through vertical greening. We are making our buildings environmentally sustainable, healthier and less carbon intensive.

In the early years of nation-building, we focused on building essential infrastructure and homes for Singaporeans. After the initial phase of development, we now have the resources and the capabilities to improve on how to build better and more sustainably.

As an urbanised city, our buildings play an important role in sustainable development. Today, 10 years after the launch of the BCA Green Mark Scheme, we have greened 29 per cent of our built environment. This makes Singapore one of the greenest cities globally. It is an important milestone.

The BCA Green Mark was conceived in Singapore. But it has universal application anywhere in the tropical belt. More than 250 projects in 75 cities from 14 countries have adopted the BCA Green Mark scheme. They use it to evaluate their sustainability performance and benchmark against one another.

This commemorative book celebrates 10 years of our green building journey. It features 50 exemplary Green Mark structures, many of them in Singapore. They demonstrate how green buildings have helped to define Singapore's landscape and showcase some thoughtful designs that enhance the living environment while ensuring environmental sustainability. It is possible to be both environmentally friendly and still meet human aspiration for high quality of life.

Our greening efforts have produced promising results. But we have yet to reach the peak. I encourage our community and corporate partners to continue the journey with us. Let's make our built environment greener and sustainable.



Khaw Boon Wan Minister for National Development

## **Message from Chairman & Chief Executive Officer**

"Our success would not be possible without the strong commitment and close coordination across the whole-of-government to catalyse transformation towards environmental sustainability. The strong partnership with other regulatory agencies, NGOs and industry has also enabled us to accelerate the green building momentum forward." his year, we celebrate 10 years of Green Mark and a decade of environmental sustainability in buildings. The Building and Construction Authority (BCA) Green Mark Scheme has evolved and achieved much, since its inception in 2005. Today, Green Mark is the leading green building rating system for the tropics and sub-tropics. Our key stakeholders had the foresight to embark on this journey with us and as a result, our top developers have risen to the forefront of corporate sustainability rankings in the world. Together, we have nurtured a strong "green collar" workforce and promoted continuous innovation through our research initiatives. There is indeed much to rejoice and be proud of.

Our success would not be possible without the strong commitment and close coordination across the whole-of-government to catalyse transformation towards environmental sustainability. The strong partnership with other regulatory agencies, NGOs and industry has also enabled us to accelerate the green building momentum forward.

This commemorative book, *Realising Singapore's Green Building Dream: Towards a Future-Ready Built Environment*, marks the achievements that we have made and showcases the buildings that have graced our landscape over the 10 years, transforming both our built environment and industry. The book features 50 Green Mark projects that are symbolic in their unique way and epitomises key elements of environmental sustainability. I hope these buildings will motivate our industry to aim higher and inspire the next generation to join our industry.

Conserving resources for our next generation is a responsibility for all. Everyone needs to play their part. While we reached a key milestone after a decade of devotion and dedication to the green building movement, the road ahead is going to be even more challenging. BCA will push forward in our efforts to shape a sustainable built environment but we cannot do this alone. We urge all of you to join us in this journey into the next decade and beyond.



Quek See Tiat Chairman Building and Construction Authority



**Dr John Keung** Chief Executive Officer Building and Construction Authority

## Introduction

# 10 YEARS In the making of a green built environment

"At least 80 per cent of the buildings in Singapore to be 'green' by 2030" – this is one of the key targets set by the Inter-Ministerial Committee on Sustainable Development (IMCSD) for Singapore's Built Environment. In merely a decade, Singapore has certified about 29 per cent of its buildings for sustainability under the BCA Green Mark Scheme, leading the way to realising the nation's vision of greening 80 per cent of the city-state's buildings by 2030.

#### The conception

In 2005, the Building and Construction Authority (BCA) launched the BCA Green Mark Scheme, which served as a yardstick to rate the environmental sustainability in buildings. It was Singapore's answer to the strategy and guidelines for sustainable urban development and long-term carbon-footprint reduction. It also formed the backbone for Singapore's 1st Green Building Masterplan, which was developed in 2006. The first Masterplan was structured to encourage, enable and engage industry stakeholders to adopt new green buildings.

#### The growth

"At least 80 per cent of the buildings in Singapore to be green by 2030" – this is one of the key targets set by the Inter-Ministerial Committee on Sustainable Development (IMCSD) for Singapore's Built Environment.

The 2nd Green Building Masterplan was launched in 2009, in conjunction with the IMCSD's target to have 80 per cent of all buildings in Singapore to be 'green' by 2030. The focus shifted to give greater emphasis on existing buildings. In 2014, the 3rd Green Building Masterplan was developed to engage building tenants and occupants more actively to drive energy consumption behavioural change and to address the well-being of the people.

Over the past 10 years, the Green Mark Scheme has grown and expanded to cater the needs of buildings and developments that serve diverse purposes, ranging from office buildings and residential apartments to wildlife theme parks and educational institutions. More categories have been created so that assessment criteria are relevant and realistic to the type of development. Today, the Scheme is not just applied to new and existing buildings, but also deployed to promote environmental sustainability beyond buildings, including infrastructure, retail, restaurants, districts and healthcare facilities, just to name a few.

The Green Mark Scheme has also grown to honour the exceptional commitments of developers. In 2008, BCA launched the Green Mark Champion Award to recognise developers with strong commitment and outstanding achievements in environmental sustainability. In 2015, BCA also gave out the Green Mark Pearl Award to show appreciation to developers and building owners who demonstrate thought leadership and efforts in actively motivating tenants to contribute jointly towards sustainability.

#### The achievements

As of September 2015, more than 2,500 buildings are Green Markcertified, and BCA is on schedule towards meeting the target of greening 80 per cent of all of Singapore's buildings by 2030. This year, the BCA Green Mark Scheme celebrates its tenth-year milestone with the launch of this book to commemorate this remarkable achievement, which would not have been possible without the dedication and participation of the government agencies, developers, building owners and tenants. Highlighting the key accomplishments, this book is a scorecard for all our stakeholders. While we take stock of how far we have come, we also hope that this book will be a source of inspiration for building owners or developers who have yet to come on board the Green Mark ride.

## Milestones

# 2006



Unveiled the 1st Green Building Masterplan

Introduced Public Sector Taking the Lead in Environmental Sustainability (PSTLES) Initiative



Implemented the S\$20 million Green Mark Incentive Scheme for New Buildings (GMIS-NB)





Unveiled the Sustainable Construction Masterplan

Developed the Green Mark Manager Course and Green Mark Professional Course

# <u> 2008</u>

Introduced the Green Mark Champion Award

Introduced the Green Mark for Parks



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Implemented the Legislation on Environmental Sustainability for New Buildings



Formed the 1st International Panel of Experts for Sustainability of the Built Environment

# 2005



Launched BCA Green Mark Scheme



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## Milestones

# 2011

E

Introduced the Green Mark for Schools

Introduced the Green Mark for Restaurants



Introduced the Pilot Building Retrofit Energy Efficiency Financing (BREEF) Scheme



Unveiled the Green Building R&D Framework



Launched the BCA Centre for Sustainable Buildings (BCA CSB) as a centre collaborating with United Nations Environment Programme



BCA clinched the World Green Building Council Government Leadership Award – Regional Leadership Award

Singapore ranked top Asia-Pacific city for Green Building Policy in the Solidiance Report

Singapore ranked 1st out of 22 major Asian cities for overall environmental performance in the Asian Green City Index

Introduced the inaugural BCA-SGBC Green Building Individual Awards





Celebrated the 1000th Green Mark project – Pasir Ris Sports and Recreation Centre

Celebrated the 100th Green Mark Platinum Award – Republic Plaza

Certified Green Mark projects in 20 Chinese Cities

Introduced the Green Mark for Retail

Introduced the Green Mark for Supermarkets

Introduced the Green Mark for Data Centres

Formulated the legislation on Environmental Sustainability Measures for existing buildings



BCA attained the United Nations-Habitat Good Practice

# 2013

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Developed Green Mark Portfolio Programme

Introduced Green Partnership Initiative

Celebrated the 100th Green Mark Office Interior

Received the 100th Green Mark Application from Malaysia

Introduced the Green Mark for Healthcare Facilities



Implemented the Annual Mandatory Submission of Building Information and Energy Consumption Data

Held the 3rd International Panel of Experts for Sustainability of the Built Environment



Introduced the Energy Innovation Research Programme (EIRP) for Building Energy Efficiency



BCA attained the International Star Award for Energy Efficiency

Singapore ranked 1st for highest level of green building activity in the world by McGraw Hill Construction World Green Building Trends Report 2013



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# Highlights



Marking our leadership in green building beyond Singapore in 75 cities in 14 countries with more than 250 projects

• Australia

# INTERNATIONAL REACH OF GREEN MARK

● China

● India Myammar ● ↓ ● Vietnam Thailand ● ↓Laos ● Philippines € Cambodia

Sri Lanka 🌒 Malaysia 🔍

Tanzania

15

# GREEN EXEMPLAR

" I think BCA has the most progressive incentive scheme I have seen so far. (BCA) Green Mark is a great tool and it will get better progressively."

Kevin Hydes Then Chair World Green Building Council Breakfast Talk for CEOs in 2008

## **Chapter One: Saluting the Pioneers**



# 1ST GREEN MARK PLATINUM NEW BUILDING

### NATIONAL LIBRARY BUILDING

Green Mark Platinum Award 2005 / 2009 / 2015

#### **Client / Developer** National Library Board

Architect TR Hamzah & Yeang Sdn Bhd

M&E Engineer Buro Happold Singapore Pte Ltd Main Contractor Nishimatsu Construction

Co Ltd Lum Chang Building Contractors Pte Ltd

## **•**

#### Singapore's 1st Green Mark building

The National Library Building joined the ranks of the pioneer batch of Green Mark award winners in 2005, establishing a milestone in Singapore's green built environment journey. Four years later, it increased energy-efficiency levels and won another Green Mark award under the Existing Buildings category.

## •

## Minimising energy use for air-conditioning

The building's façade is installed with double-glazed low-emissive glass and sunshade blades to shield off the sun to minimise heat transfer. Automatic blinds are also used to limit solar gain. On the other hand, the central transition spaces, such as the events plaza and courtyards, are designed to let users enjoy natural ventilation.



### Library of the tropics: a global architectural icon

This brainchild of Malaysian architectural firm TR Hamzah & Yeang is an internationally acclaimed architectural icon and undoubtedly an embodiment of green aspirations and innovations – in and beyond Singapore.

One of Singapore's most energy-efficient office buildings

Boasting an Energy Efficiency Index of 151 kWh per square metre per year and a 33 per cent monthly savings on energy use, this development is among Singapore's most energy-efficient Class I office buildings. It is designed to take advantage of natural light and ventilation to control the energy use for lighting, airconditioning and escalators.



#### Realising Singapore's Green Building Dream

## **Chapter One: Saluting the Pioneers**



#### Ingenious bioclimatic design taps natural light

To reduce the reliance on artificial lighting, areas such as the reference library, exhibition areas and office spaces are naturally lit. Where artificial lighting is necessary, an Integrated Lighting Control System and localised intelligent switches help to limit the lighting only to the occupied areas and floors. In addition, daylight sensors monitor the amount of natural light entering the building and dim or switch off the general lighting when the interior is sufficiently lit.

"We are honoured to be among the first buildings accorded with the Green Mark Platinum accreditation in Singapore. As an architectural icon designed with green aesthetics, the building employed energy-saving and environmentally friendly solutions in its development. By infusing our open and communicative spaces with natural daylight and luxuriant tropical gardens, we have created a unique, conducive and sustainable environment for our library visitors."

Mr William Tan Assistant Chief Executive (Corporate) and Director (Finance & Administration) National Library Board





# **1ST GREEN MARK PLATINUM NEW SHOPPING MALL**

#### CITY SQUARE MALL Green Mark Platinum Award 2007 / 2012 /2015

#### 4

#### An eco-friendly shopping centre that uses 39 per cent less energy

City Square Mall leads by example in being Singapore's first eco-friendly shopping centre that uses 39 per cent less energy than malls with standard designs. It is equipped with energy-saving features to cater to the varying lighting needs in common areas and lifts and the control systems for lifts, escalators and travellators. Its green roof keeps the ambient temperature and heat gain low, while the fabric sunscreens on the northwest façade limit the amount of heat passing through the clear glass curtain wall. Besides saving energy, the building also harvests rainwater for watering plants and recycles the condensate from the air handling units as cooling tower makeup water. In addition, the toilets are fitted with waterless urinals.

Client / Developer City Developments Limited

Architect Ong&Ong Pte Ltd

M&E Engineer Parsons Brinckerhoff Pte Ltd

**Structural Engineer** Meinhardt (Singapore) Pte Ltd

#### Quantity Surveyor Langdon & Seah

Singapore Pte Ltd

Main Contractor Kajima Overseas Asia Pte Ltd

#### Realising Singapore's Green Building Dream

### **Chapter One: Saluting the Pioneers**

# **1ST MCST\* RETROFITTED UNDER BREEF**

#### 4

#### Special financial scheme for high upfront cost offset of retrofits

North Bridge Centre is one of the first projects to be financed through the Building Retrofit Energy Efficiency Financing (BREEF) Scheme, introduced in 2009 to help developers offset the high upfront cost of energy-efficiency retrofits. The green features include installing an energy-efficient chiller plant, which improves its efficiency from 2.78 kW/RT to 0.60 kW/RT, replacing existing fan coil units with energy-efficient direct-current-motor fan coil units, as well as replacing the lighting in all the common areas with energy-efficient LED lights. In addition, the building is also a certified Water Efficient Building by PUB, Singapore's national water agency. The retrofits help the building yield annual savings of about \$\$275,000, conserving about 1.1 million kWh of energy a year.

#### NORTH BRIDGE CENTRE

Green Mark Certified Award 2012 Green Mark Gold Award 2014

#### Client / Developer The Management Corporation Strata Title Plan No. 3329

M&E Engineer COM Consultants

Structural Engineer BK Tan Consultants Pte Ltd **ESD Consultant / ESCO** G-Energy Global Pte Ltd

Facility Management Earnest Management Service Pte Ltd





# 1ST GREEN MARK PLATINUM RETROFITTED OFFICE BUILDING

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#### Boasting a 184-square-metre self-sustainable vertical garden

An iconic feature of the Six Battery Road is the Rainforest Rhapsody, a selfsustainable vertical garden of 184 square metres cultivating about 100 plant species – the largest of its kind in an office building in Singapore when it was constructed. An automatic efficient irrigation system waters the plants with harvested rainwater, while a wind turbine generates renewable energy to power the irrigation pumps. The chiller plant room system has also been redesigned to save 25 per cent of energy use. In 2011, the building's Tenant Service Centre also won a Green Mark Office Interior Gold<sup>Plus</sup> Award for efforts in reusing old desk lamps, recycling old furniture and reducing energy consumption. The development exceeded its target to reduce energy consumption by 25 per cent and achieved full-year savings of over S\$558,000 in 2012. SIX BATTERY ROAD

Green Mark Gold Award 2008 Green Mark Platinum Award 2010 / 2014





Client / Developer CapitaLand Commercial Trust

Architect RSP Architects Planners & Engineers (Pte) Ltd

M&E Engineer Squire Mech Pte Ltd

Structural Engineer RSP Architects Planners & Engineers (Pte) Ltd **Quantity Surveyor** Davis Langdon KPK

Main Contractor Low Keng Huat (Singapore) Limited

ESD Consultant / ESCO G-Energy Global Pte Ltd

Facility Management CapitaLand

#### Realising Singapore's Green Building Dream

### **Chapter One: Saluting the Pioneers**

# 100TH GREEN MARK PLATINUM BUILDING

4

A success story of two significant milestones in the Green Mark scheme's journey

Republic Plaza represents two significant milestones in the Green Mark Scheme's journey – being the first development to win a Green Mark award under the Existing Buildings category and the 100th development to garner the Green Mark Platinum Award. Some of the retrofits include an efficient chiller plant system and permanent instrumentation to monitor its efficiency, variable-speed drives for the chilled water and condenser water pumps and air handling units, LED lighting and motion sensors, which translate into total energy saving of 1.2 million kWh annually. In addition to retrofit works, the developer conducts recycling and environmental awareness programmes to promote green practices among its tenants.

**REPUBLIC PLAZA** 

Green Mark Gold Award 2005 / 2009 Green Mark Platinum Award 2012 / 2014

**Client / Developer** City Developments Limited

Architect RSP Architects Planners & Engineers

M&E Engineer Squire Mech Pte Ltd **Structural Engineer** RSP Architects Planners

& Engineers (Pte) Ltd

Quantity Surveyor Rider Levett Bucknall LLP

Main Contractor Shimizu Corporation



# 1ST PUBLIC SECTOR BUILDING RETROFITTED TO GM PLATINUM

### MINISTRY OF MANPOWER HEADQUARTERS

Green Mark Platinum Award 2010 / 2014



# Saving up to 70 per cent of potable-water use

The Ministry of Manpower Headquarters houses an efficient chiller plant system under a Guaranteed Energy Savings Performance contract to ensure it meets the expected rate of efficiency. The building is outfitted with permanent instrumentation to monitor efficiency and heat balancing of the chilled water plant. Incorporated with motion sensors, the escalators are run on regenerative and gearless drives. Recycling and reusing are significant initiatives of this building – the carpet and system furniture are totally recycled, while high-quality reclaimed water, NEWater, is used for the cooling tower, replacing up to 70 per cent of potable water used previously. Client / Developer Ministry of Manpower of Singapore

ESD Consultant / ESCO Chesterton Suntec International Pte Ltd Honeywell Pte Ltd

## **Chapter Two: Applauding the Innovators**

# SINGAPORE'S 15T BUILDING CONSTRUCTED USING SUPERCRETE

### CAPITAGREEN

#### Green Mark Platinum Award 2012

#### Client / Developer

CapitaLand CapitaLand Commercial Trust Mitsubishi Estate Asia

#### Architect

- Design: Toyo Ito & Associates Architects
- Design Development: Takenaka Corporation
- Architect off Record: RSP Architects Planners & Engineers (Pte) Ltd

M&E Engineer Squire Mech Pte Ltd

#### Structural Engineer

- Concept: Sasaki
- and Partners
- Design & Build Engineer: Takenaka Corporation
- Engineer off Record:
- RSP Architects Planners & Engineers (Pte) Ltd

**Quantity Surveyor** Langdon & Seah Singapore Pte Ltd

Main Contractor Takenaka Corporation

ESD Consultant / ESCO Arup Singapore Pte Ltd

Facility Management CapitaLand



CapitaGreen is the first building in Singapore to be constructed using Supercrete, a special grade 100 ultra-high strength concrete, which helps to cut down the amount of concrete required. This material, which derives from a hybrid of steel and precast construction technology, was used for 29 columns per floor across six floors, reducing a third of the amount of time required to spend at the work site.





## Pecycline

# Recycling construction waste

More than 70 per cent of the demolition waste was recovered and recycled through a systematic process that was put in place before and during the demolition of the previous building.

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#### Reducing heat gain with extensive vertical greenery

With a generous amount of space on every floor filled with plants, the building is designed to reintroduce lush greenery to Singapore's central business district. In fact, more than half of the building's innovative façade is covered with vertical greenery, helping to minimise solar heat gain and reduce energy consumption. Furthermore, two sky terraces add more green space and the Sky Forest crowns the building as a rooftop garden.

#### Water efficiency by recycling rainwater and condensate from AHU

Since watering the extensive greenery requires a large amount of water, nothing could be more efficient than harvesting and reusing rainwater for this purpose. Additionally, condensate from the air handling units is recycled and used for the cooling towers. The building saves nearly 35,000 cubic metres of water a year.

## **Chapter Two: Applauding the Innovators**



"This sustainability journey takes continuous effort. Having won more than 100 Green Mark awards, including a Green Mark Champion Award in 2012, we understand the way forward is to actively engage our stakeholders in various initiatives to improve the economic, environmental and social well-being of the communities we operate in."

Mr Lim Ming Yan, President and Group Chief Executive Officer CapitaLand Limited

# Finergy efficiency through innovative design

A cool void running along the building's core draws in cooler and fresher air from a height of 242 metres above ground, improves the indoor air quality, while highly efficient chillers and zoning of the building help to minimise energy consumption. Other green installations such as motion sensors, photosensors and sunpipes help limit the need for artificial lighting. With these measures, more than 4.7 million kWh of energy is expected to be saved annually.





# SINGAPORE'S 1ST NATURALLY COOLED SHOPPING MALL

**THE STAR** Green Mark Gold Award 2009

#### 4

## Featuring a displacement ventilation system and a hybrid environmental cooling system

This integrated civic, cultural, retail and entertainment hub takes advantage of passive design to encourage air movement, reduce air-conditioned spaces and boost energy efficiency. The underfloor displacement ventilation system cools the auditorium and the hybrid environmental cooling system enhances air movement and thermal comfort at the open civic plaza. One of the main challenges was to uphold the integrity of the building's design, which highlights the architectural aesthetics in the sophisticated geometrical lines of the slanted columns and facade, while implementing an open-air design that is subtle and comfortable for the users. The efforts resulted in an all-year-round naturally cool ambience even in Singapore's hot weather.

#### Client / Developer

Rock Productions (Mall owner: CapitaLand Mall Asia)

Architect Andrew Bromberg of Aedas

M&E Engineer Mott Macdonald Pte Ltd

Structural Engineer Parsons Brinckerhoff Pte Ltd

#### **Quantity Surveyor**

Langdon & Seah Singapore Pte Ltd

Main Contractor Hexacon Construction Pte Ltd

**ESD Consultant** Arup Singapore Pte Ltd

### **Chapter Two: Applauding the Innovators**

# **1ST GREEN MARK PLATINUM DISTRICT**

## CLEANTECH PARK

Green Mark Platinum Award 2012

#### An eco-business park featuring a 'blue network' and a central 'green core'

Singapore's first eco-business park, the JTC CleanTech Park, was conceptualised and developed to seed the growth of clean technology and advanced manufacturing technology research and development. It also promotes innovations through facilitating research partnerships as well as providing test-bed opportunities to promote technology commercialisation and adoption. Apart from supporting the growth of the cleantech industry, CleanTech Park embodies the essence of sustainability. Green features and strategies such as stormwater management, green walkways and sky trellises between buildings, solar panels, conservation zones and green construction methods are key highlights of the park. Its energy-efficient infrastructure and public amenities can potentially save more than 40 per cent of energy and 25 per cent of potable water, resulting in annual cost savings of about 40 per cent. With a 'blue network' of waterbodies, including streams, bioswales and ponds, the Park's district-wide stormwater management design can capture and store about 150,000 litres of stormwater a year for toilet flushing and irrigation.

A prominent development in the Park is JTC's Jurong Eco-Garden, which achieved BCA-NParks Green Mark for New Parks 2011 Platinum Award. It retains the rustic secondary forest for the delicate ecological system to thrive in, while providing a green relief space for social and recreational activities. To ensure land parcels within the CleanTech Park will achieve the required green standards, JTC has also drawn up detailed green urban design guidelines to be taken into consideration for future developments.

Client / Developer





# 1ST GREEN MARK PLATINUM EXISTING MANUFACTURING PLANT

#### **LUMILEDS SINGAPORE** Green Mark Platinum Award 2014

#### Achieved significant energy saving with an extensive energyconservation programme

Lumileds Singapore optimises its 14-year-old chiller plant by enhancing the control operation between the variable speed drives and the chilled water and the condenser water pumps as well as the cooling towers. It also uses LED lights extensively throughout the building and achieves a 40 per cent improvement in lighting power cost savings. The developer has an extensive water recycling practice of harvesting production waste water and air handling unit condensate through a recycling plant that can process 300,000 cubic metres of water a year. In addition, it actively conducts an educational and awareness programme for its employees and suppliers to curtail energy and water use and boost their concern for the environment.

**Client / Developer** Lumileds Singapore Pte Ltd

ESD Consultant / ESCO Barghest Building Performance Pte Ltd

Facility Management Lumileds Singapore Pte Ltd

### **Chapter Two: Applauding the Innovators**

# **1ST TO USE 100 PER CENT RECYCLED CONCRETE AGGREGATE IN THE REGION**

### SAMWOH ECO-GREEN BUILDING

Green Mark Platinum Award 2010 / 2014

#### Reducing construction and demolition waste with innovative use

Every year, about 2 million tonnes of construction and demolition waste is generated in Singapore and its disposal poses a great environmental challenge. Hence, Samwoh Eco-Green Building is the first building in the region to be constructed using up to 100 per cent recycled concrete aggregate, which is derived from such waste in structural concrete. In addition, the building is furnished with perforated cladding to limit heat gain, a VRV 3 air-conditioning system as well as T5 artificial lighting for energy efficiency. Certified waterefficient sanitary ware and a regulated irrigation system are among the equipment installed to conserve water.

Client / Developer Samwoh Corporation Pte Ltd

Architect **CLLA** Architects

M&E Engineer YP Ng & Associate Engineers

**Structural Engineer** TP Seow Consultants **Quantity Surveyor** Samwoh Corporation Pte Ltd

Main Contractor Megastone Holdings Pte Ltd

Facility Management Samwoh Corporation Pte I td




# TREETOPS EXECUTIVE RESIDENCES

Green Mark Gold Award 2010 Green Mark Platinum Award 2012

**Client / Developer** British and Malayan Trustees Ltd

Architect RSP Architects Planners & Engineers (Pte) Ltd

M&E Engineer Squire Mech Pte Ltd Main Contractor Low Keng Huat (Singapore) Pte Ltd

ESD Consultant / ESCO Comfort Management Pte Ltd

Facility Management DTZ Hospitality Management

# **1ST TRI-GENERATION PLANT TO BE INSTALLED IN A SERVICED RESIDENCE IN SINGAPORE**



# A tri-generation system produces electricity, hot water and air-conditioning chilled water

One of Treetops Executive Residences' unique features is the tri-generation system for producing electricity domestic hot water and chilled water for the air-conditioning system. The system comprises three 200-kW diesel generators, working together to power the entire building and reducing its total electricity consumption by half. Complementing that, the developer has signed a long-term energy performance contract with an energy consultant, which monitors the energy use and system efficiency both daily and monthly to ensure energy savings.



# **Chapter Three: Admiring the Unprecedented**

# **1ST GREEN MARK PLATINUM ZERO ENERGY BUNGALOW**

## **TSAO RESIDENCE**

Green Mark Platinum Award 2014

#### Client / Developer

## Darani Tsao

## Architect

 Schematic Design and Architect: Tsao & Mckown
 Client Architect Representative:

Metaphor Design + Architecture Pte Ltd

**M&E Engineer** WSP Ng Pte Ltd **Structural Engineer** Web Structures Pte Ltd

#### **Quantity Surveyor** Samwoh Corporation

Pte Ltd Main Contractor Daiya Engineering &

Construction Pte Ltd

**ESD Consultant / ESCO** Green Architecture Asia Web Earth Pte Ltd





## Aspiring towards the 1st zero-energy home

The first of its kind in Singapore, the Tsao Residence boasts an exceptional passive design that implements various green technologies for efficient use of energy and water, waste management, minimising environmental impact and future development. Designed by the owner, this model green development showcases her laudable commitment towards building a sustainable home that combines energy efficiency, comfort and practicality.



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# Tapping renewable energy from the sun

Using a 23.5-kWp grid-tied solar photovoltaic system, the house effectively yields solar energy for household use, including providing solar hot water.



Energy savings of this home exceed 60 kWh per year and water saving could reach 1,400 cubic metres per year.

# Harvesting rainwater for non-potable uses

Taking advantage of high levels of rainfall in Singapore, part of the residence's design is the harvesting of rainwater for non-potable uses, such as household washing, flushing toilets, irrigation and filling up the natural swimming pool. Stormwater is treated in the bio-retention pond and swales, while the water meant for the pool is cleansed with a non-chemical water treatment system.

#### Realising Singapore's Green Building Dream

# Chapter Three: Admiring the Unprecedented





"Against the backdrop of global warming and other environmental issues, as a home owner, we should all do our part through our newly developed space or existing premises to ensure a better living environment for our family and the community. Everyone needs to do their bit to unknot the environmental problems that we have created."

Mrs Darani Tsao Owner of Tsao Residence



# Enhancing the biodiversity of the surrounding

The existing greenery surrounding the house has been purposefully retained to let the development blend harmoniously with nature. Some species of tropical plants have been introduced to attract birds and butterflies and trees are also planted in the neighbouring garden.



# SOUTHEAST ASIA'S 1ST RETROFITTED ZERO ENERGY BUILDING

## 4

#### A research, development and demonstration facility of greenbuilding technologies

The Zero Energy Building is BCA's research, development and demonstration facility of green-building technologies. It is 50 per cent more energy efficient than a conventional office building. It reduces energy consumption through strategies including using natural daylight, motion sensors, energy efficient lighting, low-emissivity glass windows and shading devices to minimise heat gain from the sun as well as advanced chiller and ventilation systems for air-conditioning. To further optimise energy use, an advanced building management system is installed to control, monitor and manage all the equipment in the building. Furthermore, renewable energy is tapped using photovoltaic systems to power all the appliances, air-conditioning and lighting within the building.

## ZERO ENERGY BUILDING @ BCA ACADEMY Green Mark Platinum Award 2009

#### Client / Developer Building and Construction Authority of Singapore

Architect DP Architects Pte Ltd

M&E Engineer Beca Carter Hollings & Ferner (S.E. Asia) Pte Ltd

## Structural Engineer

Beca Carter Hollings & Ferner (S.E. Asia) Pte Ltd

Quantity Surveyor Langdon & Seah Singapore Pte Ltd

Main Contractor ACP Construction Pte Ltd



Realising Singapore's Green Building Dream

# **Chapter Three: Admiring the Unprecedented**



# ASIA-PACIFIC'S 1ST CARBONNEUTRAL® DEVELOPMENT

#### Energy-efficient building envelope design for minimal energy use

11 Tampines Concourse showcases outstanding sustainable features through its energy-efficient building envelope design. Its lighting energy consumption is reduced by taking advantage of natural daylight, particularly at the atrium and lift lobbies. For temperature and humidity control, this three-storey office building is installed with an indoor non-compressor fresh air cooling system, which uses water instead of chemical refrigerants to cool incoming outdoor air.

## **11 TAMPINES CONCOURSE** Green Mark Gold<sup>Plus</sup> Award 2009 / 2012 / 2015

#### Client / Developer City Developments

Limited

Architect Architects 61 Pte Ltd

M&E Engineer **Conteem Engineers** Pte Ltd

#### Structural Engineer LSW Consulting Engineers

Quantity Surveyor KPK Quantity Surveyors (Singapore) Pte Ltd

Main Contractor Dragages Singapore Pte I td

# 1ST OVERSEAS GREEN MARK PLATINUM PROJECT

## 4

## Unique design enables two façades to be fully self-shaded year-round

Among its architectural features, Energy Commission (ST) Diamond Building's downward and inward slants allow the north and south façades to be fully self-shaded all year round and protected from solar radiation. While the building's design allows for natural lighting, the dynamic shading system is installed at the crown of the atrium to regulate the amount of daylight entering the building and shield the interior against excess sun and heat. In addition, the floor slab cooling system helps to absorb heat and cool the atmosphere effectively throughout the day. The building harvests about 10 per cent of its required energy using photovoltaics, while its water efficiency is achieved through rainwater harvesting, installing water-efficient fittings and recycling grey water.

#### Client / Developer

Energy Commission of Malaysia/ Senandung Budiman Sdn Bhd

ST DIAMOND BUILDING

Green Mark Platinum Award 2011

Architect NR Architects Sdn Bhd Dr. Soontorn, Ecosys Co. Ltd Thailand

**M&E Engineer** PrimeTech Engineers Sdn Bhd Structural Engineer Perunding SM Cekap

**Quantity Surveyor** ARH Jurukur Bahan Sdn Bhd

Main Contractor Putra Perdana Construction Sdn Bhd

ESD Consultant / ESCO IEN Consultants Sdn Bhd



# **Chapter Three: Admiring the Unprecedented**

# 1ST GREEN MARK PLATINUM PROJECT IN CHINA

## 4

#### A test-bed and demonstration site of green-building applications

The Low Carbon Living Lab (LCLL) is designed as a test-bed and demonstration site of green-building applications, energy-saving building technologies and renewable energy adoption, among others. Constructed with passive design features to maximise natural lighting and ventilation, the LCLL is equipped with a smart monitoring system to obtain more accurate measurements and analyses. This building uses 30 per cent less energy than other similar buildings in Tianjin, with 28 per cent of the energy it consumes coming from renewable sources. The LCLL was awarded China's Green Building Design Label with a 3-star rating by China's Ministry of Housing and Urban-Rural Development in 2013, as well as achieving Platinum rating for the Green Building Evaluation Standard (GBES) jointly developed by experts from Singapore and China.

## SINO-SINGAPORE TIANJIN ECO-CITY LOW CARBON LIVING LAB

Green Mark Platinum Award 2015

#### Client / Developer

Sino-Singapore Tianjin Eco-City Investment & Development Co., Ltd

#### Architect

Jurong Consultants Pte Ltd China Construction Engineering Design Group Co., Ltd (LDI)

#### M&E Engineer

Jurong Consultants Pte Ltd China Construction Engineering Design Group Co., Ltd (LDI)

#### **Structural Engineer** Jurong Consultants Pte Ltd

China Construction Engineering Design Group Co., Ltd (LDI)

#### Quantity Surveyor Tianjin Jinjian

Construction Cost Consulting Co., Ltd

Main Contractor Second Building Co. Ltd China Construction First Building (Group) Co., Ltd

ESD Consultant / ESCO Jurong Consultants Pte Ltd





# **1ST OVERSEAS GREEN MARK PLATINUM EXISTING BUILDING PROJECT**

## **GRAHA CIMB NIAGA** SCBD JAKARTA, INDONESIA

Green Mark Gold Award 2011 Green Mark Platinum Award 2015

## 4

# Recycling exhaust air, stormwater, AHU condensate and organic waste for resource efficiency

This building recycles exhaust air via a rotary heat exchanger and ducts it to the cooling tower areas to enhance air circulation. In order to reduce water consumption, recycling of stormwater and condensate from the air handling units (AHU) is conducted within the building premises. The development boasts extensive greenery, including vertical and rooftop gardens, which is nourished by the compost generated from recycling organic waste the building produces. Retrofitting mechanical and engineering works has resulted in total energy efficiency of 12 per cent. At the basement car park, carbon monoxide sensors are linked to the ventilation system to enhance air quality effectively.

#### Client / Developer

PT GrahaNiaga TataUtama

Architect Kohn Pedersen Fox (KPF New York)

#### M&E Engineer Wiratman & Associates

**Structural Engineer** Wiratman & Associates

#### Main Contractor PT Waskita Karya

**ESD Consultant / ESCO** Dr. Ir. J. J. Luthan

Facility Management PT GrahaNiaga TataUtama

# GREEN SPIRIT

"We applaud BCA's efforts in pushing Singapore's green agenda, specifically the city's green building visions."

## **Rich Lechner**

Vice-President, Energy & Environment, IBM Business Times Commentary Writer, 8 August 2008 all



# **Chapter Four: Cultivating Greenery High Up**



# A HOTEL IN A GARDEN

## A hotel in a garden, a sanctuary in the city

The first of its kind, PARKROYAL on Pickering is a hotel that offers an exciting showcase of lush greenery made up of shade trees, palm trees, shrubs, overhanging creepers and flowering plants. Spanning 15,000 square metres throughout the building, these floral charms are spotted at the sky gardens and planter terraces, by the reflecting pools and waterfalls, and on the green walls. The landscaping constitutes more than double the total land area of the hotel.

# PARKROYAL ON PICKERING

Green Mark Platinum Award 2012

#### Client / Developer UOL Group Limited

Architect WOHA Architects Pte Ltd

M&E Engineer BECA Carter Hollings & Ferner (S.E Asia) Pte Ltd

Structural Engineer TEP Consultants Pte Ltd Quantity Surveyor

Rider Levett Bucknall (RLB) Singapore

#### **Main Contractor**

Tiong Seng Contractors Pte Ltd

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# Industry pioneer in using solar-powered landscape lighting

PARKROYAL on Pickering is one of the first hotels in Singapore to use landscape lighting that is powered by solar energy at its sky gardens.

# An architectural brainchild of an award-winning firm

Designed by internationally acclaimed architectural company WOHA, the hotel has all its elements of sustainability seamlessly integrated with the building itself, which subsequently sits in harmony with the urban surroundings. Its presence in the central business district is a refreshing addition to the Singapore skyline downtown.





#### Realising Singapore's Green Building Dream

# **Chapter Four: Cultivating Greenery High Up**





"Green architecture is the way forward. It has clear benefits, like reducing urban heat and providing a calming effect to our hotel guests and staff. For PARKROYAL on Pickering, we integrated skyrise greenery through innovative ways and achieved a green replacement ratio of 200 per cent. We hope this hotel has provided a success story that will help Singapore realise its Green Building dream and improve the liveability of the city."

Mr Liam Wee Sin Deputy Group Chief Executive Officer UOL Group Limited

#### / Innovative natural ventilation and illumination

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The greenery and water features that flank half of the hotel's guestroom corridors cool these areas naturally and cut down on energy use for round-the-clock airconditioning, while natural daylight is harnessed to illuminate the hotel's public areas, including the corridors and lobbies. For artificial lighting, the hotel uses energy-efficient LED and T5 lamps, consuming 20 per cent less power.

## Water-efficient irrigation of extensive foliage

Harvested rainwater, together with NEWater, Singapore's high-grade reclaimed water, is used for watering plants using the automatic drip irrigation method. However, rain sensors will deactivate the irrigation system when it rains. Together with other efforts for water efficiency, the hotel saves about 6,900 cubic metres of water a year.



# WORLD'S LARGEST VERTICAL GARDEN IN SINGAPORE'S CBD



# A showcase of digitised pixilation design using about 57,000 potted plants

Keppel REIT's Ocean Financial Centre was certified by the Guinness World Records as the largest vertical garden in 2013 for its green wall of 2,125 square metres. The wall is designed using a technique called digitised pixilation and about 57,000 potted plants of various species to create images that represent the maps of Singapore, Southeast Asia and the world with a three-dimensional effect. A hybrid system is installed to water and fertilise the plants automatically for minimal maintenance. Ocean Financial Centre is the first office development in Singapore to be awarded the Platinum Green Mark Award in 2008 and represents one of Green Mark's contributions to achieving Singapore's vision of becoming a City in a Garden. The building features eco-breakthroughs including using triple-glazed low-emissivity glass for the facade, photovoltaics for harnessing solar energy, and a programmable switch for tenants to control air-conditioning and lighting levels.





OCEAN FINANCIAL CENTRE Green Mark Platinum Award 2008

Client / Owner Ocean Properties LLP / Keppel REIT

Architect Architects 61 Pte Ltd Pelli Clarke Pelli Architects

M&E Engineer Parsons Brinckerhoff Structural Engineer T.Y.Lin International

Quantity Surveyor KPK Quantity Surveyors (Singapore)

Main Contractor Obayashi - Woh Hup Joint Venture

# **Chapter Four: Cultivating Greenery High Up**

# ONE OF THE WORLD'S LARGEST VERTICAL GREENERY INSTALLATIONS

# ITE HEADQUARTERS & ITE COLLEGE CENTRAL

Green Mark Platinum Award 2012

## 4

# Green walls of up to 30 metres high and more than 5,000 square metres in total size

An extraordinary feature in the institution's premises, the green walls at ITE College Central take centre stage on the façades of eight campus blocks. Reaching up to 30 metres high, the vertical garden totals more than 5,000 square metres in size, making it the largest of its kind in the world. Together with the rooftop garden, the green walls are irrigated by recycled rainwater. Apart from the massive greenery, the buildings' environmental canopies and daylight reflectors maximise the use of daylight to save electricity, while its 200-kWp photovoltaic system harnesses renewable energy for the development's consumption.

**Client / Developer** Institute of Technical Education

Architect RSP Architects Planners & Engineers (Pte) Ltd

M&E Engineer Squire Mech Pte Ltd Structural Engineer RSP Architects Planners & Engineers (Pte) Ltd

**Quantity Surveyor** Langdon & Seah Singapore Pte Ltd

**Main Contractor** Kajima Overseas Asia Pte Ltd







# WORLD'S LARGEST VERTICAL GARDEN IN 2014

**TREE HOUSE** Green Mark Platinum Award 2010

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## Reducing carbon footprint with a biomimicry design concept

Boasting a size of 2,289 square metres, the vertical garden at the Tree House condominium was certified by the Guinness World Records as the largest vertical garden in 2014. Designed with a biomimicry concept, it serves as a giant tree or a 'bio-shelter' that offers natural insulation against the sun and a vertical green lung that filters pollutants and carbon dioxide in the air, thereby reducing the building's carbon footprint. Its base is a sloped canopy with a skeletal frame that helps to channel and harvest water for irrigating the entire vertical garden. Tree House is an important contribution to the effort to transform Singapore into a City in a Garden, one of the nation's latest aspirations. In May 2015, Tree House was named World Gold Winner in the Sustainable Development category at the FIABCI World Prix d'Excellence Awards.

#### Client / Developer

City Developments Limited

Architect ADDP Architects

M&E Engineer United Project Consultants Pte Ltd

Structural Engineer DE Consultants Pte Ltd

#### Quantity Surveyor Langdon & Seah Singapore Pte Ltd

Main Contractor

Tiong Seng Contractors (Pte) Ltd

ESD Consultant / ESCO Arup Singapore Pte Ltd

# **Chapter Five: Enhancing Comfort and Well-being**

# 1ST GREEN MARK PLATINUM NEW HOSPITAL

# KHOO TECK PUAT HOSPITAL

Green Mark Platinum Award 2009

#### **Client / Developer** Alexandra Health System

/ Ministry of Health

#### Architect CPG Consultants Pte Ltd

M&E Engineer CPG Consultants Pte Ltd Structural Engineer CPG Consultants Pte Ltd

Quantity Surveyor CPG Consultants Pte Ltd

Main Contractor Hyundai Engineering & Construction Co. Ltd



## Green coverage that is 3.9 times of the building footprint

Khoo Teck Puat Hospital is one of the newest healthcare facilities that have garnered a Green Mark award. Driven by the aim of creating an environment conducive to patients' recovery, the design of this hospital maximises the amount of greenery at the balconies to create a perception of being at ground level. The top of the building features lowmaintenance tropical gardens and an organic farm. What has materialised is a green coverage that is 3.9 times of the building footprint.

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#### A therapeutic environment amid the greenery

The hospital offers a relaxing and cheerful environment with lush gardens at ground level and on the rooftop, accompanied by the tranquillity of the adjacent Yishun Pond, helping to nurse patients back to health. The greenery helps to keep the atmosphere in the hospital cooler even without airconditioning.

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# Staying energy-efficient with solar power

A 137-kWp photovoltaic system sits on the hospital's rooftop, acquiring solar energy to run the heat pumps for making hot water the hospital needs. Spanning 1,276 square metres, it was installed as part of the Clean Energy Research and Test-bedding programme by the Economic Development Board.





#### Realising Singapore's Green Building Dream

# **Chapter Five: Enhancing Comfort and Well-being**



"We designed Khoo Teck Puat Hospital to be a "Hospital in a Gardren and a Garden in a Hospital" with only one thought in our mind - to provide a soothing and healing environment to help our patients recover well. To quote Hugh Thompson, Jr., "Don't do the right thing looking for a reward." We should do it for the right reason.

**Mr Donald Wai** Director, Hospital Planning Alexandra Health System

(Hugh Thompson, Jr., was a US Army helicopter pilot who shielded local civilians in My Lai hamlet from being killed by American soldiers during the Vietnam war.)

# Maximising natural ventilation with wind walls

To ensure maximum comfort for patients in the naturally ventilated wards, the hospital's facades have wind walls to encourage optimal airflow inward. The louvre curtain walls complement this by shielding off the sun's glare to reduce heat gain.



## Water-efficient maintenance of the gardens

The hospital's gardens are maintained with the drip irrigation system and sensors that help to minimise water wastage. The hospital obtains at least half of the water required for irrigation from the nearby Yishun Pond and tops up with NEWater, which is high-grade reclaimed water. In fact, NEWater constitutes nearly 70 per cent of the hospital's non-potable and non-medical water use.

# 1000TH GREEN MARK BUILDING PROJECT



# A blend of eco-friendly sports facilities and retail and lifestyle amenities

The first of its kind, Pasir Ris Sports Centre offers a blend of eco-friendly sports facilities along with retail and lifestyle amenities connected to the adjoining park and pond. The common areas are built to take advantage of natural daylight and ventilation. The sun-shielding curtain-wall louvres are made with recycled timber obtained from the seats of the old National Stadium, which was demolished in 2010 and 2011. Being 25 per cent more energy-efficient than a traditional sports centre, it is equipped with a 170-kWp rooftop photovoltaic system that provides 12 per cent of the centre's energy needs, saving the centre S\$57,000 annually.



Green Mark Gold<sup>Plus</sup> Award 2012 / 2015







Client / Developer Sport Singapore

Architect CPG Consultants Pte Ltd

M&E Engineer CPG Consultants Pte Ltd

**Structural Engineer** CPG Consultants Pte Ltd Quantity Surveyor CPG Consultants Pte Ltd

Main Contractor Quek Hock Seng Construction Pte Ltd

# **Chapter Five: Enhancing Comfort and Well-being**



# **NEXT GENERATION HEALTHCARE HUB**

#### A window for every patient

The unique fan-shaped wards are designed to provide a window for every patient. This improves privacy and is shown to help recovery. The east-west orientation of the ward towers also takes advantage of prevailing winds to increase ventilation and double air flow, compared to that of a conventional ward. Greenery and planters outside the windows and around the premisesincluding sky terraces and gardens at the rooftops and at ground level—yields a green plot ratio of 4.7 for the development. The two hospitals have energy savings of some S\$5 million annually.

## NG TENG FONG GENERAL **HOSPITAL & JURONG COMMUNITY HOSPITAL** Green Mark Platinum Award 2013





Client / Developer Jurong Health Services

Architect CPG Consultants Pte Ltd

**M&E Engineer** Parsons Brinckerhoff Pte Ltd

Structural Engineer CPG Consultants Pte Ltd **Quantity Surveyor** Langdon & Seah Singapore Pte Ltd

Main Contractor GS Engineering & Construction

# **1ST GREEN MARK PLATINUM PUBLIC RESIDENTIAL DEVELOPMENT**

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# A public housing development with green technologies and enhanced greenery

The Housing & Development Board's (HDB) pilot eco-precinct project, Treelodge @ Punggol, is the first public housing development to be accorded a Green Mark Platinum Award. The precinct comprises seven blocks atop an Eco-Deck – the landscaped roof of a single-storey podium car park which also houses play and fitness amenities. Surrounded by greenery, the lush landscaping at the Eco-Deck and block rooftops, as well as the vertical greenery at the facades help keep ambient temperatures down. The eastand west-facing facades are also equipped with in-built thermal insulation that can further reduce heat gain in homes. Solar panels at the rooftops generate renewable energy to run lifts and pumps, and power corridor lighting such that the precinct achieves nearly zero-energy consumption level for these common services. For its work to make HDB towns more liveable and sustainable for residents, HDB won the Green Mark Champion Award in 2011, the BCA Built Environment Leadership Award in 2012 and also garnered a total of 23 Green Mark awards in 2014, the largest number of awards received by a public agency.

## **TREELODGE @ PUNGGOL**

Green Mark Platinum Award 2007



Green spaces for residents' enjoyment

Client / Developer Housing & Development Board

Architect Surbana International Consultants Pte Ltd

M&E Engineer Surbana International Consultants Pte Ltd

Structural Engineer Surbana International Consultants Pte Ltd Quantity Surveyor Surbana International Consultants Pte Ltd

Main Contractor Kay Lim Construction & Trading Pte Ltd

ESD Consultant / ESCO Housing & Development Board

Facility Management Pasir Ris Punggol Town Council



# **Chapter Six: Serving the Neighbourhood**

# **1ST GREEN MARK PLATINUM SUPERMARKET**



# NTUC FAIRPRICE SUPERMARKETS

Green Mark Platinum Award 2012

Client / Developer NTUC FairPrice Co-operative Ltd

M&E Engineer HY M&E Consultancy Service Pte Ltd

Main Contractor Teamsystem Construction Pte Ltd

#### 1st Green Mark Platinum supermarket – FairPrice Finest @ Zhongshan Park

In 2012, FairPrice Finest @ Zhongshan Park became the first supermarket in Singapore to win a Green Mark Platinum award under the Green Mark for Supermarket Scheme, which has been formulated to help tenants that occupy at least half of a building's space to deal with the challenges in implementing greening strategies. Developed specifically to recognise supermarket operators' sustainability efforts, the scheme helps operators reduce their energy load, water use, waste production and base-building energy consumption.

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#### Staying cool behind closed doors

Nearly all of the refrigeration display cases at FairPrice Finest @ Zhongshan Park are fitted with doors to ensure they stay cool efficiently with minimal electricity consumption. Electronic expansion valves, anti-sweat controls and electronically commutated fans are also installed to enhance the energy-saving property of these display cases.





# Energy-efficient refrigeration system

Energy consumption by the refrigeration system may constitute close to half of a supermarket's total energy use. Using an energy-efficient refrigeration system with variable-frequency drives to regulate motor speed and, therefore, minimising energy use help the supermarket yield significant energy savings.

## A programme to cut plastic bag use

To minimise the dispensing of plastic bags, FairPrice sets up Bring-Your-Own-Bag priority checkout counters to serve customers who bring their own shopping bags and rewards them at every checkout through the FairPrice Green Rewards Scheme.

# **Chapter Six: Serving the Neighbourhood**



The recycling corner and educational panels about green initiatives found around the store encourage customers to implement green initiatives into their own lifestyle.

# 1st Portfolio programme partner

NTUC FairPrice Supermarkets, arguably Singapore's largest and best-known supermarket chain, is the first organisation to partake in BCA's Portfolio Programme, a simplified Green Mark scheme certification process designed for businesses that operate at multiple outlets. As a partner of the Portfolio Programme, FairPrice commits to greening at least 20 stores by December 2016.

"As a socially responsible retailer and an industry leader, FairPrice has always recognised the importance of environmental sustainability. Hence, we have been committed towards greening our supermarkets. For example, with greening just one store, the FairPrice Finest outlet at Zhongshan Park, we are able to consume 30 per cent less energy. This saving is equivalent to the amount of electricity consumed by about 200 average three-room HDB flats\* per annum."

Mr Seah Kian Peng Chief Executive Officer (Singapore) NTUC Fairprice Co-operative Limited

\* HDB flats are public housing developed by the Housing & Development Board



# 1ST GREEN MARK PLATINUM RESTAURANT

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# Extending its global green strategy with a growing portfolio of green restaurants

In 2011, its outlet at Jurong Central Park garnered for McDonald's its first-ever Green Mark Platinum Award. It is also one of the first restaurants in Singapore to receive this award. Two years later, McDonald's Yishun Safra bagged another Green Mark Platinum Award, joining the ranks of the fast-food chain's five other Green Mark outlets. McDonald's is also a partner of the BCA Green Mark Portfolio Programme, which offers a streamlined approach to certifying similar spaces across a portfolio of projects by using prototype standards for faster and more cost-effective certification. McDonald's sees its participation in the Green Mark scheme as an extension of its global green strategy, including its green restaurant design showcased by its American and European outlets.



## McDONALD'S RESTAURANTS Green Mark Platinum Award 2011 / 2014



Client / Developer McDonald's Restaurants Pte Ltd

Architect Archideas Design Inc

M&E Engineer Alpha Consulting Engineers Pte Ltd

Structural Engineer Engineers Incorporated Main Contractor Megabuilders & Development Pte Ltd

ESD Consultant / ESCO Metropolitan Green Design & Technology GETC Asia Pte Ltd

# **Chapter Six: Serving the Neighbourhood**



# 1ST GREEN MARK RAPID TRANSIT SYSTEM

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#### Harvesting train-braking energy with its regenerative braking system

The Circle Line is a pioneering development that has garnered a Green Mark award under the Green Mark for Rapid Transit System scheme. Innovative construction methods are adopted to ensure materials are recycled to minimise wastage and damage to the environment. Drift eliminators reduce the drift loss in the cooling tower of the air-conditioning systems, saving about 13,550 cubic metres of water annually. A highlight of this development is the regenerative braking system, which harvests energy produced during train braking for other uses, saving about 433 MWh of energy a year. In addition, energy-efficient lighting, lifts and escalators are also installed to reduce energy use.



**CIRCLE LINE** Green Mark Gold Award 2010



**Client / Developer** Land Transport Authority

**Operator** SMRT Corporation Ltd

# 1ST GREEN MARK PLATINUM RETROFITTED RETAIL MALL

# 4

Going green with energy-efficient fittings, green lease and sustainable waste management

LED and T5 fluorescent lights, motion sensors and photo sensors are among the devices Parkway Parade uses in its energy-saving strategies. To minimise carbon monoxide emission from vehicles, its car park is fitted with a guidance system to direct drivers to the nearest available parking lots, while a charging station is made available to encourage visitors to use electric motorbikes. The developer also offers green lease to new and renewing tenants, encouraging them to opt for energy-efficient equipment. To maintain water efficiency, rainwater is recycled, harvested and stored in a water tank and used for irrigation and flushing.

## PARKWAY PARADE

Green Mark Platinum Award 2010

#### Client / Developer

The Management Corporation Strata Title No. 1008

Architect Tang Architect

M&E Engineer Ace-tech Design Pte Ltd

Main Contractor Bovis Lend Lease



# GREEN CAMARADERIE

"Singapore is now an Asian regional bridge for promoting green building methods. Singapore can serve as an example to other countries and cities."

#### Dr Arab Hoballah

Chief of the Sustainable Consumption & Production Branch United Nations Environment Programme (UNEP) The Straits Times, 12 September 2011



# **Chapter Seven: Energising the City**

# 1ST GREEN MARK PLATINUM WILDLIFE PARK

## **RIVER SAFARI**

Green Mark Platinum Award 2012

**Client / Developer** Wildlife Reserves Singapore

Architect DP Architects Pte Ltd

M&E Engineer Beca Carter Hollings & Ferner (S.E.Asia) Pte Ltd Structural Engineer Beca Carter Hollings & Ferner (S.E.Asia) Pte Ltd

**Quantity Surveyor** Langdon & Seah Singapore Pte Ltd

Main Contractor Quek Hock Seng Construction Pte Ltd







#### Photo credit: Wildlife Reserves Singapore

## An immersive natural habitat

Asia's first river-themed wildlife park, River Safari houses 400 species of plants and 200 species of animals. It has been developed to highlight the threats facing freshwater ecosystems and to educate visitors on the importance of these natural environments, championing wildlife conservation and environmental sustainability. This is a unique Green Mark development that focuses on creating natural habitats for the flora and fauna, while minimising disruption to the surrounding environment and ensuring sustainability.

Protecting our water supply

Great efforts were taken to ensure that the park's water bodies stay within closed loops. These ensure water and other particles do not infiltrate and contaminate the surrounding reservoir.

#### A water-efficient river-themed park

To keep water use to a minimum, rainwater runoff is harvested with bioswales, and biologically treated to remove pollutants. Working in a closed loop, these systems minimise the amount of water required for replacement.

# **Chapter Seven: Energising the City**



"As Asia's first and only riverthemed wildlife park, River Safari is on a mission to highlight the importance of freshwater ecosystems and inspire positive actions to conserve them. To walk the talk, the park is designed and developed with utmost concern for the environment through measures such as sustainable architecture, environmentally responsible design, and on-going green initiatives."

Mr Cham Tud Yinn Director, Exhibit Design & Development Wildlife Reserves Singapore

# Energy-efficient panda exhibit

Maintaining a suitable living environment for the giant pandas is energy-consuming. To keep the enclosure constantly at 18 to 22 degrees Celsius for the pandas' comfort, the park uses energy-efficient waterchilled air-conditioning systems. The building has double cavity walls so that the interior stays cool efficiently. The doubleglazed skylight brings in natural daylight to the exhibit, while light tubes draw sunlight into the food preparation and den areas, saving energy on artificial lighting.





# Minimal disruption to the environment

To preserve the surrounding natural secondary rainforest, modification to the site's terrain was kept to a minimum. Trees that had to be removed were relocated to the adjacent wildlife parks, and intensive reforestation was carried out.



# SINGAPORE'S HORTICULTURE MASTERPIECE

#### A 101-hectare garden rooted in environmental sustainability

This 101-hectare garden embraces the principles of environmental sustainability, particularly in relation to water and energy. Terraced filter beds, man-made islands, bog gardens and bioswales have been created and aquatic plants planted for cleansing the lake water and surface runoff, while weirs at the lake mouths regulate water flowing to and from the Marina Reservoir. Lake water is oxygenated with water features, fountains and aerators to prevent stagnation, algal growth and mosquito breeding. Chillers cooling the two conservatories are powered by a steam turbine that runs on horticultural wastes. The air is de-humidified before cooling so that it requires less energy. Photovoltaic cells fitted on some of the Supertrees produce solar energy to light up these towering vertical gardens.

# 

# GARDENS BY THE BAY

Green Mark Platinum Award 2013

#### Client / Developer Gardens by the Bay

**Client's Representative** PM Link Pte Ltd WorleyParsons Limited

## Architect

CPG Consultants Pte Ltd Wilkinson Eyre Architects Landscape Architect

Grant Associates
M&E Engineer
CPG Consultants Pte Ltd

Atelier Ten (Asia) Pte Ltd Structural Engineer

CPG Consultants Pte Ltd Atelier One Pte Ltd Meinhardt Infrastructure Pte Ltd

#### Quantity Surveyor CPG Consultants Pte Ltd

CPG Consultants Pte Ltd Langdon & Seah Singapore Pte Ltd

#### Main Contractor

Woh Hup (Pte) Ltd Expand Construction Pte Ltd Precise Development Pte Ltd Planar One & Associates Pte Ltd Swee Hong Engineering and Construction Pte Ltd

Koon Construction & Transport Co Pte Ltd

ESD Consultant / ESCO CPGreen – CPG Consultants Pte Ltd



# **Chapter Seven: Energising the City**





# RESORTS WORLD SENTOSA

Green Mark Gold<sup>Plus</sup> Award 2009

Client / Developer Resorts World at Sentosa Pte Ltd

Architect DP Architects Pte Ltd

M&E Engineer Meinhardt (Singapore) Pte Ltd Beca Carter Hollings & Ferner (S.E. Asia) Pte Ltd

Structural Engineer Maunsell Consultants (Singapore) Pte Ltd Quantity Surveyor DLS/KPK IR Pte Ltd

#### Main Contractor

Kajima-Tiong Seng Joint Venture Low Keng Huat (Singapore) Ltd China JingYe Engineering Corporation Ltd (Singapore Branch)

**ESD Consultant / ESCO** G-Energy Global Pte Ltd

# MOST THRILLING GREEN MARK PROJECT

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# Making significant contributions to tree conservation and coral relocation

Resorts World Sentosa (RWS) is a pioneer Green Mark certified district and boasts Singapore's then largest photovoltaic installation capable of generating more than 550,000 kWh of energy yearly. An eco-lagoon with a volume of 12 Olympic-sized swimming pools stores harvested rainwater and air handling unit condensate, which are used for the water-rides and irrigation. The rooftop and vertical gardens make up the expansive greenery for the development, which also utilises highly efficient district cooling. RWS has also contributed significantly to the conservation of trees by transplanting 200 trees within the development's site and relocating a coral fringe more than two years before the construction.


# 1ST GREEN MARK PLATINUM INFRASTRUCTURE

MARINA BARRAGE

Green Mark Platinum Award 2009

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# Generating renewable energy from one of the largest solar parks in Singapore

Marina Barrage is an important water catchment infrastructure for Singapore. Besides enjoying natural heat insulation provided by the huge rooftop garden, the building is fitted with double glazing to reduce heat gain, thereby minimising the energy for air-conditioning consumed. Marina Barrage also taps renewable energy produced from a collection of 405 solar panels, which makes it one of the largest solar parks in Singapore. To use water efficiently, reservoir water is channelled to cool the drainage pumps and generators during operation. Marina Barrage is also home to the Sustainable Singapore Gallery, which houses interactive multimedia displays, exhibits and games for educating the public on environmental and water issues.

Client / Developer PUB Singapore

Architect Architects Team 3 Pte Ltd

Main Contractor Koh Brothers Building & Civil Engineering Contractor Pte Ltd



### **Chapter Seven: Energising the City**

# 1ST GREEN MARK PLATINUM NEW HOTEL

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# Saving 2 million kWh of energy annually with energy-efficient air-conditioning system

Passive design has been adopted for the development of W Singapore — Sentosa Cove, enhancing thermal comfort as well as natural ventilation and lighting. The hotel's extensive use of LED lighting has brought close to 40 per cent annual energy saving, while water-efficient fittings help the hotel lower its yearly water-consumption level by more than 8,000 cubic metres. The energy-efficient air-conditioning system also helps to cut annual energy consumption by 2 million kWh. Rainwater is harvested for watering hotel's greenery, yielding approximately \$\$22,200 in annual savings.

#### W SINGAPORE — SENTOSA COVE Green Mark Platinum Award 2010

**Client / Developer** City Developments Limited

Architect

Axis Architects Planners Pte Ltd M&E Engineer

Meinhardt (Singapore) Pte Ltd

Structural Engineer KTP Consultants Pte Ltd Quantity Surveyor Langdon & Seah Singapore Pte Ltd

Main Contractor Ssangyong Engineering & Construction Co., Ltd

ESD Consultant / ESCO G-Energy Global Pte Ltd







### FURAMA CITY CENTRE & FURAMA SINGAPORE HOTEL & SHOPPING CENTRE

Green Mark Platinum Award 2010 / 2013

# 1ST GREEN MARK PLATINUM RETROFITTED HOTEL

# Using bio-enzyme for general cleaning to minimise environmental harm

This development is fitted with a heat recovery system from the air-conditioning and mechanical ventilation system, which helps to make hot water and save on energy consumption. General cleaning is carried out using bio-enzyme to minimise harm to the environment. To manage waste water in an environmentfriendly way, it is filtered through a supercapacity grease trap before disposal. These green features help save more than 1 million kWh of energy and more than 17,000 cubic metres of water annually.

#### Client / Developer

Management Corporation Strata Title Plan No 1246 Furama City Centre

Architect Biospace Architects

M&E Engineer Belmacs Consulting Engineers

#### Structural Engineer Sim Bee Teck & Associates

Main Contractor Kajima Corporation

**ESD Consultant / ESCO** G-Energy Global Pte Ltd



Realising Singapore's Green Building Dream

### **Chapter Eight: Nurturing the Future**



# 1ST GREEN MARK DISTRICT

#### NUS UNIVERSITY TOWN

Green Mark Gold<sup>Plus</sup> Award 2009

#### Client / Developer

National University of Singapore

Architect DP Architects Pte Ltd

M&E Engineer Beca Carter Hollings & Ferner (S.E. Asia) Pte Ltd

Structural Engineer Beca Carter Hollings & Ferner (S.E. Asia) Pte Ltd

#### Quantity Surveyor

Rider Levett Bucknall Langdon & Seah Singapore Pte Ltd

Main Contractor Chye Joo Construction Pte Ltd Sato Kogyo (S) Pte Ltd

# A low-carbon campus

The development of NUS University Town (UTown) was driven by the vision to build a sustainable learning environment and a lowcarbon campus that would promote biodiversity. The buildings in UTown have been designed by adopting passive techniques to minimise heat gain, maximise natural lighting in indoor spaces and facilitate natural ventilation in courtyards and indoor assembly areas. This verdant campus was designed with extensive connected sheltered walkways and dedicated bicycle lanes in order to reduce the dependence on vehicles.





# Waste management programmes

To systematically manage the various types of waste generated on campus, waste management recycling strategies involved setting up dedicated collection areas of recyclables and organic waste. Horticultural waste is also collected and together with other waste collected, are sent off-site to be composted or recycled.

# Educational programmes and campaigns

The NUS Office of Environmental Sustainability runs various outreach activities to help students understand and minimise their environmental footprint, including energy and water usage. These activities, under the campus-wide "sustainABLE NUS" campaign, are aimed at empowering individuals to take action in building a greener campus.



# Secycling demolition waste

During the construction phase, demolition waste was salvaged and used as subbase fill material for drains and roads.

#### Realising Singapore's Green Building Dream

### **Chapter Eight: Nurturing the Future**



"Climate change and environmental sustainability are among the most pressing issues of our time. NUS, as a global university, is committed to reducing our environmental impact. As a new development that will transform NUS's education. University Town gave us the opportunity to design and build the substantial extension of the Kent Ridge Campus with this goal in mind. This award reaffirms the University's bold efforts at integrating environmentallyfriendly and sustainable practices with daily campus living."

**Professor Tan Chorh Chuan** President, National University of Singapore

#### Promoting biodiversity with lush tropical greenery

UTown sits among extensive tropical vegetation on rolling terrain, a scenic result borne out of biodiversity analysis, carbon sequestration computation and the selection of suitable native species for the softscape. Lush greenery shading the roads contribute to reducing the entire campus's urban heat island effect, which is also partly moderated by heat-reflecting hardscape materials and green roof buildings.



# AN EXEMPLAR OF PASSIVE DESIGN

# Designed to preserve biodiversity, promote natural ventilation and minimise solar radiation

Ventus is the office, meeting and communal spaces for the Office of the Vice President (Campus Infrastructure), National University of Singapore (NUS). NUS aspired for this development to become an exemplar of sustainable and passive design. Responding to site conditions, the team minimised the removal of trees and excavation during construction and preserved the biodiversity of the site. The building's wind scoop promotes natural ventilation and reduces the need for air-conditioning, while its creative structural design allows the blocks to provide shading for one another to minimise solar radiation. These sustainable strategies contribute to the lower energy consumption while balancing thermal comfort. NUS is one of the first winners of the Green Mark for Districts Award for University Town in 2009 and the first educational institution to win the Green Mark Champion Award in 2012.

#### **VENTUS** Green Mark Platinum Award 2012

Client / Developer National University of Singapore

Architect MKPL Architects Pte Ltd

M&E Engineer J. Roger Preston (S) Pte Ltd

Structural Engineer KTP Consultants Pte Ltd Quantity Surveyor Davis Langdon KPK (Singapore) Pte Ltd

Main Contractor BSI (1990) Pte Ltd

ESD Consultant / ESCO Arup Singapore Pte Ltd



### **Chapter Eight: Nurturing the Future**

# NEW GENERATION EDUCATIONAL INSTITUTION

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#### Saving energy through novel air distribution systems

The Hive at Nanyang Technological University (NTU) is an eight-storey building with new-generation classrooms designed to support new pedagogies that promote more interactive small group teaching and active learning. Among the building's energy saving features is its passive displacement ventilation system that distributes cooled air through convection, eliminating the need for mechanical distribution fans. NTU earned its Green Mark Platinum award for the Hive in 2013 and bagged the Green Mark Champion Award in 2014 for its long-term dedication towards sustainability and support for the Green Mark scheme.



The Hive at Nanyang Technological University, a hive of learning and innovation (Credit: Hufton & Crow)



The Hive at NTU is interspersed with alcoves, balconies and gardens to foster interaction and sharing of ideas (Credit: Hufton & Crow)

### THE HIVE (SOUTH SPINE LEARNING HUB)

Green Mark Platinum Award 2013

#### Client / Developer

Nanyang Technological University

Architect CPG Consultants Pte Ltd

M&E Engineer Bescon Consulting Engineers Pte

#### Structural Engineer T. Y. Lin International Pte I td

#### Quantity Surveyor Davis Langdon KPK (Singapore) Pte Itd

Main Contractor Newcon Builders Pte Ltd

ESD Consultant / ESCO CPG Consultants Pte Ltd - CPGreen

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# **1ST GREEN MARK PLATINUM SCHOOL**

#### Moving towards zero-energy schools

Crest Secondary School winning the Green Mark award is a fruition of BCA's effort in reaching out to the schools and school children on sustainability matters through its Green Schools initiative. Built using green cement and other sustainable products, the school minimises resource consumption in a number of ways, including tapping natural daylight with sunpipes and maximising natural ventilation with advanced ventilation simulation software, widened windows with louvered openings, and north-south orientation of windows for maximum air circulation. Besides having resource-efficient installations, such as LED and T5 lighting, photosensors, motion sensors and water-efficient fittings, the school is outfitted with a photovoltaic system on its rooftop to generate renewable energy.

### CREST SECONDARY SCHOOL

Green Mark Platinum Award 2013

#### **Client / Developer** Ministry of Education

of Singapore

Architect CPG Consultants Pte Ltd

M&E Engineer AECOM Singapore Pte Ltd

Structural Engineer Aurecon Singapore (Pte) Ltd Quantity Surveyor Barton Bruce Shaw Pte Ltd

Main Contractor Santarli Construction Pte Ltd

ESD Consultant / ESCO CPGreen – CPG Consultants Pte Ltd



### **Chapter Nine: Greening from Within**

# **1ST PEARL PRESTIGE WINNER**

#### **CITY HOUSE**

Green Mark Gold Award 2008 /2011 Green Mark Platinum Award 2014 Green Mark Pearl Prestige Award 2015

#### **Client / Developer** City Developments

Limited ESD Consultant / ESCO

CBM Solutions Pte Ltd

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#### Green Mark Platinum building, with Green Mark certified office space

City House, a development of City Developments Limited (CDL), is a pioneering example of how building owners and tenants could collaborate to achieve sustainability goals. CDL has rolled out engagement initiatives, such as Project: Eco-Office, the "1°C Up" Programme and green fitting-out kits to encourage and enable tenants to be part of its sustainability endeavours. City House achieved Green Mark Platinum for its base building and 70 per cent of the nett lettable area is also Green Mark-certified under the Green Mark for Office Interior scheme. For this outstanding achievement, CDL became the first winner of Green Mark Pearl Prestige Award in 2015. The award recognises the strong commitment of building owners and tenants of the same development working in tandem to achieve positive outcomes in total building performance by looking at both the base building and tenanted spaces, operational practices as well as user behaviour.





# Find the second second

Several energy-saving installations have been retrofitted to lower energy consumption in City House, including an energy-efficient chiller plant, lightings and high-frequency ballasts. The air handling unit (AHU) rooms are fitted with carbon dioxide sensors for more efficient air-conditioning. CDL's various green strategies help City House save about 1.9 million kWh of energy a year, translating to about S\$500,000. Taking the lead in greening the building's interiors, CDL's offices within City House have attained the Green Mark for Office Interior certification.

### **Chapter Nine: Greening from Within**

"At CDL, we believe that the real estate sector can and must play a significant role in sustainable development. As a major developer in Singapore, we recognise our unique position and the opportunity it affords us to encourage greater environmental and social stewardship amongst stakeholders and our supply chain. Since 1995, 'Conserve as we Construct' became our ethos and we embraced a holistic life-cycle approach towards sustainability. Beyond developing dynamic green buildings and managing them sustainably, we actively engage our building users to achieve greater environmental sustainability."

Mr Kwek Leng Joo Deputy Chairman City Developments Limited

#### Engaging tenants through Green Lease Partnership programme

CDL proactively engages its tenants and encourages them to play a more active role in Singapore's sustainability agenda. As of May 2015, more than 80 per cent of the tenants have joined the CDL Green Lease Partnership programme introduced in 2014. They have signed the CDL Green Lease Memorandum of Understanding, pledging to monitor and reduce energy consumption of their occupied spaces.

Taking the lead in greening the building's interiors, CDL's offices within City House have attained the Green Mark for Office Interior certification.





# BEBR\* TOP 10 COMMERCIAL BUILDINGS (2014 & 2015)

MAPLETREE BUSINESS CITY Green Mark Platinum Award 2009 / 2013

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#### One of the lowest Energy Usage Index (EUI) for commercial buildings

Mapletree Business City boasts an extensive list of green features demonstrated by the physical structures, including the façades and landscaping; systems and fittings for energy and water efficiency; as well as the harvesting and recycling of otherwise wasted resources. Most notably, Mapletree issues every tenant a set of interior fit-out and operational guidelines that complies with the Green Mark Office Interior criteria, motivating them to go green as a collective effort towards sustainability. With 12 Green Mark projects rated Gold and above, Mapletree Investments, which owns Mapletree Business City, emerges as the Green Mark Champion Award winner in 2015. Harvesting the fruits of its labour, the company saves more than 53 million kWh of energy annually.

Client / Developer Mapletree Investments Pte Ltd

ESD Consultant / ESCO Building System & Diagnostics Pte Ltd

Facility Management Mapletree Business City Pte Ltd

#### Realising Singapore's Green Building Dream

### **Chapter Nine: Greening from Within**



# 1ST PEARL AWARD WINNER

A Green Mark Platinum (office interior) development

The DNV GL Technology Centre used a high proportion of green construction materials certified by the Singapore Green Building Council and Singapore Environment Council. They also adopted a green demolition protocol to recycle crushed concrete waste at a recovery rate of 39 per cent. High thermal performance double-glazed low-emissivity glass was used to minimise solar heat gain and a green roof was provided to further reduce cooling load. Ascendas Land, which developed DNV GL Technology Centre, has been steadfast in delivering sustainable business space, especially through partnership with its customers, and the building became one of the first winners of the Green Mark Pearl Award in 2015. This award compliments both the developer and tenants of the same development for jointly collaborating to meet sustainability goals.

DNV GL TECHNOLOGY CENTRE Green Mark Gold<sup>Plus</sup> Award 2013

Client / Developer Ascendas Land (S) Pte Ltd

Architect

DCA Architects Pte Ltd M&E Engineer Parsons Brinckerhoff

Pte Ltd
Structural Engineer

T.Y. Lin International Pte Ltd **Quantity Surveyor** Northcroft Lim Consultants Pte Ltd

Main Contractor Lum Chang Building Contractors Pte Ltd







# **1ST GREEN LEASE BUILDING**

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#### Helping tenants go green with regulations and a technical guide

313@Somerset is the first building in Singapore to implement a green lease, coupled with incentive schemes, to encourage its tenants to go green. The Centre Management House Rules, spelt out in the green lease, specify the developer's sustainability initiatives governing the tenants' daily operations, while the Technical Design Guidelines provide the tenants with information on how to fit out and operate sustainably at their tenanted spaces. Ventilation technologies, such as heat recovery wheels, jet fans as well as carbon dioxide and carbon monoxide sensors are used in 313@Somerset to improve the conventional ventilation design. Other green practices include recycling waste cooking oil, harvesting solar energy, and recovering waste heat to produce hot water.

#### 313@SOMERSET

Green Mark Platinum Award 2008 / 2013

**Client / Developer** Lendlease and its managed fund, Asian Retail Investment Fund

Facility Management Lendlease

M&E engineer Bescon Consulting Engineers Pte Ltd Quantity Surveyor WT Partnership (S) Pte Ltd

Main Contractor Lendlease



### **Chapter Nine: Greening from Within**

# 1ST GREEN MARK PLATINUM OFFICE INTERIOR

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#### An office space equipped with energy- and water-efficient fittings and green furnishings

The office interiors are outfitted with LED lighting and motion sensors, while photosensors line the building's perimeter to allow for adjustments to the amount of artificial lighting used. To save energy on air-conditioning, the office spaces are zoned for temperature control to efficiently cool only where it is necessary. These two levels in the building are also equipped with water-efficient fittings, and rainwater and reclaimed water, NEWater, are used for toilet flushing. Furthermore, the system furniture is made up of more than 30 per cent recycled materials, while the carpets, laminates, waterproofing system, vinyl flooring and dry-wall partitions used are certified green.

Green Mark Platinum Award 2011

**CREDIT SUISSE REGIONAL** 

DATA CENTRE - LEVEL 2 &

Client / Developer Credit Suisse AG

**3 OFFICES** 

Architect AWP Pte Ltd

M&E Engineer J Roger Preston (S) Pte Ltd Main Contractor AWP Pte Ltd

ESD Consultant / ESCO Kaer Pte Ltd

Facilities Management Credit Suisse AG





# **1ST GREEN MARK PLATINUM NEW DATA CENTRE**



# Reducing chemical waste with flywheel-powered dynamic rotary uninterruptible power supply

With data centres contributing to nearly 4 per cent of Singapore's total electricity consumption, ensuring the energy efficiency of such facilities has become imperative to reducing carbon footprint. Keppel Datahub 2 is designed to be operated using flywheel-powered dynamic rotary uninterruptible power supply instead of battery-run uninterruptible power systems to reduce chemical waste. Built extensively with sustainable materials, the data centre adopts the cold and hot air containment method to ensure efficient cooling and uses motion sensors and zoning control to maintain low-energy consumption.



**KEPPEL DATAHUB 2** Green Mark Platinum Award 2014

Client / Developer Keppel Datahub 2 Pte Ltd

Architect BK Consulting Engineers Pte Ltd

**M&E Engineer** Plan-One Engineering Services **Structural Engineer** BK Consulting Engineers Pte Ltd

Main Contractor Acme Associates Pte Ltd

ESD Consultant / ESCO Building System & Diagnostics Pte Ltd



### **Chapter Ten: Bringing Everyone Together**

# **1ST ONE-STOP ECO-FRIENDLY LIFESTYLE HUB**

#### KAMPUNG ADMIRALTY

Green Mark Platinum Award 2015

Client / Developer Housing & Development Board of Singapore

Architect WOHA Architects Pte Ltd

M&E Engineer AECOM Singapore Pte Ltd

**Structural Engineer** Ronnie & Koh Consultants Pte Ltd **Quantity Surveyor** Davis Langdon KPK (Singapore) Pte Ltd

Main Contractor Lum Chang Building Contractors Pte Ltd

ESD Consultant / ESCO AECOM Singapore Pte Ltd

#### Experiencing green living

Kampung Admiralty offers an array of eco-features which tap on renewable resources for energy and water efficiency. The new features include motion sensor controlled energy efficient lighting, solar panels to harness solar energy, bioswales for treating and harvesting rainwater for irrigation. It will also have a pneumatic waste collection system for clean and fuss-free waste disposal.

Through these initiatives, residents can get to enjoy clean, green and sustainable living.





# Integrated multi-agency development

The first Integrated Development and one-stop hub of its kind, Kampung Admiralty is developed by HDB, in partnership with agencies such as the Alexandra Health System, National Environment Agency, National Parks Board, Land Transport Authority, Early Childhood Development Agency, Ministry of Health and Ministry of Social and Family Development. The development encourages social interaction and active living for its residents and the local community through its innovative design, communal spaces and sustainable features.

Zoned into three tiers, it will complement the residential apartments with communal facilities, green spaces, healthcare, childcare and eldercare amenities, retail and dining facilities, and basement car parks. Slated for completion in 2017, the development is an interpretation of urban living with integrated facilities, materialised through innovative land use.

#### Realising Singapore's Green Building Dream

### **Chapter Ten: Bringing Everyone Together**



"HDB has been designing spaces that encourage social interaction and active living. We took on the master developer role for Kampung Admiralty to integrate facilities in a single development, and drew up a blueprint with cohesive living in mind."

Mr Yap Chin Beng Deputy Chief Executive Officer (Estate & Corporate) Housing & Development Board

# Reigniting the kampung spirit

Kampung Admiralty was designed with the community in mind. The concept evokes the kampung spirit of yesteryear. The concentration of amenities within a community, particularly green spaces and communal facilities, creates more opportunities for residents to meet and interact, fostering stronger community bonding. The abundant greenery, community farm and herb garden interspersed throughout the development provide residents with options to live near lush greenery, which creates a soothing environment for all.

# **1ST GREEN HERITAGE-THEMED CIVIC CENTRE**

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### A culturally distinctive and inclusive multi-agency development that celebrates the heritage of Geylang Serai

Wisma Geylang Serai (WGS) is envisioned to be the community-social, civic and cultural heart of the Geylang Serai precinct. WGS aims to celebrate the heritage of Geylang Serai and all other local community, encouraging social interaction and community bonding among all ages and races. It will house the Geylang Serai Community Club, the South East Community Development Council, a Malay Heritage Gallery, arts and social/community-related facilities, and is scheduled to be ready in 2017/2018. Within WGS, there will be public spaces, a plaza and a comprehensive pedestrian network that will enhance accessibility and connectivity to other developments in the precinct, bringing the wide range of facilities and services in WGS to the community. This development is a collaborative effort of the People's Association, Ministry of Social and Family Development, Ministry of Health, National Arts Council, National Heritage Board and Ministry of National Development.

#### WISMA GEYLANG SERAI

Targeting for Green Mark Platinum Award

#### Client / Developer People's Association

Architect Design-Environment Group Architects LLP

M&E Engineer Rankine & Hill (S) Pte Ltd

Structural Engineer ECAS-EJ Consultants Pte Ltd **Quantity Surveyor** Franklin + Andrews Pte Ltd

ESD Consultant / ESCO Building System & Diagnostics Pte Ltd



#### Realising Singapore's Green Building Dream

### **Chapter Ten: Bringing Everyone Together**



# A GREEN TOTAL WELLNESS – FAMILY LIFESTYLE HUB

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# Promoting social, mental and physical well-being to residents of all ages

The Bedok Integrated Complex is a community development described as the Total Wellness – Family Lifestyle Hub, which targets to open its doors to users in 2017. Visitors will be able to access numerous amenities, including a community club, a library, a sports centre, a polyclinic and a healthcare centre for the elderly. This development aims to promote social, mental and physical wellness through facilities and programmes that cater to residents of all ages. The project is a multi-agency collaboration among the People's Association, National Library Board, SingHealth Polyclinics, Ministry of Health and Sport Singapore.

#### BEDOK INTEGRATED COMPLEX

Targeting for Green Mark Platinum Award

#### Client / Developer People's Association

Architect Ong&Ong Pte Ltd

M&E Engineer Rankine & Hill (S) Pte Ltd

**Structural Engineer** KTP Consultants Pte Ltd

Quantity Surveyor Langdon & Seah Singapore Pte Ltd

#### Main Contractor

Kim Seng Heng Engineering Construction Pte Ltd

ESD Consultant / ESCO Building System and Diagnostics Pte Ltd

# **1ST GREEN MARK AIRPORT**

#### Sporting a 300-metre-wide, five-storey-high vertical garden with more than 10,000 plants

Changi Airport Terminal 3 sports a one-of-its-kind roof that features 919 skylights double-glazed low-emissivity low iron glass that rejects heat while providing natural daylight spectrum indoor. Together with the automatically controlled louvre system, this daylighting system also eliminates glare and thermal discomfort. Terminal 3's west-facing façade is also integrated with a louvre sunshade system to provide added shelter from direct sunlight and glare into the building. Air-conditioning distribution for Terminal 3 departure hall is diffused at level close to the occupied zones by jet diffusers. The resulting stratification avoids the cooling of the upper unoccupied space and helps in saving energy. Another of the terminal's highlights is its huge vertical garden, which spans 300 metres wide and reaches a height of five storeys, displaying more than 10,000 plants and 25 species of climbers.





CHANGI AIRPORT **TERMINAL 3** Green Mark Gold Award 2009

Client / Developer Changi Airport Group (Singapore) Pte Ltd

CPG Consultants Pte Ltd

Structural Engineer CPG Consultants Pte Ltd

Architect

M&E Engineer

Quantity Surveyor CPG Consultants Pte Ltd Main Contractor

Shimizu Corporation CPG Consultants Pte Ltd

Facility Management Changi Airport Group (Singapore) Pte Ltd

### Closure

# MOVING FORWARD

#### Key takeaways over the decade

Since the implementation of the Green Mark scheme, there has been a transformational paradigm shift in the design, construction, operation and maintenance of buildings. Environmental sustainability has become more prevalent in the industry.

One significant validation has been the strong business case for energy efficient retrofitting works for existing buildings. A study of 83 retrofitted Green Mark existing buildings showed an average of **42 per cent** improvement of chiller-plant efficiency from 1.1 kW/RT to 0.64 kW/RT. This translated to about S\$41 million energy savings annually, significant when considering we have a pool of more than one thousand commercial buildings. There is now greater awareness on the importance and impact of cooling systems on overall performance as significant savings can be reaped with better design, operation and maintenance.

As Singapore continues to develop while moving towards becoming a City in a Garden, there could be potential competition. Buildings that are Green Mark certified have to minimally replace any greenery displaced during development. In the process, a notable achievement in Green Mark buildings has seen an **average greenery replacement of more than two times the site area.**  With a long-term goal of achieving "net positive energy low-rise buildings and low energy high-rise buildings in the tropics", solar energy is recognised as a key enabler to achieve this goal. The Green Mark Scheme has played a key role in propelling solar PV installations. As at 2014, solar PV systems designed for and installed in Green Mark projects **accounted for about half of Singapore's grid-connected installed capacity of around 15 MWp.** 

#### Green Mark 2015

Under the 3rd Green Building Masterplan launched in 2014, BCA is setting an ambitious vision of becoming "a global leader in green buildings with special expertise in the tropics and sub-tropics, enabling sustainable development and quality living".

In support of this vision, we are rolling out the BCA **Green Mark 2015** to elevate environmental sustainability to the next level. The new scheme will play a more prominent role in driving sustainability outcomes that address climate change. It will make mainstream the 'leadership' required to drive improvements to the overall environmental credentials of projects for better business sustainability reporting.

The revised criteria will cover four broad sections. **Climate Responsiveness** focuses on ensuring building designs are optimised for the site and its climatic conditions. **Resource Stewardship**  focuses on optimising or minimising resource consumption throughout a building's lifecycle. **Conservation of Ecological Systems** will identify the measures for conserving eco-systems and preserving abiotic cycles. Lastly, **Health & Wellbeing** ensures that the building systems and operations will take care of the well-being of the occupants.

These improvements will position the BCA Green Mark Scheme as the leading green-building rating tool of choice in the tropics and sub-tropics, centred on climate responsiveness, energy effectiveness, user-centricity, smarter buildings and greater solar photovoltaic adoption.

#### Smart and green buildings

As Singapore embarks to become the world's first Smart Nation, BCA will support this whole-of-government, whole-of-nation effort. **Smarter buildings can lead to greener and healthier living environments.** Technology can help to optimise

efficiency, thereby saving energy, enhancing indoor environmental quality and improving thermal comfort.

#### Next phase of our journey

We welcome you to join us on the next phase of our journey. Be a part of an exciting decade ahead to bring about significant impact to shape our built environment for the next generation and beyond.

The Building and Construction Authority (BCA) would like to express our gratitude to everyone who has been supportive of our continuous efforts to promote environmental sustainability in the built environment. The BCA Green Mark has played a key role in transforming the industry throughout this decade of sustainability that we are celebrating. Without the strong commitment from the industry stakeholders and close coordination across the whole-of-government, we would not have been able to achieve so much.

Through this commemorative book, we showcase the buildings that are symbolic in this journey and extend our heartfelt thanks to the various stakeholders for their contributions in making this publication possible.

#### Advisory Committees and Panels

#### International Panel of Experts on Sustainability of the Built Environment (IPE-SBE)

IPE-SBE 2013-2015

#### **CO-CHAIRS**

**Dr John Keung Kam Yin** *Chief Executive Officer* Building and Construction Authority

**Er Lee Chuan Seng** *Emeritus Chairman* Beca Asia Holdings Pte Ltd

#### INTERNATIONAL EXPERTS

Mr Brian Castelli Chief Executive Officer and President Home Performance Coalition

**Mr Jens Lausten** *Founder and Director* 2peach

**Ms Maria Atkinson** *Director* XO Pte Ltd

Mr Stephen E. Selkowitz Senior Advisor to the Division Director, Building Science, Group Leader, Windows and Envelope Materials Lawrence Berkeley National Laboratory Dr Yamina Saheb Policy and Scientific Officer Joint Research Centre, European Commission

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Mr David Tan Assistant Chief Executive Officer, Development Group JTC Corporation

Mr Kenneth Foo Head of Building Operations, Property Management Hongkong Land

Mr Lim Tow Fok General Manager, Property Management & Knowledge Management Keppel Land International Limited

#### Prof Raymond Wong

Senior Research Fellow and Associate Professor, Division of Thermal and Fluids Engineering, School of Mechanical & Aerospace Engineering & Energy Research Institute Nanyang Technological University Dr Uma Maheswaran Chief Executive Officer (India) & Senior Vice President (Sustainable Urban Solutions, Singapore) Jurong Consultants Pte Ltd

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#### CHAIRMAN

**Er Lam Siew Wah** Deputy Chief Executive Officer, Industry Development Building and Construction Authority

#### CO-CHAIR

**Mr Tai Lee Siang** *Vice-Chair* World Green Building Council

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Mr Heng Whoo Kiat Deputy Director, Licensing Unit Council of Estate Agents

Dr Ho Nyok Yong President The Singapore Contractors Association Ltd

Dr Johnny Wong Group Director, HDB Building Research Institute Housing & Development Board

Mr Koh Chwee Director, Development Group, Technical Services Division JTC Corporation

Mr Lim Fatt Seng Director, EnergyConservation.sg Comfort Management Pte Ltd

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Mr Tan Siong Leng Former Deputy Chief Executive Officer Urban Redevelopment Authority

Mr Theodore Chan Immediate Past President Singapore Institute of Architects

**Er Tony Tay Chye Teck** *Director and General Manager* Parsons Brinckerhoff Pte Ltd

**Mr Vincent Low** *Vice President* G-Energy Global Pte Ltd Mr Wong Kang Jet Director (Social), Strategy Group Prime Minister's Office

#### Green Mark Advisory Committee (GMAC)

#### CHAIRMAN

**Er Lee Chuan Seng** *Emeritus Chairman* Beca Asia Holdings Pte Ltd

#### **DY CO-CHAIRS**

Prof Heng Chye Kiang Professor and Dean, School of Design and Environment National University of Singapore

**Er Lam Siew Wah** Deputy Chief Executive Officer (Industry Development) Building and Construction Authority

#### MEMBERS

Mr Allen Ang Deputy General Manager, Projects and Head, Green Building City Developments Limited

Mr Johnny Wong Group Director, Building Research Institute Housing & Development Board Prof Lee Siew Eang Professor, Department of Building School of Design & Built Environment National University of Singapore

Mr Lim Fatt Seng Director Comfort Management Pte Ltd

Mr Lim Tow Fok General Manager, Property Management & Knowledge Management Keppel Land International Limited

**Mr Poon Hin Kong** *Chief of Design Review Unit* CapitaLand Limited

Mr Ram Bhaskar Director, Energy Efficiency and Conservation Department, Environmental Protection Division National Environment Agency

Prof Raymond Wong Senior Research Fellow and Associate Professor, Division of Thermal and Fluids Engineering, School of Mechanical & Aerospace Engineering & Energy Research Institute Nanyang Technological University

Mr Tang Kok Thye Associate Partner ADDP Architects LLP **Mr Theodore Chan** *Partner* CIAP Architects Pte Ltd

**Mr Tony Khoo** *Chief Executive Officer* EM Services Pte Ltd

**Mr Tony Tay** *Director and General Manager* Parsons Brinckerhoff Pte Ltd

**Mr Vincent Han** *Owner* Vincent Han & Associates

Mr Vincent Low Vice President G-Energy Global Pte Ltd

#### Green Mark Champions

BCA GREEN MARK PLATINUM CHAMPION AWARD

City Developments Limited

#### BCA GREEN MARK CHAMPION AWARD

Ascendas CapitaLand Group Housing & Development Board JTC Corporation Keppel Land Limited National University of Singapore Nanyang Technological University Mapletree Investments Pte Ltd

#### Green Building Individual Award (GBIA)

#### Year 2011

#### GREEN ADVOCATE OF THE YEAR

#### Mr Allen Ang

Deputy General Manager, Projects and Head, Green Building City Developments Limited

#### GREEN ENGINEER OF THE YEAR

**Er Tan Kiat Leong** *Executive Director* Beca Carter Hollings & Ferner (S.E. Asia) Pte Ltd

#### GREEN ARCHITECT OF THE YEAR

Mdm Vivien Heng Director RSP Architects Planners & Engineers (Pte) Ltd

#### GREEN INNOVATOR OF THE YEAR

**Dr Ho Nyok Yong** *Chief Operating Officer* Samwoh Corporation Pte Ltd

#### Year 2012

#### GREEN ADVOCATE OF THE YEAR

Mr Eugene Seah Group Managing Director Langdon & Seah Singapore Pte Ltd

Mr Tan Phay Ping Managing Director Building System and Diagnostics Pte Ltd

#### GREEN ARCHITECT OF THE YEAR

Mr Tang Kok Thye Associate Partner ADDP Architects LLP

#### GREEN INNOVATOR OF THE YEAR

Er Tay Cher Seng Managing Director Natflow Pte Ltd

#### Year 2013

#### GREEN ADVOCATE OF THE YEAR

Mr Mann Young Head of CLT Business, Asia Lend Lease Asia Holdings Pte Ltd

#### GREEN ENGINEER OF THE YEAR

**Er Russell Cole** *Director* Arup Singapore Pte Ltd

#### YOUNG GBIA OF THE YEAR

**Dr Kelvin Lee** Senior Technical Manager Samwoh Corporation Pte Ltd

Dr Uma Maheswaran Chief Executive Officer (India) and Vice President (Sustainable Design) Jurong Consultants Pte Ltd

#### COMMENDATION AWARD

**Ms Jaye Tan** *Principal Architect* Studio Green Architect

Mr Jerry Ong Senior Vice President (Architecture) CPG Consultants Pte Ltd

**Mr Owen Wee** *Vice President (Architecture)* Surbana Jurong Pte Ltd

**Er Teh Poh Suan** Director, Building Research Housing & Development Board

#### Year 2014

#### GREEN ADVOCATE OF THE YEAR

**Mr Vincent Low** *Vice-President* G-Energy Global Pte Ltd

#### YOUNG GREEN ADVOCATE OF THE YEAR

**Mr Jason Pomeroy** *Principal* Pomeroy Studio

#### GREEN ARCHITECT OF THE YEAR

Mr Alan Tan Director, Environmental Sustainability Research Housing & Development Board

#### GREEN ARCHITECT OF THE YEAR

Mr Tan Shao Yen Managing Director CPG Consultants Pte Ltd

GREEN ENGINEER OF THE YEAR

**Er Patrick Foong** *Managing Director* e2green Pte Ltd

#### GREEN INNOVATOR OF THE YEAR

Dr Sujit Ghosh Chief Executive Officer Holcim Limited

#### GREEN FACILITIES MANAGER OF THE YEAR

Mr Anthony Goh Senior Vice President of Property and Facilities Management City Developments Limited

#### GREEN FACILITIES MANAGER OF THE YEAR

Mr Lim Tow Fok General Manager of Property Management & Knowledge Management Keppel Land International Limited

#### COMMENDATION AWARD

Er Lee Boon Woei Director (Environmentally Sustainable Design) DP Architects Pte Ltd

**Mr Martin Gui** *Managing Director* Facility Link Pte Ltd

**Dr Ng Khee Yang** *Managing Director* ECO-Applications Pte Ltd **Er Richard Phua** *Associate Director* Squire Mech Pte Ltd

#### Year 2015

GREEN VISIONARY AWARD

**Er Lee Chuan Seng** *Emeritus Chairman* Beca Asia Holdings Pte Ltd

GREEN VISIONARY AWARD

**Mr Kwek Leng Joo** *Deputy Chairman* City Developments Limited

#### GREEN ARCHITECT LIFETIME ACHIEVEMENT AWARD

Dr Kenneth Yeang Principal T. R. Hamzah & Yeang Sdn Bhd

#### GREEN INNOVATOR LIFETIME ACHIEVEMENT AWARD

Mr Lee Eng Lock Vice Chairman Measurement & Verification Pte Ltd

#### GREEN ADVOCATE AWARD

**Ms Farizan d'Avezac de Moran** *Senior Partner* GreenA Consultants Pte Ltd

#### YOUNG GBIA - GREEN ADVOCATE AWARD

**Mr Sam Tan** *Group Managing Director* KEN Holdings Bhd

#### YOUNG GBIA - GREEN ARCHITECT AWARD

Mr Tan Szue Hann Deputy Head (Sustainable Urban Solutions) & Principal Architect Surbana Jurong Pte Ltd

#### YOUNG GBIA - GREEN INNOVATOR AWARD

Dr Shah Kwok Wei Assistant Director, Department of Building, School of Design and Environment National University of Singapore

Deputy Head, Institute of Materials Research and Engineering Agency for Science, Technology and Research

#### **COMMENDATION AWARD**

Er Alfred Lim Vice President and Head (Property Services) CapitaLand Singapore Ltd

Mr Koh Kok Sin Director (Organisation Development) NTUC Fairprice Co-operative Ltd

**Mr Paul Lau** *General Manager (Projects)* Keppel Land Limited

**Er Tang Pei Luen** Asst Chief Structural Engineer JTC Corporation

**Mr Wu Tzu Chiang** *Director* DP Architects Pte Ltd

**Er Yong Siew Onn** Associate Director DP Engineers Pte Ltd

#### **Other Project Partners**

#### **Chapter One**

#### NATIONAL LIBRARY BUILDING

**Project Manager** Rider Levett Bucknall LLP

Landscape Consultant DLQ Design Pte Ltd

#### CITY SQUARE MALL

Landscape Consultant Ong&Ong Pte Ltd

Solar Study CPG Corporation Pte Ltd

**Energy Consultant** G-Energy Global Pte Ltd

Traffic Consultant MWH Consultants (Singapore) Pte Ltd

#### NORTH BRIDGE CENTRE

**ESCO** G-Energy Global Pte Ltd

#### SIX BATTERY ROAD

Interior Design Consultant Eco-ID Design Consultancy Pte Ltd

#### MINISTRY OF MANPOWER HEADQUARTERS

Energy Consultant Honeywell Pte Ltd

#### **Chapter Two**

#### **CAPITAGREEN**

Project Manager CapitaLand

Landscape Consultant Sitetectonix Pte Ltd

Lighting Consultant Lighting Planners Associates (S) Pte Ltd

Façade Consultant Arup Singapore Pte Ltd

Acoustics Consultant Arup Singapore Pte Ltd

Vertical Transportation Consultant Arup Singapore Pte Ltd **Typical Office-levels Interior Consultant** Mitsubishi Jisho Sekkei Inc

Signage Consultant Square Peg Design Asia Pte Ltd

#### THE STAR

Landscape Consultant ICN Design International Pte Ltd

Environmental Arup Singapore Pte Ltd

Lighting Planners Associates Inc

#### SAMWOH ECO-GREEN BUILDING

Landscape Consultant Nature Landscapes

#### **Chapter Three**

#### **TSAO RESIDENCE**

Landscape Consultant BHNA Pte Ltd Zero Energy Building @ BCA Academy

Project Manager Beca Carter Hollings & Ferner (S.E. Asia) Pte Ltd

#### ZERO ENERGY BUILDING @ BCA ACADEMY

Project Manager Beca Carter Hollings & Ferner (S.E. Asia) Pte Ltd

#### 11 TAMPINES CONCOURSE

Landscape Consultant COEN International Consultants

Others The CarbonNeutral Company

#### ST DIAMOND BUILDING

Project Manager Senandung Budiman Sdn. Bhd.

Landscape Consultant KRB Enviro Design Sdn. Bhd.

Interior Design NR Interior Design

Planner GDP Planners Sdn. Bhd.

Sustainability Consultant Ecosys Co. Ltd Thailand IEN Consultants Sdn. Bhd.

#### SINO-SINGAPORE TIANJIN ECO-CITY LOW CARBON LIVING LAB

Landscape Consultant Tianjin Yalan Landscape Design Engineering Co., Ltd

#### **Chapter Four**

#### PARKROYAL ON PICKERING

Landscape Consultant Tierra Design (Singapore) Pte Ltd

Acoustic Consultant CCW Associates Pte Ltd

Lighting Consultant LPA Lighting Planners Associates Inc

Façade Consultant Meinhardt Façade Technology (Singapore) Pte Ltd

#### OCEAN FINANCIAL CENTRE

**Project Manager** Keppel Land International Limited

Façade Consultant ALT Cladding, Inc, (Access & Maintenance), Mr Lee Herzog

Wind Tunnelling Consultant WindTech Consultants Acoustic Consultant Acviron Acoustics Consultants Pte Ltd

Green Mark & Energy Consultant G-Energy Global Pte Ltd

Landscape Consultant Tierra Design (S) Pte Ltd

Architectural Lighting Consultant Parsons Brinckerhoff Pte Ltd Lighting Planners Associates Inc.

Energy & Green Mark Consultant G-Energy Global Pte Ltd

Façade Access Consultant Lerch Bates – Façade Access

Wind Engineer Services Consultant WindTech Consultants Pty Ltd

#### ITE HEADQUARTERS & ITE COLLEGE CENTRAL

Landscape Consultant Grant Associates

Acoustic Consultant Acviron Acoustics Consultants Pte Ltd

#### TREE HOUSE

Landscape Consultant COEN Design International Pte Ltd

#### **Chapter Five**

#### KHOO TECK PUAT HOSPITAL

Project Manager PM Link Pte Ltd

Landscape Consultant Peridian

Others Total Building Performance Team (NUS)

#### PASIR RIS SPORTS CENTRE

Landscape Consultant CPG Consultants Pte Ltd

#### NG TENG FONG GENERAL HOSPITAL & JURONG COMMUNITY HOSPITAL

Project Manager PM Link Pte Ltd

Landscape Consultant Peridian Asia Pte Ltd

Façade Consultant Building Façade Group

Acoustic Consultant ZEB Technology Pte Ltd

**TBP and Green Mark Consultant** ZEB Technology Pte Ltd

#### Security Consultant STET Homeland Security Services

Pte Ltd

Design Consultant Studio 505

Hospital Planning Consultant

Interior Design Bent Severin & Associates Pte Ltd

#### TREELODGE @ PUNGGOL

Landscape Consultant Surbana International Consultants Pte Ltd

#### **Chapter Six**

#### NTUC FAIRPRICE SUPERMARKETS

M&E Contractor Victor Engineering & Trading Pte Ltd

Refrigeration Contractor VSD Engineering Enterprises Pte Ltd

Refrigeration Engineer VSD Engineering Enterprises Pte Ltd

#### McDONALD'S RESTAURANTS

Landscape Consultant Ong&Ong Pte Ltd Plantwerkz Pte Ltd

#### PARKWAY PARADE

Landscape Consultant Exklusive Landscape Pte Ltd

Energy Consultant UGL Premas

#### **Chapter Seven**

#### **RIVER SAFARI**

**Project Manager** Wildlife Reserves Singapore

Landscape Consultant Wildlife Reserves Singapore

#### GARDENS BY THE BAY

Park Manager Gardens by the Bay

Landscape Consultant Grant Associates

Design Wilkinson Eyre Architects

Green Mark CPGreen@CPG Consultants

Irrigation Specialist Water Equipment Technology Signage Thomas Matthews CPG Consultants

Interpretive Media Land Design Studio

**Façade** Arup Facade Engineering

Fire ArupFire @ Arup Singapore Pte Ltd

Acoustic Specialist VIPAC Engineers & Scientists Pte Ltd

Climate TRANSSOLAR Energietechnik GmbH Stuttgart Munich New York

Water Specialist Cardno Lawson Treloar

#### RESORTS WORLD SENTOSA

Landscape Consultant ICN Design International

Lighting Consultant Light Cibles

Acoustic Consultant Acviron Accoustics Consultants Pte Ltd

#### MARINA BARRAGE

Main Consultant Camp Dresser & Mckee International (S) Pte Ltd

#### W SINGAPORE - SENTOSA COVE

Project Manager City Developments Limited

Landscape Consultant Cicada Private Limited

Acoustic Consultants Aviron Acoustic Consultants Pte Ltd

Lighting Consultant Light Cibles

#### **Chapter Eight**

#### NUS UNIVERSITY TOWN

Landscape Consultant Sitetectonix Pte Ltd

Lighting Consultant Bo Steiber Lighting Design

Acoustic Consultant Acviron Accoustics Consultants Pte Ltd

Green Consultant Arboculture Pte Ltd

#### VENTUS

Project Manager NUS Office of Estate and Development

Landscape Consultant ICN Design International Pte Ltd

Acoustic Consultant Arup Singapore Pte Ltd

#### THE HIVE (SOUTH SPINE LEARNING HUB)

**Design Consultant** Heatherwick Studio Pte

Landscape Consultant Perfect Sense

**PDV Consultant** ME(TCS) Consulting Engineers

Fire Consultant LKH Fire Engineering Pte Ltd

Acoustic Consultant CCW Associates Pte Ltd

#### CREST SECONDARY SCHOOL

**Project Manager** Parsons Brinckerhoff Pte Ltd

#### **Chapter Nine**

#### **CITY HOUSE**

Others CBM Pte Ltd (Engineering)

#### MAPLETREE BUSINESS CITY

IAQ Auditor TÜV SÜD PSB Pte Ltd

#### DNV GL TECHNOLOGY CENTRE

#### **Chapter Ten**

#### Landscape Consultant ICN Design International Pte Ltd

#### 313@SOMERSET

D&C Contractor Bovis Lend Lease Pte Ltd

Energy, Wind & Sun Consultant Building Systems & Diagnostics Pte Ltd

Carbon Management Consultant Battle McCarthy, DCarbon8

**Lighting Consultant** Speirs & Major Associates

#### CREDIT SUISSE REGIONAL DATA CENTRE - LEVEL 2 & 3 OFFICES

Project Manager Confluence Project Management Pte Ltd

Managing Agent Jardine Engineering (S) Pte Ltd

#### KAMPUNG ADMIRALTY

#### Landscape Consultant

Atelier Dreiseitl Asia Pte Ltd

Fire Safety Engineer AECOM Singapore Pte Ltd

# BEDOK INTEGRATED COMPLEX

Project Manager Arcadis Project Management Pte Ltd

#### CHANGI AIRPORT TERMINAL 3

Landscape Consultant Tierra Design (S) Pte Ltd

