Sustainable Architecture

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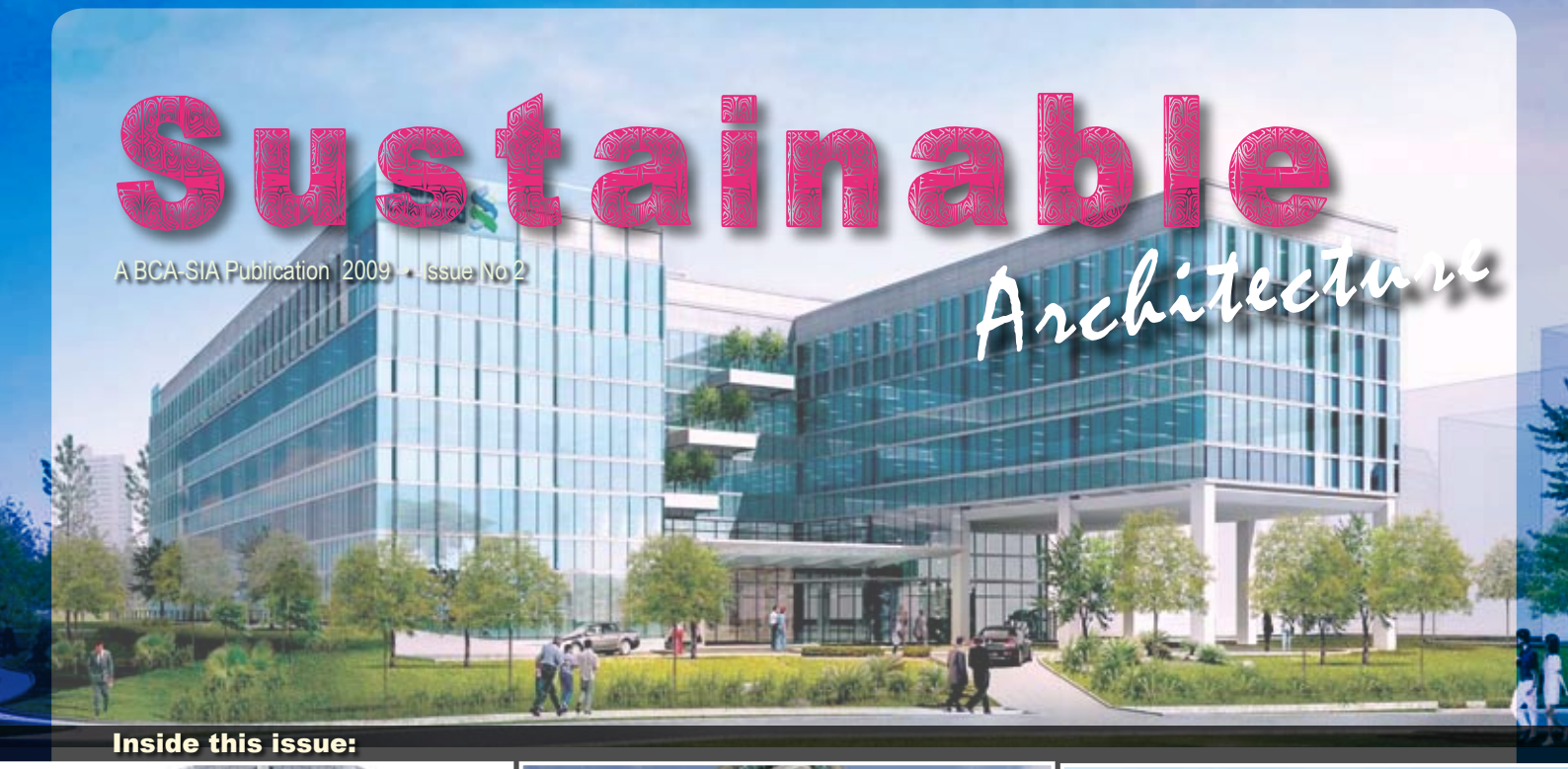

Inside this issue:

Build Green. The future is now.

This is the theme of the inaugural International Green Building Conference (IGBC), a three-day conference organised by the Building and Construction Authority and held alongside BEX Asia 2009. Together, both events will gather industry experts and stakeholders from all over world to discuss and focus on green issues concerning the industry, with an emphasis on green building technologies and designs. On behalf of the editorial team, I would like to welcome all international delegates, exhibitors and participants who have come to join us at this milestone event.

In similar fashion, we will also showcase in this issue of Sustainable Architecture, a collection of some of the green building technologies successfully adopted in existing buildings.

We speak with Mr Steve Riley, Project Director at Standard Chartered Bank (SCB) about its green bank office at Changi Business Park. The SCB development incorporates extensive green features such as self-sustainable landscaping, grey water recycling, rainwater harvesting and the use of renewable energy sources to achieve BCA Green Mark Scheme's highest accolade, the Green Mark Platinum Award. We also look deeper into SCB's worldwide green policies and how they use the Changi development's sustainable features and data to support environmental education programmes and maximise the efficiency of the seven-storey building, including the basement carpark.

For building owners who are undecided about making significant investments to upgrade the building's air-conditioning system, Plaza by the Park shares with us how it improved energy efficiency and cut its electricity bills by as much as 50 percent through a major air-con retrofit.

Next, we look at the National Library Building (NLB) along Victoria Street. This development obtained the Platinum Award under the Green Mark for New Buildings Scheme in 2006 and successfully renewed its Green Mark Platinum status this year under the Existing Building category. We also got NLB's CEO, Dr. N. Varaprasad, to share with us how his philosophy on the green movement has led NLB to further improve its energy efficiency by 16 percent over the past three years.

Moving beyond buildings, BCA is also introducing Green Mark for Districts, a new Green Mark scheme for large scale built environment developments. We have put together in this issue, an introduction to Green Mark for Districts and its two pilot projects to illustrate what the new scheme is all about.

Last but not least, we also feature the Green Mark Incentive Scheme which was launched in April this year with an aim to encourage private building owners to build and design green buildings. Through this scheme, building owners would be able to enjoy bonus GFA and cash incentives while doing their part for the environment, and is truly an incentive building owners should seriously consider.

Lee Jang Young
Building and Construction Authority

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GOING GREEN *with Standard Chartered*

Standard Chartered Bank (SCB) is on its way to develop a 26,900 sq m facility to house the bank's operations at Changi Business Park. As an environmentally conscious and socially responsible corporation, SCB is committed to design and develop a Green building for its new 'home' – Standard Chartered @ Changi, which has won a Platinum Green Award.

The SCB development is designed to maximise efficiency with the formation a six-storey building, comprising of a basement car park and a roof top garden. Scheduled to be completed for occupancy by the fourth quarter of 2009, it incorporates extensive green features such as recycling of grey water, condensate and rainwater for flushing or landscape management, use of recycled materials and renewable energy sources, combined with a continued program of environmental education using the development's sustainable features and data.

One unique feature of the building is its double-glazed low emission blue façade with extensive low glass shading coefficient value that achieves an Envelope Thermal Transfer Valve (ETTV) of 39.3 W/sq m. The building is oriented to NE-SW orientation with 44.4 percent of window to wall ratio to minimise direct sunlight, reducing ultraviolet (UV) transmission and guarantees optimum room temperature.

The incorporation of Green features will increase the overall building construction cost by less than four percent of total base build cost, with an expected payback period of about six to seven years.

Key Features in Standard Chartered @ Changi

Water Recycling

Rainwater harvesting will be adopted for irrigation of the majority landscape areas and has a storage capacity of five days use. An automatic drip and sprinkler irrigation system will be utilised on landscaped areas. Moisture sensors will also be installed to enhance the efficiency of the irrigation system.

An integrated grey water system is used for flushing. Collection of grey water from the floor traps, basins and condensate water from the AHU will be filtered and recycled for the flushing system and further supported by rainwater harvesting system as required.

Recycling of waste water, condensate and rain water collection will result in considerable water savings of up to 19,890 m^3 of water per year which is enough to fill eight Olympic-size swimming pools.

The installed photovoltaic cells on the building generate 11 kWp.

Renewable Energy

A photovoltaic system of 11 kWp will provide sufficient quantities of renewable energy to the building to maintain emergency systems and landscape irrigation when unoccupied, thereby effectively reducing the energy required.

Sustainable Activities and Materials Usage

To promote recycling, the building incorporates a dedicated recycling chute for dry recyclable waste such as paper, glass and plastic. SCB is also implementing centralised printing and fully AV equipped meeting rooms, reducing the need to print and discouraging the use of paper. By 2011, SCB aims to decrease paper consumption per full-time employee (FTE) to 25 kg, a reduction of 50 percent compared to 2008 levels.

A high proportion of eco-friendly recycled and/or sustainable materials have been utilised throughout the building including ceiling boards, carpets, dry wall partitions, furniture and composite wood products. All adhesives and paints used within purchased products and constructed space are certified low or no VOC content and in addition, AHU coils are coated to further enhance indoor air quality.

Energy Management and Conservation Systems

The building will also incorporate an integrated energy management system, consisting of:

- Lutron lighting management system integrating motion/occupancy detectors to minimise light levels at appropriate times
- Low energy lighting incorporating the use of T5 fittings, compact fluorescents, solar and LED lighting/ signage throughout the building and exterior
- AHUs featuring continuous CO_2 monitoring to optimise fresh air volume, AerisGuard coil coating to reduce corrosion and room sensors to power down AC for areas not in use will all contribute to reduced energy consumption and optimisation
- BMS monitoring and control of Lighting, AC and Power management systems optimises the energy consumption throughout the building and ensures the high efficiency of energy use
- Natural ventilation for the basement car park combined with CO_2 sensors and variable speed ductless ventilation fans

Standard Chartered @ Changi utilises double-glazed, low E glass for its exterior surface.

Grey water filtration system

Educational Programs

SCB intends to implement educational programs to highlight their eco-friendly building and landscape features to their staff and public. Some of these features include:

- Endangered Species Garden: First-of-its-kind in commercial building, this garden will feature a range of plants which are extinct or at risk of extinction in the wild due to over-collecting or deforestation. SCB will collaborate with Botanic Gardens Conservation International (BGCI) and the Singapore Botanic Gardens to participate in awareness programs
- Building Management System (BMS): Shows the efficient building's real-time energy and water-saving details, which will be displayed at common areas

FAST FACTS WITH STEVE RILEY

Steve Riley is the Project Director of Singapore Relocation Projects, Corporate Real Estate Services in Standard Chartered Bank, Singapore.

He is responsible for driving the overall strategy and programme management for the Bank's property consolidation into Changi Business Park and the Marina Bay Financial Centre.

1. Standard Chartered Bank has always been one of the leaders in creating Green Environment and has recently achieved Green Mark Platinum Award for its new building at Changi Business Park. Could you elaborate on Standard Chartered Bank's (SCB) Green Initiatives that have been taken for the new development at Changi Business Park as well as SCB's Corporate Social Responsibility and Green Policy?

Standard Chartered @ Changi is a built-to-suit office building integrating energy and water efficient features and is expected to reduce energy consumption by up to 36 percent compared to conventional buildings in Singapore. The building will also incorporate an endangered species educational garden as part of its comprehensive range of eco-friendly features.

First-of-its-kind in office buildings, the garden is designed to be a recreational space as well as to raise awareness of environmental conservation among employees and the community. Located on the ground level, the garden will feature a range of plants that are extinct or at risk of extinction in the wild due to over-collecting or deforestation.

Approximately 20 percent of the plants across the building's 70,000 sq ft landscaping will be of the endangered variety with educational areas focusing on a range of endangered plants with everyday uses in medicine or food.

This is part of Standard Chartered's efforts to educate the next generation on the importance of protecting the environment. The Bank will collaborate with Botanic Gardens Conservation International (BGCI) and the Singapore Botanic Gardens to participate in awareness programmes. The new building includes energy efficient and water saving features such as:

• Solar panels to generate sufficient power to maintain the building when unoccupied. This would maintain emergency systems and landscape irrigation so the building effectively has zero energy consumption when not in use.

• An automatic drip-feed irrigation system utilising rainwater and recycled water for effective landscape management

• Recycling of wastewater, condensate and rain water collection will result in considerable water savings of up to 19,890 m^3 of water per year which is enough to fill eight Olympic-size swimming pools

Minimising the impact of our business on the environment has always been an integral part of Standard Chartered's sustainable agenda. The Bank is committed to improving the environmental impact of its operations, especially in the area of energy consumption in its buildings.

Standard Chartered has had a formal environment policy in place since 1998, involving our businesses and support functions, aligning with our business goals. Action plans are built around the strategy's three pillars of operational impact, sustainable finance and stakeholder engagement:

i) Operational impact: minimising our use of resources and carbon dioxide emissions, focusing on energy consumption in buildings, paper use and emissions from air travel

ii) Sustainable finance: integrating climate and environmental risk as well as social and governance issues into our lending criteria and providing the products and services that will support the shift to low-carbon economies

iii) Stakeholder engagement: addressing environmental issues that are relevant and meaningful in the markets where we operate. We provide tools and encouragement for employees to move from awareness to action in their work and private lives. Externally, we work with customers, regulators, communities, investors and non-governmental organisations (NGOs) and others to stimulate action by creating an awareness of what must be done to protect the environment.

2. Standard Chartered Bank made an upfront commitment to design a Green Building that fully utilises current technologies available to increase its performance, while reducing building impacts on human health and the environment. This was the main agenda unlike the normal perception that construction cost comes first. What is the key motivation factor?

At Standard Chartered, we are determined to lead by example in the markets we operate. In addition to contributing to economic growth through our core business activities, we want to help protect the environment and have a broader positive impact on the societies in which we live and work. We make a conscious effort to reduce carbon dioxide emissions caused by our operations, energy use of our buildings and to minimise our own carbon footprint and paper use.

3. Could you share Standard Chartered Bank's sustainable design philosophy that balances economic objectives and environmental viability?

The Bank is committed to protecting the environment by reducing our operational environmental impacts. This commitment also applies to our sustainable design strategy of buildings where we aim to achieve efficiencies in resource consumption while minimising environmental impacts. The Bank believes that having sensible green designs in buildings usually lead to cost savings in the long term. We plan to incorporate sustainable building designs in our real estate to make Standard Chartered a great place to work as well as creating a balance in economic objectives and environmental viability.

4. Standard Chartered Bank has regional offices around the world, and the upcoming Singapore office has achieved Green Mark Platinum. Are the regional offices also going for Green Building certification such as LEED or BREEAM? Is that compulsory?

All major Standard Chartered commercial buildings are encouraged to achieve green building certifications such as LEED, BREEAM or any other green building certification programme that is recognised locally such as Singapore's Green Mark and Hong Kong's BEAM. As part of the sustainability agenda for the Bank's real estate strategy, we aim to achieve no less than the equivalent of the United States' LEED 'Gold' rating for our new buildings.

In 2009, Standard Chartered developed an internal rating called the BEAS (Building Environmental Assessment System) to measure the operational environmental impacts of the Bank's buildings in terms of its environmental conservation features, indoor environmental quality, and its water and energy efficiencies. BEAS provides a simple indication of how well the environmental impacts are managed in a particular building compared with another building in the Bank's property portfolio. This unique initiative supports the Bank's programmes to incorporate sustainable designs in both major commercial buildings and smaller premises.

5. Our perception is that bank buildings consume more energy as there are big data centres in the buildings and people are working 24 hours. Is this the main reason to going green or any other possible reasons? What has been the most important deciding factor in keeping Standard Chartered green?

The Bank is a founding member of The Climate Principles, which is a voluntary framework to guide the finance sector in tackling the challenge of climate change. The Climate Principles address the management of operational greenhouse gas (GHG) emissions. More importantly, they provide strategic direction on managing climate change across the full range of financial products and services, including: research activities; asset management; retail banking; insurance and re-insurance; corporate banking; investment banking and markets; project finance. As a leading bank, we engage in addressing climate change and incorporating sustainable designs in our real estate portfolio is one of the key programmes.

6. What do you think of disclosing buildings' energy and water consumption data to the public, which could indirectly create a competition between buildings and raise awareness of Green Buildings?

We are committed to continue to focus on building a sustainable business as a bank. We have been reporting on our environmental performance since 2001 and our social performance since 2004 when we published our first Corporate Responsibility Report. We monitor energy consumption in our buildings using the Global Environmental Management System (GEMS), which is modelled after the ISO, the international environment management standard. In 2008, we introduced the Environmental Information Management System, an online tool to improve measurement and data collection.

We have recently started a quarterly reporting of energy consumption data, which will focus attention on energy by highlighting any excess usage early. A footprint estimation tool is also used to cover the rest of our portfolio. Our Sustainability Review, published in 2008, reports on our integrated strategy - activity and commitments, targets and progress under each of our seven sustainability priorities.

7. Could you please let us know more about the educational corner in the new erection at Changi Business Park that will feature Eco friendly building and landscape including endangered plants?

The educational corner, which is currently under development, will showcase a number of endangered plant species. There will be information boards developed by BGCI highlighting the characteristics and facts about the species available. This will enable people to learn the facts about environmental conditions and raise awareness of the severity of the situation.

8. Based on your personal observations, what do you think the next trend will be in greening buildings, and any advice you could give to others?

I believe that with greater awareness on green movement and activities today, more effort will be taken to incorporate environmental factors in building planning. This is being done at an earlier stage in the development process. Having a green building will become a way of doing business and companies will need to look into efficient and sustainable buildings in their portfolio. The greatest change will need to occur in the retrofitting and upgrading of current buildings to reduce environmental impact.

Saving energy

at Plaza By The Park

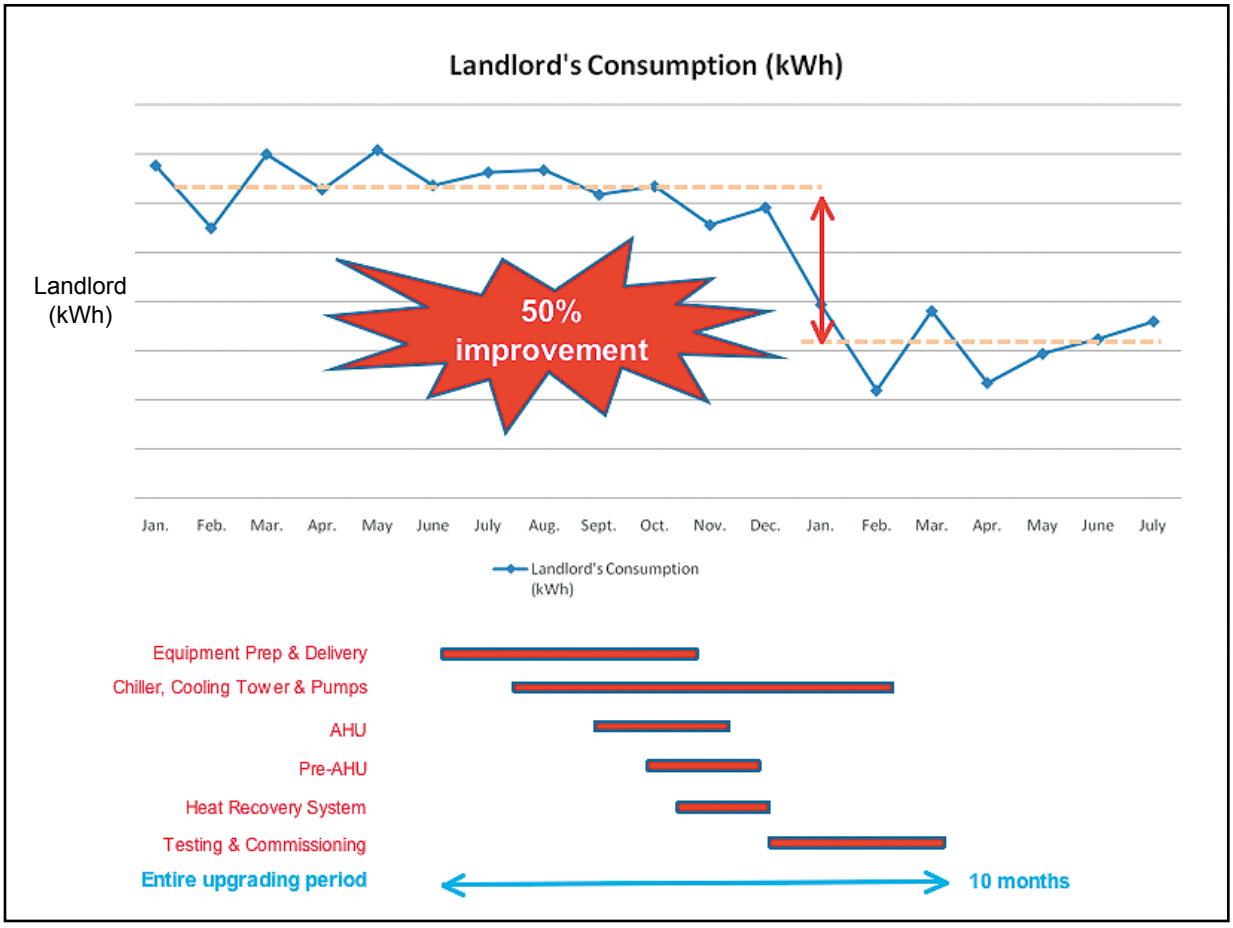
Plaza by the Park is a 20-year-old commercial building, which recently underwent major upgrading and successfully garnered BCA Green Mark Award (Provisional GOLD) in 2009. Located within the Cultural and Civic District, it is accessible with strong public transport connectivity. Both the City Hall and Dhoby Ghaut MRT Interchanges are within short walking distance and the upcoming Bras Basah Station of the Circle Line is located just opposite the building.

The building consists of a five-storey podium and an 11-storey office tower and sprawls over a GFA of 27,850 sq m. The ground floor of 28,000 sq ft lettable space is made up of retail outlets and F&Bs where some outlets operate around the clock to cater to the vibrant crowds from Singapore Management University, Nanyang Academy of Fine Arts, Singapore Arts Museum, participants of cultural activities that are organised by the various centres located along Waterloo Street, and hotels in the close vicinity.

The upper floors are designed to international specifications and are incorporated with flexible office accommodation. The average floor plate circa of 23,600 sq ft is large by Singapore's standards and provides a point of differentiation from other buildings in the CBD. The anchor tenants are MNCs that have long working hours.

The building was completed in 1989 with a central air-conditioning system. The water-cooled chiller systems and air-handling units that are controlled by the Building Automation System cater to the varying requirements from the different usage. As part of a building assets renewal process, major

Pre-cool AHUs with heat pipes



upgrading to the Aircond Plant and Building Automation System was recently undertaken. Energy-saving features are introduced wherever possible.

Energy-efficient Features

Chiller System

The chiller system is reconfigured and chillers are built in with Variable Speed Drive to best cater to the varying load profiles throughout. The system is complete with new pumps, cooling towers and associated pipe work valves, fittings, balancing valves, related components like digital power meters and breakers in the electrical switchboard. It is supported by a new Building Management System.

Energy Saving Features	Payback Period
<u>AC system related equipment</u> Chillers, Cooling Towers, Pumps (VSD), BMS, AHUs (VSD), CO_2 Monitoring System Heat Recovery, Heat Pipe, Auto Tube Cleaning System	< 6 years
<u>Carpark Equipment</u> T5 lightings incorporated with High Frequency Ballast, CO Monitoring System	< 2.5 years
<u>Staircases</u> T5 lightings incorporated with High Frequency Ballast, Motion Sensors	1 year

Estimated payback period of the energy saving features adopted in Plaza By The Park

Nalco 3D Traser Chemical Treatment System to Cooling Tower

This system offers a much higher 24 COC than the guideline of six COC, hence reducing blow down rates and water consumption. It also provides real time monitoring of water conditions and doses chemicals on demand basis, which maintains asset reliability.

Auto Condenser Tube Cleaning System

This system constantly cleans the chiller condenser tube in order to maintain chiller efficiency and reduce chiller down time for manual tube cleaning.

Air Handling Units (AHU)

The old AHUs were oversized and running at constant speed regardless of load condition, making them less efficient. New Variable Speed Drive, DDC Controller, and CO_2 sensors with modulating valve respond accordingly to load condition.

Pre-cool AHUs with Heat Pipes

The old sets of pre-cooled AHUs were replaced and completed with Variable Speed Drive and Heat Pipes. The function of the heat pipes is to create condensation and in this process, reduce the moisture content of the fresh air intake, which will then provide a more comfortable air quality to the occupants.

Recirculation of AHU condensate to Cooling Towers

The condensates from the AHUs are discharged into a separate piping system that leads them to the cooling tower to be recycled.

Heat Recovery System

The system recovers heat from a DX condenser to supply free hot water to the executive toilets. The DX condenser serves to alleviate condensation problems in the staircase.

CO Sensors at the Carpark

CO Sensors to control the activation of the mechanical ventilation from monitoring the level of carbon monoxide in the carpark.

T5 lighting at the Carpark and Staircases

T8 lighting was replaced by T5 lighting in the carpark and staircases to achieve savings.

Motion Sensors

Motions sensors are installed in the toilets and staircases to trigger the lighting only when it is in use from the motion detected, hence conserving energy when not in use.

CO Sensors activate carpark MV fans when carbon monoxide levels are high.

Auto condenser tube cleaning system

Engaging Tenants' Participation

Besides installing the hardware for energy savings, the building management also introduced programmes to promote environmental consciousness amongst tenants, encouraging their participation in recycling programmes and raising the room temperature by 1°C up to about 24°C.

Actual Savings Achieved

The Energy Efficiency index (EEI) of the building calculated based on 2008 energy data was 232 kWh/sq m/yr. After the full implementation of the measures, the EEI is 178 kWh/sq m/yr with projection for the savings in the remaining months of year 2009. The expected reduction in energy use by 23 percent will place Plaza By The Park close to the top 25th percentile of energy achievers in the industry.

The BCA Green Mark
Incentive Scheme for Existing Buildings

To accelerate the pace of energy efficiency improvement in our existing buildings, BCA is now implementing the 2nd BCA Green Building Masterplan, which will include a strong focus on energy efficiency in existing buildings. Recognising the challenges faced by building owners in upgrading their existing buildings' energy performance, BCA launched a SG$100 million Green Mark Incentive Scheme for Existing Buildings (GMIS-EB) on 29 April 2009. It aims to encourage developers and building owners to carry out energy efficiency retrofitting works in their existing buildings.

The GMIS-EB provides:

i) Cash incentives that co-fund up to 35 percent of the costs of installing energy-efficient equipment in the retrofitting works.

ii) A "Health Check" scheme that will co-fund 50 percent of the energy audit cost in order to determine the building's air-conditioning plants' efficiency.

Cash Incentive Scheme

i) Eligibility

This scheme is targeted mainly at energy intensive buildings such as shopping malls, hotels, office buildings, hospitals, and other centrally air-conditioned buildings. Private building owners will be eligible for the GMIS-EB scheme if their buildings meet the following criteria:-

- It is an existing non-residential development with gross floor area of 2000 sq m and above
- It has a central air-conditioning plant
- It is undergoing energy-related improvement retrofitting works
- It must apply for the Green Mark assessment and achieve Green Mark Certified rating or higher and also the energy savings

In addition, the application for the GMIS-EB scheme must be lodged before the start of the energy-related retrofitting works.

ii) Qualifying criteria and co-funding amount

Qualifying Criteria	Rate	Cap
GM Certified with > 20 % Energy Savings OR GM Gold (with 15 % Energy Savings)	20 % Co funding	SG$150,000
GM Gold with > 32.5 % Energy Savings OR GM Gold^{PLUS} (with 30 % Energy Savings)	30 % Co funding	SG$500,000
GM Gold^{PLUS} with > 37.5 % Energy Savings OR GM Platinum (with 35 % Energy Savings)	35 % Co funding	SG$1,500,000

The above rates refer to co-funding the equipment purchased in achieving the energy savings. Energy bills before and after the retrofitting works must demonstrate the savings.

The co-funding rates are meant to encourage higher levels of energy savings. Higher rates are given for higher levels of energy savings achieved. For example, a building that has achieved Green Mark Gold rating (15 percent energy savings) is given a 20 percent subsidy while a building with Green Mark Platinum rating (35 percent energy savings) is given 35 percent subsidy.

Building owners who put in additional efforts to achieve higher energy savings than what is required under a particular Green Mark rating are also rewarded. For example, a building with Green Mark Certified rating but with higher 20 percent energy savings will receive the same subsidy as the building that achieves a Green Mark Gold rating with 15 percent energy savings.

Health Check Scheme

In addition to the co-funding cash incentives, the GMIS-EB also includes a "Health Check" scheme. The objective of this scheme is to help building owners who are applying for Green Mark certification to determine the efficiency of its existing air-conditioning plant via energy audit.

The audit will be carried out by BCA appointed term contractor and GMIS-EB will co-fund 50 percent of this audit costs. The building owner can also engage their own Energy Services Company (ESCO) to do the audit and claim 50 percent from the "Health Check" scheme. However, the subsidy rate will be based on the BCA term contractor's rate.

This scheme is a useful starting point for the building owner to determine the performance of his air-conditioning plant and also identify effective energy efficiency solutions.

More information can be obtained at: ***http://www.bca.gov.sg/GreenMark/gmiseb.html***

The BCA Green Mark

Gross Floor Area Incentive Scheme

BCA launched the BCA Green Mark Scheme in January 2005 to promote the sustainable development of our built environment. To accelerate the adoption of environmentally friendly green building technologies and building design practices and to defray some of the upfront capital cost of installation of green features, we are pleased to release a set of Green Mark incentive in the form of additional Gross Floor Area (GFA).

The incentive scheme will be in effect for a period of five years with a mid term review after two years implementation. Developer/ Building owner's application and green building design concept proposal will be evaluated by BCA and incentive will be given to buildings that achieve the stipulated BCA Green Mark Platinum or Goldplus rating. The GFA incentive scheme has been in effect since 29 April 2009 for new Green Mark certifications.

The GM GFA Incentive Scheme will apply to all new private developments, redevelopments and reconstruction developments submitted on or after the effective date. Developments which have obtained planning approval but have not commenced construction of the superstructure works on site may also be considered for the GM GFA Incentive Scheme. For such cases, the applicant should obtain BCA's endorsement for the GM proposal before making an amendment or fresh submission to URA to include the additional GFA.

Types of development that are eligible for this scheme are:

Residential	Non-landed, Mixed development and others (approved case-by-case)
Non-Residential	Commercial, office, retail, business parks, industrial, institutional, community building, hotel, hospital, white site development and others (approved case-by-case)

Developers who take up the Green Mark GFA Incentive Scheme will not be eligible for the Green Mark Incentive Scheme (GMIS).

Buildings that achieve GM Platinum can qualify for up to two percent additional GFA (subject to a cap of 5000 sq m) while those achieving Green Mark Gold plus can qualify for up to one percent additional GFA (subject to a cap of 2500 sq m).

Green Mark Rating	GM GFA Incentive Scheme
Platinum	Up to 2% additional GFA beyond Master Plan GPR (subject to cap of 5,000sqm)
Gold plus	Up to 1% additional GFA beyond Master Plan GPR (subject to cap of 2,500sqm)

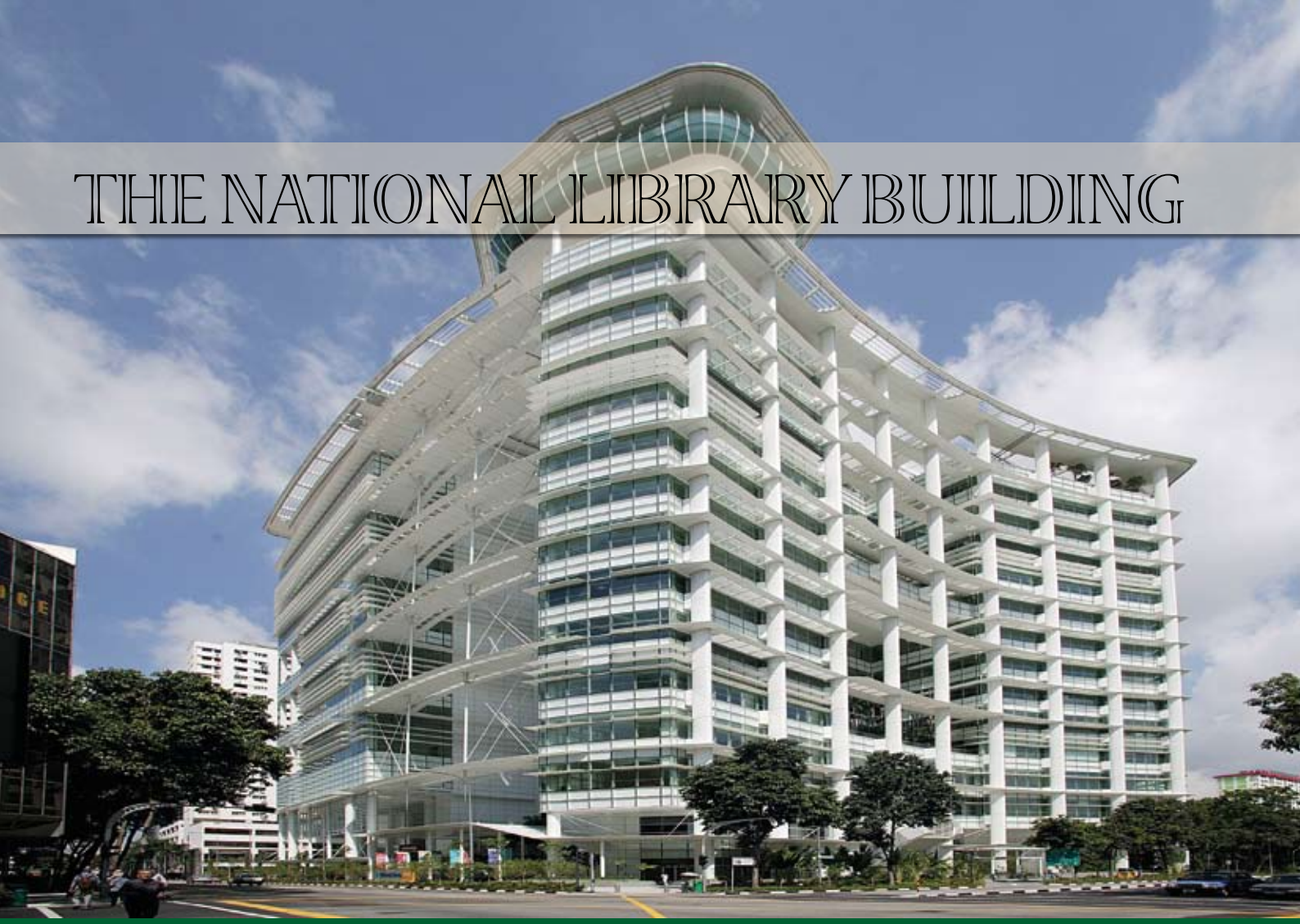
Upon acceptance of the application, developers will raise a security deposit and submit it to the BCA prior to the approval of the Written Permission (WP) by the URA. The approval of the additional Green Mark GFA is subject to:

i) Endorsement of the green building design concept by the BCA
ii) Achievement of stipulated GM standard assessed by BCA under the prevailing BCA's Green Mark Assessment criteria
iii) Compliance with all other planning and urban design requirements for the site
iv) Payment of Development Charge (DC).

The applicant shall apply to BCA for Green Mark assessment and submit documentation that demonstrates achievement of the stipulated Green Mark rating before Temporary Occupation Permit (TOP) stage.

More information can be obtained at: ***http://www.bca.gov.sg/GreenMark/gmgfa.html***

THE NATIONAL LIBRARY BUILDING



The National Library Building combines innovative architecture, 'green' features incorporated through bio-climatic design techniques, advanced mechanical and electrical engineering, as well as cutting-edge information and communication technologies. With 58,783 sq m of gross floor area, this iconic building is 16 storeys high and reaches a height of 102.8 m. There are also three basement levels and an observation pod located on the 16th level offering a panoramic view of the city.

All sanitary fittings are with water efficient labels.

The escalators use pressure sensors, which activate only when there is human traffic.

Energy efficient features

Many of the green features in the National Library Building conserve energy. For example, the escalators use pressure sensors, which activate only when there is human traffic. This helps conserve energy when they are not in use. Lighting sensors are used to switch off lights in many of the public reading and common spaces during the day. These are minimal cost utilities but achieve energy savings and prevent unnecessary wastage.

The Lee Kong Chian Reference Library, exhibition and office spaces are largely naturally lit. Daylight sensors at the perimeter of the library areas monitor the amount of natural light entering the building, allowing the general lighting to dim or switch off. The electrical lighting provides only the level of illumination required, thus lowering energy consumption. A sophisticated Integrated Lighting Control System allows strategic programming of the internal and external lights to control energy consumption. Localised intelligent switches for the office floor provide lighting only when required at the occupied areas, instead of illuminating the entire floor. In addition, blinds are automatically activated when necessary during the day to reduce solar gain and reduce air-conditioning load.

About two thirds of the building façade is double-glazed with high quality low-emissivity glass to minimise heat transfer. The building is also heavily shaded to reduce solar heat gain through the façade. Close attention has been paid

to control solar heat, glare and humidity to optimise user comfort and protect the library collections.

Natural ventilation is adopted in central transition spaces such as internal walkways, events plaza and courtyards. Vegetation and landscaping are also utilised to improve the indoor thermal environment and thermal performance of the building. The sunshade blades or laneway sunshades, spanning between 18 m to 35 m between the two blocks, are major solar shielding devices. These blades protect the northwestern and southeastern facades from solar penetration and glare. The installation of these blades is a structural feat. These blades are constructed using modular cladding components tensioned with steel cables to increase rigidity.

Lighting sensors are used to switch off lights in many of the public reading and common spaces during the day.

Green Building

The National Library Building is an innovative 'green' building designed as a "Library for the Tropics" using bioclimatic design techniques. Our deployment of various innovative 'green' features helps to keep the building operating in an energy-efficient way and do its part for a more sustainable environment. Among the key 'green' features is the use of bioclimatic vegetation and extensive landscaping, with sky terraces and roof gardens. This improves the indoor thermal environment by lowering the local ambient temperature. The 'green' concept also fulfils NLB's corporate social responsibility in being environmentally friendly.

In recognition of its environment-friendly design and performance, the building won the Green Mark Platinum Award in 2005, the highest accolade under the Green Mark Scheme, launched by Singapore's Building and Construction Authority (BCA) in the same year.

In 2007, the National Library Building also won the Singapore Silver Award, under BCA's Universal Design Awards, for its wide spaces, good lighting, accessibility, and clarity in way finding, as well as the ASEAN Energy Efficiency Award 2007.

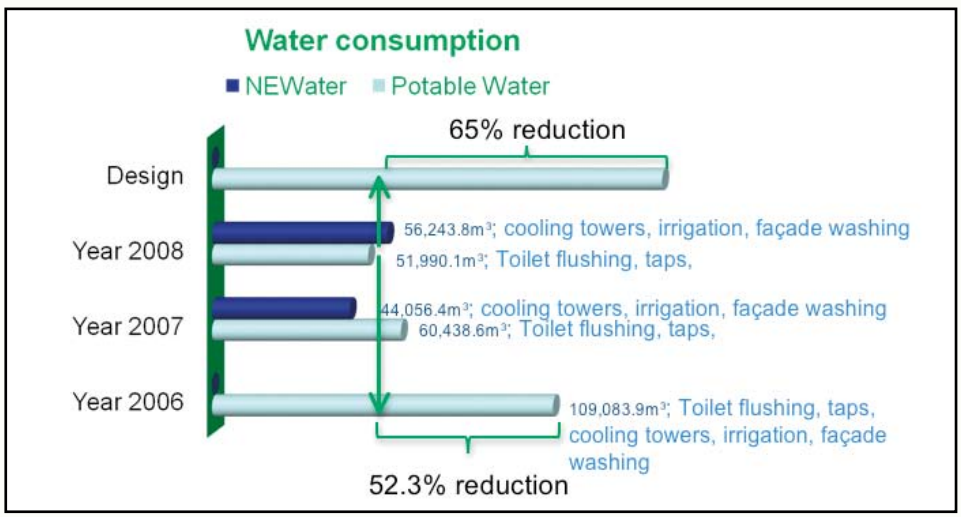
The National Library Building is energy-efficient by design and is maintained in a way that ensures both operational efficiency and user comforts are achieved. During the development of the project, based on a study by specialist consultants from the Total Building Performance Team (TBPT) at the National University of Singapore (NUS), the initial energy target set for the building was 178 kWh/sq m/yr. This placed the National Library Building among the top most energy-efficient Class 1-office buildings.

In 2009, the National Library Building was again awarded the Green Mark Platinum Award under the existing building category and it was the only building to be certified as such under the existing building category for that year. After nearly five years in operation, NLB has achieved an even higher level of energy efficiency than what was set initially.

Design performances versus operating performance

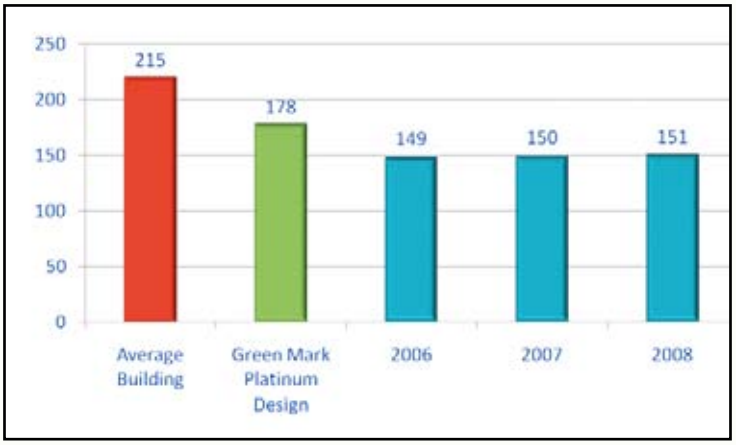
Comparing the National Library Building's Energy Efficiency Index (EEI) of 150 kWh/sq m/yr with the national average of 215 kWh/sq m/yr, it is remarkable in view of the high visitorship to the building. This was the average figure based on the monthly figures from 2006 to 2008. The building has thus performed 16 percent better than its design energy efficiency index (178 kWh/sq m/yr) and about 30 percent better than the national average. With this achievement, the National Library Building has positioned itself within the top 10 percent cohort to reach the EEI benchmark established by the Energy Sustainability Unit of the National University of Singapore (ESU/NUS). Normalised EEI is calculated by dividing the average monthly electricity consumption by the total air-conditioned area, and normalising the result to 55 hours per week).

Domestic water consumption has also been reduced by significantly through the use of NEWater for the cooling towers and irrigation. In addition, all basin taps and toilet cisterns has been installed with auto sensors



Green cost premium

The green features allow the National Library Building to optimise its usage of electricity and water. The extensive use of landscaped areas has also created a more pleasant environment and experience for people working in or visiting the building. According to the study conducted in the United States, although the average premium for green buildings is about four percent more than the



NLB's Energy Efficiency Index (EEI) kWh/sq m/yr

conventional buildings, they are 28 percent more energy efficient (Gregory H, Kats, 1999), Green Building Costs and Financial Benefits. In the National Library Building's case, we too obtained significant energy savings by going 'Green'.

Good FM practices to maintain the performance of the National Library Building

NLB's Properties and Facilities Management Division wanted to promote and champion a proactive and holistic approach to adopting 'green' initiatives and attaining the best built-up environment for the National Library Building. There was strong commitment, drive and collaboration among all parties involved in the management and maintenance of the building. The team studied, developed and collaborated with Keppel FMO Pte Ltd (facilities managing contractor), SuperSolutions Pte Ltd (energy consultants), Victrad Enterprises Pte Ltd (M&E term contractor), and other external agencies such as National University of Singapore to optimise the building's energy consumption even further.

Some "no cost / low cost" measures as well as others requiring some form of minimal capital expenditure were implemented to achieve the desired energy savings.

"No Cost / Low Cost" Energy Saving Measures

Some of the "No Cost / Low Cost" energy saving measures identified and implemented include the following:

- Setting the air-conditioning temperatures at recommended levels to optimise the energy consumption

Sky terraces improve indoor thermal environment by lowering local ambient temperature.

- Reducing the security lights for all library areas after library operating hours.
- Checking and switching off non-essential lights from the Building Management System.
- Reducing the security lighting at the basement carpark after operating hours.
- Installing motion sensors in all the public toilets.
- Installing energy saving LED lights to replace the incandescent lights for the lift hall indicators at the public lift lobby.
- Replacing the halogen down lights at the information counters from Levels seven to Levels 11 with energy-saving lights.

Primary Air Handling Units (PAHU) Optimisation

Previously, the PAHUs were designed to operate for 24 hours and as such consumed higher amount of energy. Operating the PAHUs after library hours also brought into the building an excessive amount of fresh air unnecessarily, which would consume more energy to cool and dehumidify the air.

The team arranged to switch off the PAHUs after library hours and to operate them at a lower fan speed during the daytime to achieve both energy savings and pressurisation.

Chiller Plant Optimisation

The following measures are being implemented to further improve the chiller plant performance.

- Reconfiguring and optimising the primary chilled water pumping system
- Reconfiguring and optimising the secondary chilled water pumping system
- Reconfiguring and optimising the condenser water pumping system
- Optimising the cooling tower operations
- Recalibrating the temperature sensors
- Enhancing the existing chiller plant to operate according to the different cooling loads

Revision of Contracted Maximum Demand Capacity

The actual monthly maximum demand was averaging at a lower level than the contracted power capacity with M/s Power Seraya for the National Library Building. As such, the team sought to reduce the contracted capacity to enjoy savings in the electricity bills.

The team plans to conduct an energy audit exercise later this year and with the results, it will continue to monitor and implement other energy saving measures to achieve a higher level of energy efficiency. The team's target is to achieve an EEI of 145 kWh/sq m/yr. This would translate to more energy savings.

NLB is conscious of the role it can play to contribute in the area of environmental sustainability, hence its adoption of the "green" concept for the building. Given the size of the building, recurrent energy cost would be a major consideration. Thus, achieving energy efficiency was and is an important measure for the National Library Building.

Dr N. Varaprasad is the Chief Executive of the National Library Board Singapore, overseeing the development and operations of the National Library Singapore, the network of 22 public libraries as well as the operations of several client libraries in the country.

He was the Founding Principal/CEO of Temasek Polytechnic (1990-2001) and also a Deputy President of NUS (2001-2004).

Dr Varaprasad has made many significant contributions to public service and education in Singapore. He has served on many Boards of public and private organizations. Currently he sits on the Board of Trustees of SIM University (UniSIM), and SINDA. He is a holder of the Champion of Creativity Award of the American Creativity Association and Public Administration Medal (Gold) from the Government of Singapore.

A chat with Dr. N. Varaprasad, Chief Executive of the National Library Board Singapore

1. Being one of the pioneering buildings to be certified green mark platinum, would you care to share with us what are some of the more memorable moments in the journey of attaining and maintaining a Green mark Platinum building? And how does NLB ensure that the library stays certified after three years of certification with so many activities (VVIP visitations) taking place?

The National Library Building was positioned from the beginning of its development as an efficient and well-integrated building that is climatically responsive. Saving energy and using 'green' features also fulfils NLB's corporate social responsibility in being environmentally friendly.

After achieving the Green Mark Platinum as a new building, continuous efforts were made to ensure that the building remained green. This is a big challenge as all the low-hanging fruits have been taken. But we persevered nevertheless. The energy performance of the building was closely monitored and various measures were put in place after the building commenced operation in July 2005. For example:

• Motion sensors were installed to control lighting at staircase landings in between floors, resulting in estimated savings of 34,058.8 kWh/year.

• Carpark security lighting was reduced, without compromising security, from 40 percent to 20 percent after carpark operation hours. This resulted in energy savings estimated at 23,885 kWh/year.

• Lights on a typical floor were rezoned from one zone per floor to four zones (2008). Energy savings are estimated to be 9394 kWh/year.

• Incandescent bulbs for lift car buttons were replaced with LED lights.

• Motion sensors were installed in all the public toilets. These sensors are activated after the building's opening hours.

• Without compromising security, the security lighting at various locations in the building was reduced from 20 percent to 10 percent after the library opening hours.

• All the fire exit staircases in the building are secured with EM (electromagnetic) locks. However, a review of the operations revealed that operational efficiency would be increased and energy would be saved by allowing access to the fire exit staircase serving the basement floors. This resulted in the non-public lifts being less used to access the different basement levels and staff could use the stairs to access the basement floors.

We are currently working on a project to further optimise the chiller plant efficiency to achieve an EEI (Energy Efficiency Index) of 145 kWh/sq m/yr by the end of December 2009. This would translate to about 821,000 kWh of energy being saved per annum.

2. What are some of the considerations in engineering design for good indoor air quality?

Indoor air quality should satisfy the comfort of end users without compromising the efficient use of energy. The following active air-conditioning control strategies are implemented to ensure good indoor air quality and energy efficiency.

Variable Air Volume (VAV)

The air distribution to the library, offices and commercial spaces are through VAV boxes that allow for better zone temperature control. Better energy efficiency is also achieved through the reduction of fan speed when the air-conditioning system is running at partial load.

Carbon dioxide (CO_2) sensors

CO_2 sensors installed at the Air Handling Units (AHUs) ensure that the percentage of fresh air in the air supply is maintained at acceptable levels in all areas. The sensors optimise the amount of fresh air supply and avoid wastage of energy in cooling unnecessary amounts of fresh air.

Night Setback

The library spaces require 24 hour air-conditioning. Thus, as an energy saving measure, a night setback strategy is used in the building. This strategy allows a higher temperature to be maintained in the building outside of the library operating hours. This reduces the energy consumption of the chiller plant during this period. Furthermore, by employing such a strategy, less energy is needed to bring the building back to the designated temperature during the library's opening hours.

3. Does the NLB have any plans for the rest of the libraries to go green in relation to maintaining commitment to the environment and public sector taking the lead?

Yes. To fulfil NLB's corporate social responsibility in being environmentally friendly and as part of the public sector taking the lead in the promotion of green buildings, NLB, where applicable, will implement green features in existing libraries and new libraries. For example, we have taken the opportunity offered by the re-lamping requirement at 12 NLB premises to replace T8 fluorescent lamps with T5 fluorescent lamps.

4. It is understood that the designed EEI of the National Library Building was 178 kWh/sq m/yr. However, three years later, the actual operational EEI turned out to be 151.36 kWh/sq m/yr. How was it possible to make a big improvement in energy efficiency?

NLB has been consistent in its continual efforts to enhance the National Library Building's energy performance. The key success factor lies with the engagement of a qualified maintenance team to carry out the preventive maintenance of the various systems in the building for optimum level performance. In addition, the daily operations of the building were monitored closely and additional measures were made to further optimise the utilisation of energy. Examples of the measures undertaken are listed above, under the first question.

5. What advice would you give developers or existing building owners embarking on a green initiative? And what advice would you give existing building owners going for re-certification?

Our records show that we can save an average of about 30 percent on the monthly energy bill compared to a similar building without green features. Hence, the long-term savings to be derived can be quite significant. The operational costs would have been higher if not for the 'green' features. Therefore, developers and building owners should take a long-term view of the benefits to be obtained from incorporating "green" features in their developments.

After obtaining the initial Green Mark certification, building owners should continue to invest time and effort to monitor the actual operations of the building and, subsequently, implement measures to optimise the usage of energy. It would help if building owners view these measures not only as a means of saving energy but as a part of their contribution towards maintaining a sustainable environment in Singapore.

6. Please tell us more about the ASEAN Energy Efficiency Building Awards and what spur NLB to take part in such an award.

The Asean Energy Efficiency Building award is a competition organised by the intergovernmental organisation, Asean Centre for Energy (ACE), for buildings with good energy performance in the various Asean countries. The BCA Green Mark Advisory Committee nominated the National Library Building for this award in 2007 under the New and Existing Building category.

NLB also wanted to share our experience in developing an energy efficient building not only locally but also with other regional countries. The National Library Building won the first prize in the New and Existing Building category. A workshop was also organised to share the experiences of the various winning entries for the delegates from all the Asean countries.

7. How would you suggest existing buildings in a tropical climate like Singapore's, which consumes one third of total energy, be made more energy efficient?

Retrofitting existing buildings to achieve greater energy efficiency would first need the building owner's willingness to achieve it. It would also entail detailed monitoring and recording of data, which would help to determine the amount of energy savings achievable. The building owner would then need to ensure that the various measures are implemented.

Incentives, both fiscal and monetary, from the relevant authorities may also help existing building owners to retrofit their buildings for more efficient use of energy.

8. Do you think making energy consumption data publicly available would be effective in letting building owners/managers to know where their buildings stand in relation to the other similar building type in Singapore?

Yes, we would agree that the data should be publicly available. However, this alone may not be enough. The data needs to be understood by building owners/managers and their support of how being energy efficient is beneficial to all is imperative.

Green Mark for Districts

A new member in the BCA Green Mark family

The BCA Green Mark scheme is fast becoming the de facto Green Building Rating Standards in the tropical region not only in Singapore but also in other Southeast Asian countries. As part of BCA's continuous efforts to expand our green reach beyond buildings, BCA has introduced three new Green Mark categories. They are the Green Mark for Office Interior, Green Mark for Infrastructures and Green Mark for Landed Houses, all of which were launched during the last BCA Awards Ceremony in May 2009. BCA is now introducing a new rating scheme for large scale built environment developments. Called **Green Mark for Districts**, it evaluates the environmental performances of a district or precinct, comprising various types of infrastructures, buildings and public amenities, as a holistic system. The criteria cover energy efficiency, water conservation, material/waste management and innovative features. Since 2008, BCA has worked closely with industry partners and master-developers on two pilot projects under the new scheme, the University Town in National University of Singapore and Resorts World Sentosa. Through the pilot studies, the two projects were able to be reviewed, improving the master-planning and building designs to achieve environmental sustainability in a more comprehensive and in-depth manner.

NUS University Town

NUS University Town is a 19.15 ha mixed-use residential, educational and research development connected by a vehicular, bicycle and pedestrian bridge to the main NUS Kent Ridge campus across AYE. The campus is designed and maintained to be a safe and vibrant campus with residential colleges and educational facilities nestled within a lush tropical landscape. Through practical passive design principles and respect of existing ecological habitat and site topography, the campus aims to encourage a sustainable lifestyle to complement the pedagogical experience of the local and foreign students in this living and learning campus.This vision of a sustainable campus environment are exemplified by three key objectives:

(1) to strive towards achieving a Carbon Neutral Campus
(2) to encourage the growth of an Ecological Biodiversity Habitat
(3) to create a Pedagogical Sustainable Environment that is enjoyed by the residents of this campus.

NUS University Town

Resorts World Sentosa

Resorts World Sentosa

Resorts World Sentosa (RWS) is a family holiday destination slated for a 49 ha site on Singapore's Sentosa Island in 2010. Set amidst lush greenery, the resort is built with the objective to be a sustainable development with considerable efforts made during the design stage to conserve the environment and to use breakthrough green technologies. Some of the eye-grabbing green features include the relocation of 200 pieces of coral which would otherwise have been eradicated by land reclamation. In addition, RWS has started relocating about 200 of the site's 3000 trees to a temporary nursery. They will subsequently be replanted in about three years time. Another 700 trees, including those in a 2.9 ha coastal forest located on the western edge of the construction site, will also be left untouched. About 300 trees that could not be saved are to be recycled for timber and will return to the resort as furniture, souvenirs and construction structures. Furthermore, 500kWp PV Panels will be mounted on the Dark Ride 1 building in the Universal Theme Park to generate power to a grid tied system.

For more information on the Green Mark Districts, please contact: Dr Gao Chun Ping, 6325 5009, ***gao_chun_ping@bca.gov.sg*** or Mr Lee Jang Young, 6325 5085, ***lee_jang_young@bca.gov.sg***

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* Source: U.S. Energy Information Administration