

# BUILDgreen

Building and Construction  Authority  
We shape a **safe**, **high quality**, **sustainable** and **friendly** built environment.

ISSUE 13/2018

## BuildSG

TO PARTNER INDUSTRY  
IN IMPLEMENTING  
CONSTRUCTION INDUSTRY  
TRANSFORMATION

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PRACTICES

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# CEO'S MESSAGE

2017 was an eventful and fruitful year for the Building and Construction Authority (BCA) as we embarked on many exciting new developments and charted out key thrusts of industry transformation. In September, we convened the 4<sup>th</sup> International Panel of Experts for Sustainability of the Built Environment which reviewed the initiatives of our 3<sup>rd</sup> Green Building Masterplan to guide the next leg of Singapore's green building journey. In the same month, during the Singapore Green Building Week (SGBW), we gave out the SGBC-BCA Sustainability Leadership Awards in recognition of industry stakeholders who have contributed in driving environmental sustainability in the built environment.

Following the launch of the Construction Industry Transformation Map (ITM) in October last year, BCA has been working closely with our tripartite partners to collectively transform our sector into one that is productive, competitive, and sustainable, so as to offer good jobs for people in our industry. A transformation office, BuildSG, comprising three centres - iBuildSG, weBuildSG, and SGBuilds - was formed to drive collaboration with the Trade Associations and Chambers (TACs), industry firms, Institutes of Higher Learning (IHLs) and unions, to level up efforts in workforce capability, industry transformation and internationalisation.

In addition, as the Facilities Management (FM) industry plays a crucial role in maintaining a high quality built environment, BCA is also coordinating the development of Singapore's FM sector. Together with TACs and other partners, we are in the midst of formulating and implementing transformation plans to uplift the FM sector too.

As Singapore works together towards the national goal of 'greening' 80 percent of our buildings by gross floor area (GFA) by 2030, there is a need for greater community engagement to raise awareness of our green efforts. Our BCA-MOE Back to School (B2S) programme is one such outreach effort, which was enhanced to welcome green-minded built environment firms on board as industry mentors to help nurture the next generation of green professionals. In addition, the North West Community Development Council (NWCDC) is also taking the lead in helping residents in the North West District to lead more sustainable and green lifestyles through their green programmes such as Green Homes @ North West. I am confident that these ground-up initiatives will give us further motivation to forge closer collaborations with communities.

It is heartening to note that building users appreciate the benefits of green buildings. A local survey conducted by Frost & Sullivan last year showed that residents in Singapore have a keen interest and are aware of the benefits and value that green buildings can bring. Such findings are indeed crucial in helping us better understand how stakeholders perceive green buildings and direct our engagement efforts more effectively in the next lap of Singapore's green building journey.

I am glad to share that BCA is all geared up for our annual event, International Green Building Conference (IGBC) 2018 at the SGBW to be held from 5-7 September 2018 at the Marina Bay Sands. The theme "Build Green: Build Smart, Build Communities" is an apt one for this Year of Climate Action. We will be focusing on driving smarter, greener and higher quality buildings for Singapore. I look forward to your support and participation at the event!

**Mr Hugh Lim**  
*Chief Executive Officer*



# 4<sup>TH</sup> INTERNATIONAL PANEL OF EXPERTS

## ON SUSTAINABILITY OF THE BUILT ENVIRONMENT (IPE-SBE)

**Reviewing BCA's Green Building Masterplan and accelerating Singapore's green building movement.**

The International Panel of Experts (IPE) on Sustainability of the Built Environment comprising leading experts in green building and environmental sustainability was convened in Singapore in September 2017.

The IPE engaged in rigorous discussions with BCA and key representatives from the public, private and people sectors to review the various initiatives under the 3<sup>rd</sup> Green Building Masterplan. Recommendations were also made by the experts present to help accelerate our green building movement and take us further on our environmental sustainability journey.



CO-CHAIRS	
CEO/BCA	Mr Hugh Lim
Chairman/WorldGBC	Mr Tai Lee Siang
President/SGBC	Mr Tan Swee Yiow
Honorary Advisor, Founding president/SGBC	Er. Lee Chuan Seng

DISCUSSION TOPICS
Smart green existing buildings to meet our 80% national target
Zero and super low energy in the Singapore context
Applying behavioural science to nudge owners, tenants and the public
Getting tenants to play their part
Capability building for a thriving green building ecosystem
How can green buildings be healthier in the Singapore context



Figure 1: IPE-SBE Discussion





## SNIPPETS FROM THE IPE'S DISCUSSIONS

### SINGAPORE'S GREEN BUILDING JOURNEY

The IPE agreed that Singapore has made significant progress in its green building movement since the BCA Green Mark was launched in 2005. Looking ahead, BCA will intensify measures towards its 80% green GFA target. The IPE also supported BCA's vision to realise Zero Energy buildings in the tropics and for green buildings to go beyond energy efficiency and provide healthier spaces for its occupants.



Singapore's significant progress in the green building arena over the past 12 years is commendable. I am confident that with the strategies in place and its plans for the future, BCA and its partners will be able to overcome challenges to achieve zero and positive energy buildings that are greener and healthier.



**Stephen Selkowitz,**

Senior Advisor for Building Science,  
Lawrence Berkley National Laboratory



Figure 2: Mr Jeffrey Chua, CEO, Ascendas Services shared on the role played by facilities managers in ensuring optimal building performance.

### RAISING STANDARDS OF FACILITIES MANAGEMENT

Beyond greening more buildings, the IPE emphasised the need to ensure current Green Mark buildings maintain their efficient building performance throughout their lifetime. Operation & Management (O&M) accounts for the bulk of a building's life cycle cost and significant energy savings can be accrued from optimising O&M processes. Sound facilities management (FM) processes play a critical role in optimising green building systems so they can achieve their design performance. Some of the recommendations put forth included making considerations for FM processes during the design stage, building FM capability and driving the uptake of data analytics.

### STRONGER PUBLIC ENGAGEMENT ON SUSTAINABILITY

Outreach is key to sustainability in the built environment. The IPE particularly focused on raising awareness of green buildings in schools and institutions to nurture the next generation of green-minded Singaporeans, cultivating them to become stewards of the built environment to sustain the current green building momentum. The IPE members commented that technology and social science, when combined, would achieve a very big impact in spurring climate action. The ideas they offered included incorporating green building messages in school curriculums, strategic public-private partnerships and even a national energy saving challenge!



Figure 3: Ms Lynette Leong, CEO, CapitaLand Commercial Trust (CCT) shared on CCT's green journey and working together with tenants to achieve sustainability outcomes.



Figure 4: Dr Wolfgang Kessling, Partner and Principal, Transsolar Energietechnik shared on his experience with low energy-high comfort concepts for buildings in hot and humid climates.

### EXPLORING INNOVATIVE STRATEGIES TO ACHIEVE OCCUPANT COMFORT AND ZERO ENERGY BUILDINGS

As Singapore is located in the tropics, air-conditioning is an essential but energy intensive building service. The IPE challenged traditional notions of comfort in Singapore and explored looking beyond efficient air-conditioning as the only strategy to create thermal comfort in the tropics. Doing so would require deeper R&D in certain areas such as elevated air speed, hybrid cooling and adaptive cooling. It may also involve changing public perceptions and behaviour with regard to what optimum thermal comfort constitutes.

**LOOK OUT** FOR THE IPE'S COMPLETE LIST OF RECOMMENDATIONS AND THE OUTCOMES OF THE 3<sup>RD</sup> GREEN BUILDING MASTERPLAN REVIEW DURING THE SINGAPORE GREEN BUILDING WEEK 2018

# BUILD SG TO PARTNER INDUSTRY IN CONSTRUCTION INDUSTRY TRANSFORMATION

At the Building and Construction Authority (BCA) Awards ceremony, Minister for Social and Family Development and Second Minister for National Development, Mr. Desmond Lee, unveiled the official BuildSG logo which signifies a national movement that encapsulates the spirit of collaboration in transforming our built environment sector to *Build Singapore*.

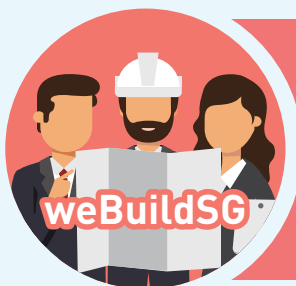
## BuildSG

### COLLABORATION TO TRANSFORM THE BUILT ENVIRONMENT SECTOR

THE TRANSFORMATION OFFICE FOR THE SECTOR  
COMPRISES THREE CENTRES



will work with Trade Associations and Chambers (TACs) and key firms to uplift the perception of and practices in the sector to attract, develop and retain more talent and provide better jobs for Singaporeans, especially at the professional, managerial, executive and technical (PMET) levels. It will also function as a career office and provide support for interested individuals and those already in the built environment sector.



will be the go-to centre for firms and TACs, as they work on translating the Industry Transformation Maps (ITM) into detailed action plans for implementation. Their current goal is to build up expertise in the transformation areas identified under the Construction ITM, namely Design for Manufacturing and Assembly (DfMA), Integrated Digital Delivery (IDD) and green buildings. Through various initiatives and government support schemes, weBuildSG will work with firms and TACs to build up capacity and capability to meet Singapore's domestic needs and grow to offer their services internationally.



seeks to bring firms together to collaborate in bringing the Singapore brand of development and construction overseas. It will support firms in their internationalisation efforts through building stronger networks and cultivating deeper ties in overseas markets, sharing knowledge on overseas opportunities, and facilitating formation of cluster-level consortiums for projects of interest.

# DATA CENTRES EMBRACE IDCEM TO BOOST ENERGY EFFICIENCY

Data Centres (DCs) account for 9% of Singapore's total electricity demand in 2015<sup>1</sup>. With a growing demand for services such as cloud computing, Internet of Things (IoT) and Artificial Intelligence, the electricity consumed by DCs is projected to increase to 12% by 2020<sup>2</sup>. This is especially so as DCs usually operate 24/7, with air-conditioning accounting for 40% of its electricity consumption.

In 2012, the Building and Construction Authority (BCA) and the Infocomm and Media Development Authority (IMDA, then IDA) collaborated to develop the BCA-IMDA Green Mark for Data Centres rating system for new and existing DCs to drive the adoption of energy efficient design, technologies and systems in the DC sector. Over the years, the industry has become more familiar with the green strategies that they can incorporate to improve the power usage effectiveness (PUE<sup>3</sup>) of DCs.

## EMBRACING INTELLIGENT DATA CENTRE ENERGY MANAGEMENT (IDCEM)

Recently, a Singapore-based DC operator, Racks Central Pte Ltd, embarked on a major retrofitting plan for their public DC operating from 23 Tai Seng Drive. The project team set an ambitious plan to improve their average PUE which is above 2, to 1.43, making it potentially one of the most energy efficient DCs in Singapore.

Supported by BCA's Green Buildings Innovation Cluster Demonstration Scheme (GBIC-Demo)<sup>4</sup>, Racks Central proposed to adopt a suite of innovative energy efficient technologies to achieve this target. These include:

- replacing the existing air-cooled chillers with water-cooled magnetic-bearing chillers to allow for better part-load efficiencies and lower life-cycle cost compared to conventional screw and centrifugal chillers, resulting in a significant improvement in chiller efficiency;
- installing regulating valves and variable speed drives (VSDs) on the Computer Room Air Handling Units (CRAH), controlling dampers to minimise fresh air intake and bypassing heating coils to cool and dehumidify the air;

- consolidating the existing Uninterrupted Power Supply (UPS) dedicated for each data hall into pooled UPS with load shifting and double-conversion bypass capabilities, while maintaining the 2N setup to ensure that there is no disruption to the DC in the event of an extended power outage; and
- deployment of IOT sensors and machine learning software, which has the capability to carry out data analytics and self-optimisation of chillers, airside and UPS systems, thus helping the company to better manage energy efficiencies across the whole data centre.

## INNOVATING FOR GREENER DCs

Working with Kaer, a Singapore-based energy service company (ESCO) and technology integrator, Racks Central Pte Ltd will be adopting the International Performance Measurement and Verification Protocols (IPMVP) to validate the performance of the adopted technologies.

The project is expected to be completed in 2019. Once completed, it will be a useful platform to demonstrate how greater energy savings can be achieved through embracing new innovative green technologies.

Figure 5: Data Centre at  
23 Tai Seng Drive



<sup>1</sup> Source: Fact Sheet (19 Jul 2017) IMDA, Huawei and Keppel Data Centres Sign Memorandum of Intent to conduct a joint-feasibility study for a first-of-its-kind High-Rise Green Data Centre Building

<sup>2</sup> With the sector accounting for 50% of the region's DC capacity, making Singapore the DC hub of Southeast Asia

Source: Fact Sheet (19 Jul 2017) IMDA, Huawei and Keppel Data Centres Sign Memorandum of Intent to conduct a joint-feasibility study for a first-of-its-kind High-Rise Green Data Centre Building

<sup>3</sup> PUE indicates the ratio between the energy consumed by a DC (inclusive of the facility itself and its IT equipment) against that utilised by the equipment. A PUE of 1 is ideal but impossible to achieve due to power losses during cooling and delivery. According to a study conducted by NEA in 2012, the average PUE for existing DCs in Singapore is about 2.07.

<sup>4</sup> The GBIC-Demo Scheme co-funds up to 70% of the qualifying costs of demonstrating innovative energy efficient technologies that are able to achieve at least 20% energy savings compared to the best-in-class building energy efficiency index (BEEI).

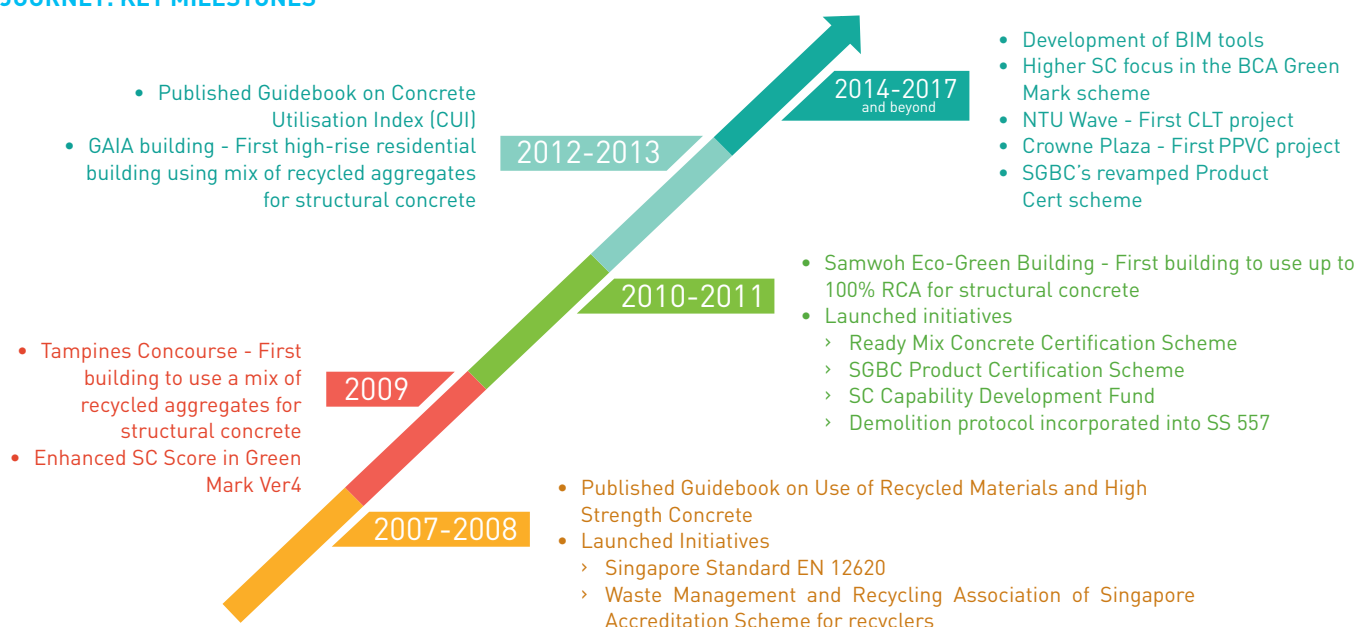
# BCA'S SUSTAINABLE CONSTRUCTION JOURNEY



*It is important that we ensure a steady and adequate supply of construction materials such as sand and granite supplies for the built environment sector. Over the years, BCA has spearheaded the Sustainable Construction (SC) efforts to drive the whole construction value chain. To this end, BCA has been working closely with the relevant industry stakeholders.*

A slew of initiatives implemented by BCA has helped the industry to build up the necessary skill-set, technical know-how and capabilities in sustainable construction materials.

## SC JOURNEY: KEY MILESTONES



## SCORING MATERIAL ACHIEVEMENTS VIA INNOVATION

The recent innovation by Newsoil Technologies to convert excavated non-contaminated soft clay into stable reclamation material again shows our industry's technical capabilities. Besides soft clay, other materials that could be potentially used for higher value building and construction applications include Incineration Bottom Ash (IBA) and sedimentary rocks from Jurong Rock Cavern (JRC). Although it would take some time before these materials are tried and tested and the relevant codes and regulations put in place, advancement in material science and technology has opened up exciting possibilities for their use. Such materials might one day even be incorporated into the Design for Manufacturing and Assembly (DfMA) process for constructing our future homes.

materials like ferrous metals (such as steel), recycled concrete aggregates and used slag (such as steel slag and Washed Copper Slag (WCS) are well over 98%. Moreover, materials such as IBA and WCS which are produced by other industrial sectors, have now been given a newfound niche within the building and construction sector!

Therefore it is important that we continue to drive such efforts as the price for not sustaining our built environment would certainly be costly. In the next phase, BCA will not only focus on aspects of environmental sustainability but productivity as well to enable more stakeholders to benefit from SC.

## ON TRACK TO THE NEXT LAP

BCA's SC efforts have certainly paid off and Singapore is well on track to achieving near zero waste for the construction industry. Based on NEA's statistics<sup>1</sup>, the reuse and recycling rates of SC

<sup>1</sup> Reference to NEA's website, <http://www.nea.gov.sg/energy-waste/waste-management/waste-statistics-and-overall-recycling>



# UPLIFTING THE FACILITIES MANAGEMENT INDUSTRY

*The facilities management (FM) industry plays a crucial role in maintaining the high-quality built environment that Singaporeans can enjoy. However, the current FM landscape is facing the challenges of an ageing workforce and potential technological disruption.*

There is great opportunity for our firms to grow and improve the delivery of building services, while allowing the FM workforce to enjoy more fulfilling careers. To leverage this potential, the impetus for the Industry Transformation Maps (ITM) initiative, BCA will be coordinating the overall development of Singapore's FM sector under the Real Estate Industry Transformation Map (ITM).

## SMARTER FM, FOR A HIGH QUALITY BUILT ENVIRONMENT

BCA's vision is to have **FM executed in an integrated and efficient manner by a professional and productive workforce for a good quality built environment**. Emphasis will be placed on not only the *upstream* consideration for *Design for Maintainability*, but also *downstream* adoption of smart FM elements during the building's operations phase. We envisage that in the future, FM will leverage the Integrated Digital Delivery (IDD) value chain,

and employ smart technologies to provide a safe, healthy, clean and conducive environment for people to live, work, and play in.

BCA will also seek to nurture an ecosystem to encourage the research and development (R&D) of FM technology solutions, build manpower capabilities and competencies to ensure relevancy, and improve the professionalism and enhance attractiveness of our FM Industry.

In addition, a tripartite FM Implementation Committee (FMIC) has been formed to spearhead the FM transformation. Comprising representatives from companies supplying FM services, industry associations, FM service procurers and government agencies, the FMIC will look into formulating detailed implementation plans to enhance the FM industry, so that we can all enjoy a smart, efficient and well-maintained built environment in Singapore.

## TRANSFORMING FACILITIES MANAGEMENT

### Key Initiatives



#### Design and build places with FM in mind

- Implement district-level FM systems in future precincts
- Maintainability to be systematically considered in the building design



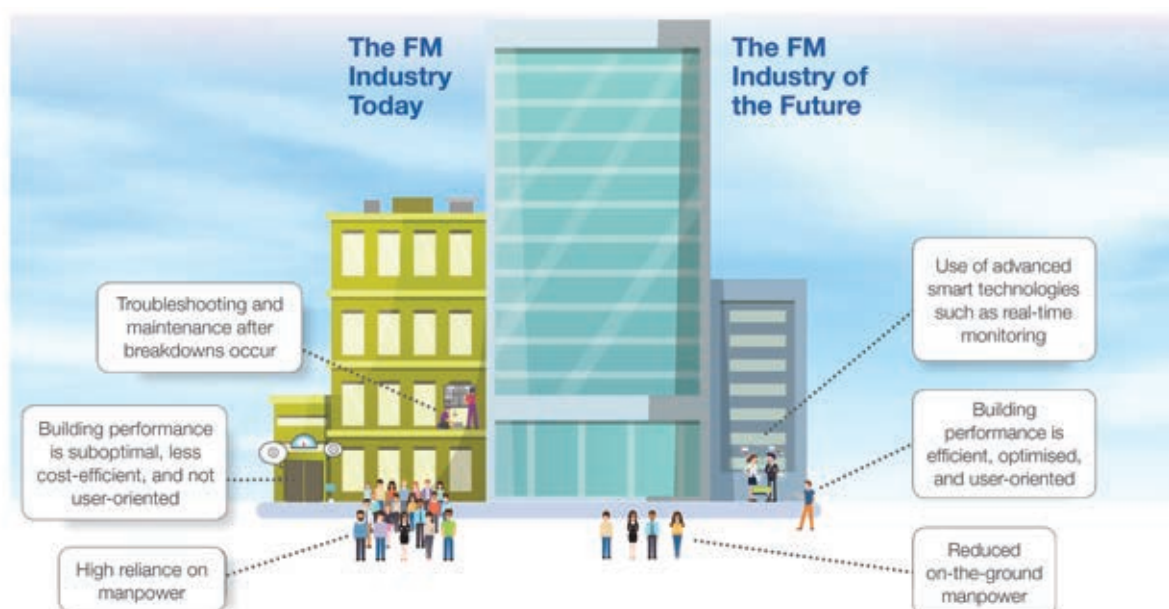
#### Encourage use of innovative FM solutions

- Facilitate adoption of Smart FM solutions island-wide
- Further encourage R&D of FM-related technology



#### Build up local FM talent and raise professionalism and attractiveness of FM industry

- Review and update curriculum in schools
- Expand training and development opportunities
- Study possibility of industry accreditation scheme





JOIN  
NOW

5-7

September 2018

Marina Bay Sands,  
Singapore



# ASIA'S PREMIER GREEN BUILDING EVENT IS BACK



green · smart · communities



Year 2018 has been designated as the Year of Climate Action. It's set to be a milestone year for green building development as well as zero energy and zero carbon initiatives.

The built environment sector is going through rapid changes, brought about by various smart initiatives to raise productivity, improve energy performance and enhance our quality of life. But even as we tap on smarter and more efficient solutions, we need to rally stakeholders and users to come together as a community to help drive the green building agenda.

Themed "Build Green: Build Smart, Build Communities", this year's International Green Building Conference (IGBC) aims to be the premier platform in synergising efforts to develop smart, green and high quality buildings in line with the Construction Industry Transformation Map (ITM).

IGBC 2018 will focus on three transformation areas under the Construction ITM namely Green Building, Design for Manufacturing and Assembly, and Integrated Digital Delivery.

## SINGAPORE GREEN BUILDING WEEK 2017 IN NUMBERS



10,775+

industry  
professionals  
converging  
to exchange  
ideas, share  
experiences  
and network



50+

countries  
represented



67%

are influencers  
or decision  
makers



20%

are  
international  
participants

Organised by

Building and Construction  Authority

Strategic Partners

 Reed  
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SINGAPORE  
GREEN  
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PRODUCT  
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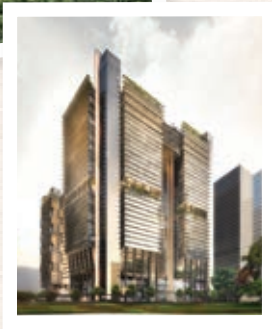
## KEY TAKEAWAYS FROM IGBC 2017

### 1. BEHAVIOURAL CHANGE

The need for behavioural and lifestyle change at the personal and community levels is the key driver to help Singapore achieve its target of 80% green by 2030.



(Top) The Arc at NTU  
(Bottom) Marina One



### 2. PUSHING BOUNDARIES

Industry stakeholders should continue to push boundaries to achieve Super Low Energy (SLE) buildings and engage users in effective ways to combat global warming.



Global warming will increase the demand for smart, healthy and zero energy buildings, giving Singapore great opportunities to demonstrate leadership in the built environment, which will be relevant to many major cities around the world."

**Mr Desmond Lee**

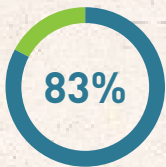
Minister for Social and Family Development and Second Minister for National Development

### 3. COLLABORATION

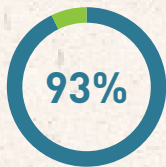
Collaboration between the public, private and people sectors is a crucial factor in accelerating the global transformation of the green building movement.



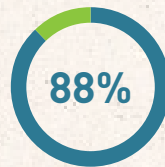
#### SURVEY RESULTS FROM IGBC 2017 DELEGATES



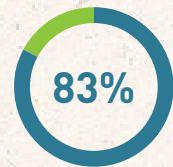
are generally happy with speaker profiles and conference topics



think the duration of the conference is just right



are satisfied with the opportunities for networking



think that IGBC 2017 had a wide variety of speakers and conference topics

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BCA Breakfast Talk for CEOs Sponsor



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# SINGAPORE'S PARTICIPATION IN GREENBUILD 2017

In November last year, 40 representatives from the built environment sector, academia and public agencies spent one week in the United States, visiting government office, research centres and notable green buildings in New York and Boston, en-route to the Greenbuild Conference and Expo held from 8-10 November.

Led by Chief Executive Officer of BCA, Mr Hugh Lim, the delegation made various stops in the two cities to gain a greater understanding of green buildings in action:

## CITY MAYOR'S OFFICE

for Long Term Planning and Sustainability to learn about the success and challenges of various initiatives rolled out towards its carbon reduction target.

## DELOS HEADQUARTERS

which was designed to WELL building standards, to experience first-hand on a healthy office building.

## BLOOMBERG CENTER

in Cornell Tech campus, which was designed to be LEED Platinum, to witness the green technologies and features that would contribute towards its Net Zero Energy goal.

## MASSACHUSETTS INSTITUTE OF TECHNOLOGY (MIT)'S

Photovoltaic research, Organic & Nanostructured Electronics and Big Data Living Labs, to learn about the applications of latest research to green buildings.



Figure 6: CEO of BCA, Mr Hugh Lim (5<sup>th</sup> from right in front row), leading a delegation to the US Greenbuild 2017. Photo taken at the GreenBuild Conference, Boston Convention and Exhibition Center.





Figure 7: "Net Zero Energy Building Design in High Density Urban Cities" presented by Dr John Keung, Dean of BCA Academy, Prof Lam Khee Poh of NUS and Mr Stephen Selkowitz of Lawrence Berkeley National Laboratory (LBNL).

#### SHOWING SINGAPORE IS "ALL IN" ON GREEN BUILDING

Greenbuild 2017, themed "All In", captures the breadth of the green building movement, which is itself living proof that real change does start with the people. The conference put together a stellar line-up of inspiring speakers, covering topics on the latest developments in government policies, technology and research, rating systems and best practices in the global context. The special set "Net Zero Energy Building Design in High Density Urban Cities", which was jointly presented by Dr John Keung, Dean of BCA Academy, Prof Lam Khee Poh of NUS and Mr Stephen Selkowitz of Lawrence Berkeley National Laboratory (LBNL), provided a fresh perspective of Singapore's sustainability journey, and how the various challenges posed by tropical climatic conditions could be overcome in the march towards having Zero Energy buildings. The lively and interactive session drew much interest from the global audience.

Singapore's green building expertise was also showcased at the Greenbuild Expo. At the Singapore Pavilion, exemplary Green Mark projects and corresponding project teams were profiled. Local companies including Elmich Pte Ltd and

Singapore Safety Glass Limited also took the opportunity to exhibit their green building products and services at this prestigious international event.



SAVE  
THE DATE:  
**GREENBUILD 2018  
CONFERENCE  
AND EXPO**

**CHICAGO, IL,  
14-16 NOV 2018**



# BACK TO SCHOOL TO SPUR GREEN PRACTICES

The BCA-MOE Back to School (B2S) Programme is a collaboration between the Building and Construction Authority (BCA) and the Ministry of Education (MOE) to get all schools to achieve the BCA Green Mark (GM) certification. Student interns, also known as GREENterns, from Institutes of Higher Learning (IHLs) are deployed to their alma maters (both primary and secondary schools) to spearhead green initiatives and enhance the schools' environmental programmes and infrastructure, thereby helping them secure the GM certification.



Figure 8: Mr Lee Fook Sun, Chairman, BCA and Mr Hugh Lim, Chief Executive Officer, BCA, with B2S interns at the International Green Building Conference 2017.



Figure 9: B2S interns and industry partners with the BCA team at the International Green Building Conference.





Figure 10: GREENterns conducting sustainability workshops in line with Earth Day for their alma mater.

Under the guidance of BCA mentors, GREENterns would take on the role of GM consultants, to identify areas for improvement before working together with the schools to implement recommendations to close these gaps.

#### WELCOMING NEW PARTNERS ON BOARD

Last year, the programme was further enhanced to welcome green-minded built environment firms on board as mentors to help train up the next generation of green-collared workforce.

On top of the guidance given to GREENterns on the process of greening schools, these industry mentors will also share their insights on the built environment sector and expose the GREENterns to different job scopes in accordance with the firms' expertise.

Through the programme, the B2S-Industry interns were given valuable opportunities to work with various building owners and occupants. This allowed them to gain insights on the goals of different stakeholders, and understand their perspectives in the course of decision-making. The internship experience has given the students much exposure and inspired them to pursue their career in this field.

Participating industry partners have also provided feedback that the B2S-Industry Track has opened up opportunities for talent scouting, with the internship serving as a good opportunity to assess the potential of individual students for recruitment upon their graduation. Furthermore, interns can also contribute by acting as brand advocates for the firms when they share their enriching experience with their peers.

#### FROM SCHOOLS AND BEYOND

Through the collective efforts of the public agencies, industry firms, and schools, more than 40 GREENterns from 7 IHLs have been deployed to more than 70 schools to assist with their GM certifications.

**ADDP**  
ARCHITECTS LLP

**BSD**  
building system & diagnostics

**Carrier**  
Gator Technologies  
turn to the experts

**CPG**  
FACILITIES  
MANAGEMENT

**C&W  
SERVICES**

**DPSD**  
DP SUSTAINABLE DESIGN

**GAC Enterprise**  
新加坡亚世通企业

**G-ENERGY  
GLOBAL**

**GUTHRIE  
GTS**  
Since 1951

**Johnson  
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B2S Industry Partners (As of July 2018)

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3. Carrier Singapore
4. CPG Facilities Management Pte Ltd
5. Cushman & Wakefield
6. DP Sustainable Design
7. G-Energy Global Pte Ltd
8. G.A.C Enterprise
9. Guthrie Engineering Pte Ltd
10. Johnson Controls



The B2S programme marks the beginning of a green building journey for many schools. Through the collaboration with MOE, BCA hopes to trigger a ripple effect to stir up greater ground-up participation and initiatives on environmental sustainability within and beyond the school walls.

For more information, please visit: [https://www.bca.gov.sg/GreenMark/Green\\_Mark\\_for\\_Schools.html](https://www.bca.gov.sg/GreenMark/Green_Mark_for_Schools.html)

# GREENING THE COMMUNITY

**The North West Community Development Council (NWCDC) is taking the lead to help residents in the entire North West District lead more sustainable and green lifestyles.**

Speaking at the second annual Singapore Green Building Council Leadership Conversations forum at The South Beach on 7 July 2017, Dr Teo Ho Pin, Mayor of the North West District, emphasised the importance of collective effort by a committed government, forward-looking industry partners and an active civic society in order to drive sustainability initiatives forward.

## COMING TOGETHER TO GO GREEN

Indeed, going green has become a key message in NWCDC's activities. A part of the Eco CC @ North West initiative, the Bukit Panjang Community Club was awarded with the BCA Green Mark Gold<sup>PLUS</sup> rating early this year. With green building features such as a green wall, photovoltaic system, and energy efficient air-conditioning and lighting systems, the Community Club is able to enjoy estimated energy savings of 6,000 kWh/year along with estimated water savings of 1,000 cubic metres. The plan is to transform CCs into green educational centres, installed with energy and water efficient "hardware" while simultaneously developing green "software" to drive green living messages to residents through regular activities.

## KEEPING TAB, WIDENING ENGAGEMENT

The NWCDC also published the inaugural Green Living @ North West Sustainability Report in March 2017 to communicate sustainability efforts in the North West District more effectively and inspire more partners to strengthen collaboration in promoting green living.



*Figure 11: Dr Teo Ho Pin, Mayor of North West District, sharing on the inaugural Green Living @ North West Sustainability Report.*



*Figure 12: Solar panels helped to provide 20% of energy required by Bukit Panjang community centre.*

As the first-of-its-kind, the Green Living @ North West Sustainability Report details community green efforts in the North West District, summarising the progress of the North West CDC's Green Living @ North West initiatives since the inception of the 10-Year Eco Plan from 2009 - 2016, measures its impact on the community and assesses the NWCDC's future sustainability plans in the coming years to stay on track with the goals set out in the Eco Plan.

One sustainability outreach initiative is the Green Homes @ North West programme, recognising homeowners for their efforts through a simple home audit and certification by volunteers. The volunteers will look at the electrical appliances installed within individual homes to verify whether they have been certified by a recognised energy efficiency rating system, as well as at areas like natural ventilation in the common living areas and established recycling corners.

## BEYOND THE FAÇADE

As Singapore progresses along its national goal of greening 80 percent of the built environment by 2030, the need for community engagement is more important than ever. It is only with the commitment and expertise of passionate organisations structured in a sound public-private partnership, can green building truly reach beyond the façade.



# ENHANCED COMPUTATIONAL FLUID DYNAMICS SIMULATION GUIDELINES

FOR GM NRB: 2015 AND GM RB: 2016

A key strategy of the BCA 3rd Green Building Masterplan is to sustain building performance through the optimisation of design. This can be better achieved if such performance can be more accurately predicted, which in turn calls for an improvement in the way Computational Fluid Dynamics (CFD) is practised.

The BCA Green Mark scheme, launched in 2005, encourages the adoption of effective passive design that leverages the fundamentals in our built environment. The CFD simulation methodology and evaluation matrix used in the BCA Green Mark have recently been enhanced to improve the accuracy of simulations in predicting the actual performance of naturally ventilated spaces. The enhanced methodologies, developed for the BCA Green Mark schemes for new non-residential buildings and new residential buildings (GM NRB: 2015 and GM RB: 2016), aim to improve building performance in terms of air flow, air quality, thermal comfort and mitigation of rain penetration in naturally ventilated spaces. Specific matrices are applicable for different building types including healthcare facilities, industrial facilities, hawker centres, sports facilities, commercial atriums and schools for the NRB requirements, and residential buildings for the RB requirements.

## MORE FLEXIBILITY, GREATER ACCURACY

New guidelines were also developed to provide comprehensive guidance on the setting of computational domain, surface roughness, recommended range of grid size, turbulence model and convergence criteria. Key features of the enhancement made to the CFD methodology and guidelines include:

- Introducing turbulence models beyond the existing k-e model to suit more complex cases;
- Defining surface roughness to maintain wind profile;
- Relaxing of requirements on mesh types and sizes to suit more complicated building geometries; and
- Simplifying of approach for residential buildings based on pressure differences to ease the requirements on computational recourses.

With these enhancements, the accuracy of ventilation simulation can be improved to better predict the actual effectiveness of natural ventilation design, not just in terms of air velocity but also other parameters including: thermal comfort; indoor air quality; and wind driven rain performance.

## A BOON TO PASSIVE DESIGN

Thermal comfort and indoor air quality can be used when evaluating natural ventilation as a viable alternative path for a building. Mechanically assisted fans may be included in the

simulation for both residential and non-residential buildings in instances where there are constraints to achieving the required airflow.

In addition, this new set of CFD guidelines is also the first to introduce Wind Driven Rain (WDR) simulation methodology, encouraging the industry to explore feasible solutions to prevent rain penetration while harvesting good natural ventilation. With the enhanced CFD simulation methodology and guidelines providing a more flexible and holistic approach, architects and designers can now be more confident when predicting actual design performance and hopefully be more motivated to adopt passive design principles in their course of work.

Area	GM RB/NRB V4.1	GM NRB 2015	GM RB 2016
Computational Domain	3 times in vertical and horizontal	BR ≤3%	BR ≤3%
Surrounding Buildings	6 times radius	500 m offset	6 times radius or 500m offset, whichever is smaller
Grid Size	Unit 0.1-0.2m, Domain 10 m	Unit 0.1 - 0.5m, Domain 5 -- unlimited	Unit 0.1-0.2m, Domain 10 m
Inlet Atmospheric Boundary Condition	Log law	Log law with surface roughness	Log law with surface roughness
Ground Surface Roughness	Nil	Aerodynamic and Sand-grain	Aerodynamic and Sand-grain
Wind Profile Horizontal Homogeneity	Nil	Required	Required
Discretization Schemes	1 <sup>st</sup> Order	2 <sup>nd</sup> Order	2 <sup>nd</sup> Order
Convergence Criteria	10 <sup>-3</sup>	10 <sup>-4</sup>	10 <sup>-4</sup>

Table 1: Comparison between GM RB/NRB V4.1, GM NRB 2015 and GM RB 2016.

# BCA GREEN MARK

## FOR EXISTING NON-RESIDENTIAL BUILDINGS 2017 SCHEME

The GM ENRB: 2017 scheme went through one year of piloting from September 2017. It presented a more holistic and market-friendly approach to 'greening' existing buildings in Singapore.

Since its launch in 2005, the BCA Green Mark for Existing Non-Residential Buildings scheme has been continually enhanced to keep pace with improvements in technology, building standards and industry best practices. The GM ENRB: 2017 is the latest criteria under the scheme designed with the aim to future-proof existing buildings, drive incremental improvements in energy efficiency and guide building owners to take practical improvement measures towards achieving total building performance.

Industry stakeholders were engaged extensively in the review and development of the enhanced criteria. The strong industry participation and involvement provided a practical dimension to the scheme and empowered industry professionals with the ownership to strive for better environmental performance.



Figure 13: Schneider Office - Green Mark Platinum Award (GM ENRB: 2017)

Key highlights of the GM ENRB: 2017 include (a) greater tenant and occupant engagement, (b) performance-based procurement for retrofit and maintenance, (c) energy efficiency of the air distribution systems, (d) promoting use of renewable energy, (e) enhanced indoor environment quality, and (f) adoption of smart control technologies.

### SCHNEIDER OFFICE, GREEN MARK PLATINUM AWARD UNDER GM ENRB: 2017

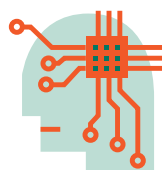
**Schneider Office** is one of the pilot projects that has achieved the BCA Green Mark Platinum award under the GM ENRB:2017 scheme. The company recently relocated and centralised operations to its new hub office at 50 Kallang Avenue in Singapore. The building was originally built in 1998 and retrofitted in 2017 to the highest standards of environmental design and performance. This is part of Schneider Electric's global commitment to stay at the forefront of environmental sustainability, lead the digital transformation in energy management and automation, and become 100% carbon neutral by 2030.

#### KEY GREEN FEATURES



##### RENEWABLE ENERGY

Hybrid model of renewable energy is utilised to power the 9 storey building. Solar energy is generated from on site photovoltaic panels. Additionally, off-site renewable energy is purchased to power 45% of the building's total estimated energy consumption.



##### SMART TECHNOLOGIES

Cooling and lighting systems are integrated with Schneider Electric's own interconnected systems enabling network convergence, data analytics and future ready power distribution.

# EVALUATION OF ENERGY PERFORMANCE FOR HOT WATER SYSTEMS

A central hot water system accounts for approximately 5% -10% of a building's energy consumption and therefore offers potential for energy savings. In 2017, a study was conducted to evaluate the performance of typical central hot water systems and establish a performance baseline for such systems.

A building's central hot water plant generally consists of the heating equipment, circulation and make-up water pumps, storage or calorifier tanks and auxiliary heaters (if any).

In 2017, a study was commissioned to evaluate the performance of typical central hot water systems with the objective of establishing a performance baseline for such systems. Six buildings, comprising hotels and hospitals, were selected for the purpose of this study. These buildings use chilled water- (CHW) source, condenser water- (CDW) source or air-source heat pumps.

## METHODOLOGY OF THE STUDY

The Coefficient of Performance (COP) serves to denote the ratio of useful heating or cooling achieved versus the corresponding power input. However, this commonly used performance indicator does not take into account the energy consumption in relation to auxiliary equipment. Hence, as part of the study, a Hot Water System Ratio (HWSR<sup>1</sup>) was proposed to more accurately represent the performance of a building's central hot water plant.

## FINDINGS AND OBSERVATIONS

In the audited buildings, the efficiency of the heat pumps is rated at an average COP of 3. However, it was observed that the operating COP scores are in fact lower. From the perspective of the whole plant, there is a significant performance drop after accounting for the thermal energy losses, which at a range of 26% to 72% (refer to Table 2) are considered substantial. This is primarily due to losses occurring during plant standby and through the building's hot water circulation network.

In relation to the findings highlighted above, the study has shown that in addition to system design, type of heating equipment used and equipment efficiency, hot water plant performance is

also determined by the level of insulation installed. Although the code of practice (SS553:2016) recommends a minimum pipe insulation thickness for heating systems, there is a need to create greater awareness on the issue of energy losses and closer supervision to ensure proper installation.

One of the recommendations made after the study is to install accurate measurement and verification (M&V) instruments comprising temperature sensors, flow meters and power meters. With the trended data, building owners and facility managers can then monitor plant performance and identify areas for improvement, and therefore be better positioned to address these issues.

## MOVING FORWARD

The proposed HWSR performance baselines for new and existing buildings are 1.60 and 1.45 respectively. For new hot water plants still at the design stage, we should strive for higher efficiency while for existing systems, incremental improvements could be made through system optimisation and proper maintenance measures.

The results of the study can serve to create greater awareness on the design and operating efficiency of hot water systems and potential for energy savings via reduction of energy losses. This is especially important in air-conditioned buildings as any energy loss contributes directly to an increase in the air-conditioning load.

Building owners are encouraged to install M&V instrumentation to monitor their operating system performance. Preventive maintenance can be carried out more effectively with the help of such instrumentation and a maintenance program involving regular inspections on the central hot water plant.

Description\Buildings	Building 1 CHW source heat pump	Building 2 CHW source heat pump	Building 3 CDW source heat pump	Building 4 CDW source heat pump	Building 5 Air source heat pump	Building 6 Air source heat pump
Heat Pump COP ( $\text{kW}_T / \text{kW}_E$ )	2.11	2.41	3.39	3.76	2.48	2.94
Total Energy Loss in Hot Water System (%)	26%	37%	46%	47%	72%	52%
Hot Water System Ratio	2.08	1.23	1.37	1.46	0.66	1.49

Table 2: Summary on audit findings

<sup>1</sup> HWSR is a ratio of the effective hot water thermal energy consumption to the total electrical energy input by the entire hot water system less any effective energy recovered from water-source heat pump.

# LOCAL SURVEY SHOWS STRONG DEMAND FOR GREEN BUILDINGS

A survey involving some 2,200 respondents found that half of the homeowners were willing to pay 3-4% more for green buildings.

A survey conducted recently in Singapore with more than 2,200 respondents comprising homeowners, office tenants, property agents, facility managers and developers found that a majority of them understand the benefits associated with green buildings. More than half of the homeowners surveyed were also willing to pay a premium for such buildings. The survey, which quizzed the respondents about their perception of green buildings, was commissioned by the Building and Construction Authority and conducted by management consultancy firm Frost & Sullivan.

## **BENEFITS OF GREEN BUILDINGS**

The respondents were clearly aware of the tangible and intangible benefits of green buildings, with over 90% of them perceiving that green buildings result in:

1.



Lower utility bills (cited by at least 88% of the respondents)

2.



Reduced environmental impact (cited by at least 87% of the respondents)

3.



Better health benefits (cited by at least 85% of the respondents)





In particular, about 80% of the office tenants who were surveyed agreed that green buildings lead to higher productivity and efficiency, with 86% of them highlighting that this also leads to better health benefits for their employees. This affirms the findings from a recent research study conducted by BCA and NUS on Indoor Environmental Quality, which concluded that BCA Green Mark buildings provide a healthier indoor environment. Occupants in these buildings were also more satisfied with their indoor environment and have less risk of experiencing sick building syndrome.

**BUSINESS CASE FOR GREEN BUILDINGS**

The respondents were aware of the commercial value of green buildings. More than 70% homeowners acknowledged that green buildings enjoy a better resale value and about half of them were willing to pay approximately 3% to 4% more for a green building that is certified by the BCA Green Mark, due to the perceived benefits. 72% of developers indicated that they would prefer to invest in or purchase a green building over a non-green building, and were willing to pay up to 5% more.

Reiterating the confidence in green buildings, 80% of the property agents interviewed agreed that green buildings help improve sales and that their clients show a preference to invest in, purchase or rent green developments. They felt that their clients would be willing to pay up to 7% more for a home or office in a green building, as compared to one in a non-green building.

Interviews with office tenants showed that they were willing to pay an average of 3.5% premium in lease for an office in a green building, due to the perceived benefits for their employees. Typically, they expect to generate returns on their higher investment in 7 to 8 years.

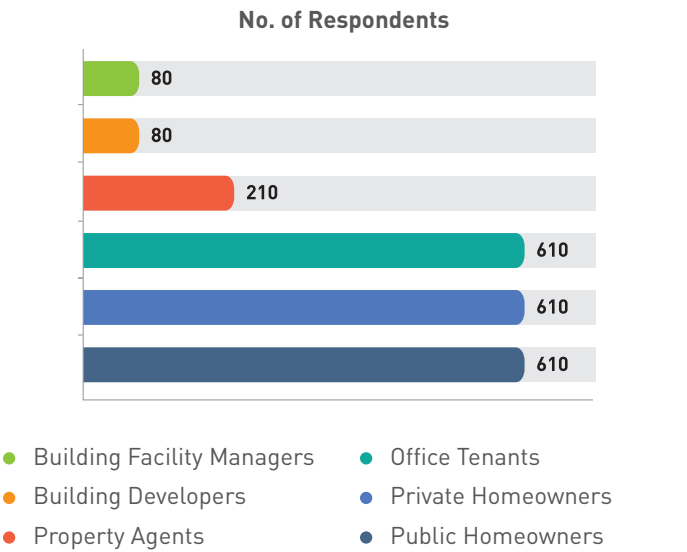
**GREEN BUILDINGS GAINING PUBLIC TRACTION IN SINGAPORE**

The findings from the survey affirm the keen interest that residents in Singapore have for green buildings and their awareness of the benefits and value that green buildings bring. Mr Hugh Lim, Chief Executive Officer of BCA, said: “The findings of the survey will help us better understand how our stakeholders perceive green buildings. As BCA continues to engage stakeholders in the next lap of Singapore’s green building journey, we want to have more targeted approaches to reach out to building users, as well as to raise greater awareness of the BCA Green Mark and the benefits green buildings bring. As more people appreciate green buildings and create demand for them, we expect that green buildings will become a design norm in the near future.”

The findings of the survey were shared with developers and practitioners from the built environment sector at an industry event organised by the Singapore Green Building Council (SGBC). Mr Tan Swee Yiow, President of SGBC, said, “With environmental sustainability gaining traction in Singapore, it is important for developers to adopt an integrated approach in the way they design, construct and operate developments. Green buildings, offering better indoor environmental quality and improved overall well-being for its occupants, reap long-term cost savings for both the property owners and their occupiers. SGBC will continue to work with BCA to drive engagement and education efforts to create better places for people with reduced environmental footprint, and advocate responsible procurement practices in the industry.”

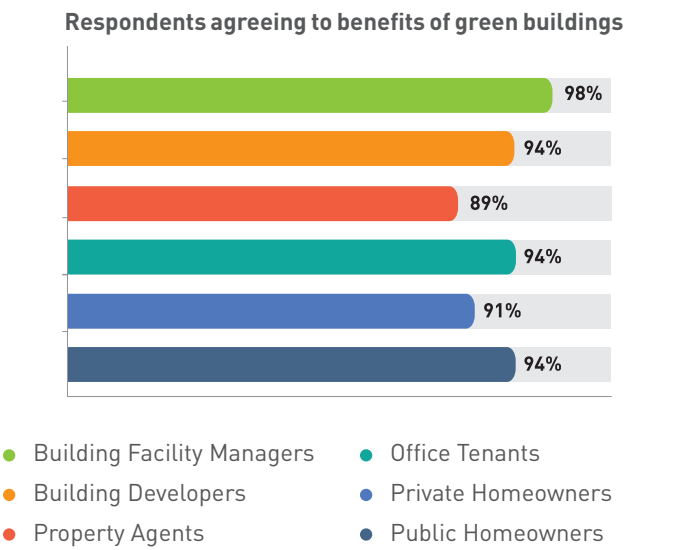
**ANNEX A**

Below is the breakdown of the types of respondents who participated in the survey:

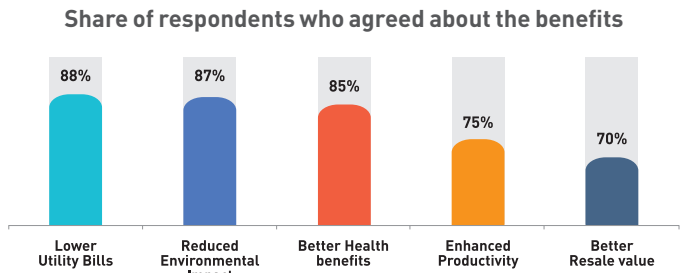


**ANNEX B**

The share of respondents who agreed that green buildings lead to benefits is shown in the chart below:



The majority of the respondents believed that green buildings result in the following types of benefits:





# PUSHING THE BOUNDARIES TO GREEN OUR BUILT ENVIRONMENT

The Singapore Green Building Council (SGBC) and BCA jointly held the SGBC-BCA Sustainability Leadership Awards in 2017 to recognise individuals who have contributed to Singapore's sustainability development, projects with sustainable design and performance, and companies which embrace sustainable practices.

The Awards were given in three main categories:

**The Green Building Individual Award**

**The Business Leadership in Sustainability Award**

**The Leadership in Sustainable Design and Performance Award**

## GREEN BUILDING INDIVIDUALS

Recognises individuals and professionals in the green building industry with outstanding achievements and contributions to the sustainable development of Singapore and Green Mark.



**Dr John Keung,**  
Dean, BCA Academy

### GREEN VISIONARY AWARD

Highly-driven and passionate forerunners who have effectively transformed the industry and continue to shape, lead and influence sustainability efforts locally and regionally.

As the Chief Executive Officer of BCA from 2006 to 2017, Dr Keung played a key role in spearheading Singapore's green building movement with the launch of the nation's first Green Building Masterplan in 2006. Since then, Singapore's green building development has grown from strength to strength. Recognising that achieving a sustainable built environment requires collaborative efforts with the private sector, Dr Keung also played an instrumental role in the formation of the industry-led Singapore Green Building Council (SGBC) in 2009. For his vision, passion and contributions to the green building scene over the years, Dr Keung was the unanimous winner for the Green Visionary Award.

## OTHER GREEN BUILDING INDIVIDUAL AWARDS:



**GREEN  
ADVOCATE OF  
THE YEAR**

**Ms Esther An**  
Chief Sustainability Officer  
City Developments Limited



**GREEN  
ARCHITECT OF  
THE YEAR**

**Ar. Khoo Poh Bin**  
Deputy Managing Director  
DCA Architects



**YOUNG GREEN  
ADVOCATE OF  
THE YEAR**

**Ms Joanne Koh**  
Course Manager  
Temasek Polytechnic



**YOUNG GREEN  
ADVOCATE OF  
THE YEAR**

**Mr Quek Yang Thee**  
Assistant Programme Chair (DGEM)  
Republic Polytechnic



**GREEN  
ARCHITECT OF  
THE YEAR**

**Ar. Kuan Chee Yung**  
Senior Vice President  
CPG Consultants Pte Ltd



**GREEN  
FACILITIES  
MANAGER OF  
THE YEAR**

**Er. Tong Kok Kwang**  
Project Director/ Principal  
Mechanical Engineer  
Nanyang Technological University



**YOUNG GREEN  
INNOVATOR OF  
THE YEAR**

**Mr Zac Toh**  
Director  
GWS Living Art Pte Ltd



**COMMENDATION:  
GREEN  
ADVOCATE**

**Ar. Quek Ser Bock**  
Deputy Director (Design  
Implementation)  
Housing Development Board

## GREEN BUILDING ORGANISATIONS

Recognises companies that have demonstrated deep integration of sustainability into their business models and have contributed significantly to the transition towards a sustainable built environment.

## BUSINESS LEADERSHIP IN SUSTAINABILITY

### City Developments Limited



**CITY  
DEVELOPMENTS  
LIMITED**

- “Conserving as we Construct” since 1995 to promote recycling, reduce waste and raise productivity
- Net zero carbon emissions for corporate office since 2009
- Company-wide sustainability policy and committee
- Emphasis on sustainability across entire supply chain
- Robust assessment of suppliers and builders
- Strong relationship with tenants: Green Lease
- Recognised global thought leader in sustainability
- Multiple end-user outreach and education programmes

### Interface

**Interface®**

- “Mission Zero” since 1994 to eliminate any negative impact on the environment
- On track to achieving mission by 2020 through 7-front framework
- Sustainability-focused company culture
- Life Cycle Assessment to track manufacturing carbon emissions
- ReEntry Carpet Recycling Program
- Inclusive Purchasing Policy, Internal Transportation Programs
- Deriving business value through sustainability
- Requiring new hires to undergo mandatory sustainability induction
- First carpet manufacturer to achieve highest SGBP-Leader rating

## LEADERSHIP IN GREEN BUILDING PRODUCT

### AGC Asia Pacific Pte Ltd

**AGC**

- Environment identified as shared value for the entire group
- Corporate environmental policy reflect due consideration for the environment
- CSR Committee established since 2005
- CSR Reporting Framework, Integrated Environment Management System and GRI V4 guidelines

### Akzo Nobel Paints (Singapore) Pte Ltd



- Target set to reduce carbon emission by 20-30% by 2020
- Green office with energy efficient fittings, practices, etc
- Sustainable business: life cycle of products, sustainable sourcing
- Resource efficiency: reduction in emissions, resource use, etc
- Sustainability functional training for key functions such as Sales, Marketing, Supply Chain and RD&I
- Global Sustainability Day

## GREEN BUILDING PROJECTS

Recognises pioneering green building projects that deliver a range of benefits through a holistic approach to sustainability. These are projects that go beyond simply minimising their impact by considering factors that lead to positive outcomes for both the environment and people. There are three sub-categories in this Awards category.

## LEADERSHIP IN SUSTAINABLE DESIGN & PERFORMANCE - COMMERCIAL

### Alexandra Point

438 Alexandra Road, Singapore 119958



Alexandra Point exemplifies how an existing building of >20 years can be retrofitted to operate in a sustainable manner and as efficiently as a brand new building.

- Ranked among Top 10 Commercial Private Office Buildings in 2015 and 2016 Building Energy Benchmarking Report
- Offices at some levels attained GM Office Interior Gold<sup>PLUS</sup>
- Energy savings of about 36% after retrofitting
- NEWater used for cooling tower and irrigation
- Sustainability seminar talks conducted for tenants & stakeholders
- Recycling bins and electronic waste bins placed at prominent locations

## LEADERSHIP IN SUSTAINABLE DESIGN & PERFORMANCE - INSTITUTIONAL

### Our Tampines Hub

1 Tampines Avenue 4, Singapore 528523



The team has adopted extensive green and eco-design features and considerations in Tampines Hub to create an integrated space for the community.

- Excellent chiller plant design to achieve system efficiency of below 0.60kW/RT
- PV panels to help meet the energy needs of the building
- Highly insulated façade with low-E double glazing
- Green Leasing adopted to increase tenants' environmental awareness
- Reuse of concrete waste from demolished buildings
- Eco-Digester Centre and Eco-Signages/ collaterals liberally displayed within the Hub

## LEADERSHIP IN SUSTAINABLE DESIGN & PERFORMANCE - RESIDENTIAL

### Blossom Residences

34 Segar Road, Singapore 677721



Blossom Residences has incorporated extensive passive design features coupled with active education of residents on its ecological design.

- Orientated in the North-South direction with good cross ventilation for all units
- Extensive lush landscape deck
- Sky garden, green wall of multi-storey carpark and green roof of clubhouse further enhance the ecological design
- Informative signage on sustainable ecological design such as “Clean Waterway” and “Green Infrastructure”

2030 (TARGET)

80%

July 2018

>36%

2010

10%

2005

0.5%



# PERCENTAGE OF GREEN BUILDINGS (by Gross Floor Area) IN SINGAPORE