SG Green I Issue 6.0

MARCH 2018

SG GREEN

SINGAPORE GREEN BUILDING COUNCIL

MCI permit number (MCI (P) 085/05/2017)

TOWARDS NET ZERO

INSIDE:

Lower energy cost and maximize guest comfort.

Upgrade your existing air-conditioning system with our EC fans to help reduce operating expenses and improve noise level.

SINGAPORE GREEN BUILDING COUNCIL MEMBER

ebm-papst develop highly efficient fans for air-conditioners that can be easily retrofitted into existing solutions that let guests enjoy a quieter night's sleep. Besides being especially quiet, they're also exceedingly efficient to help reduce utility cost significantly. That's great news for hotel managers and owners – and for the environment as well. **salesdept@sg.ebmpapst.com**

ebmpapst

The engineer's choice

SG GREEN

EDITORIAL TEAM

Ashvinkumar
Allen Ang
Clifford Chua
Pang Chin Hong
Tan Szue Hann
Yvonne Soh
James Tan

CONTRIBUTORS & ADVERTISERS

Architects 61 Pte Ltd
Big Ass Fans Singapore
ebm-papst SEA Pte Ltd
Technoform Bautec Asia Pacific Pte Ltd
Grundfos (S) Pte Ltd
National Climate Change Secretariat

PUBLISHER

Singapore Green Building Council

DESIGN & PRINTING

Cathy Tan / MD Faizal
SC (Sang Choy) International Pte Ltd

CONTENTS

MESSAGE FROM THE EDITORIAL TEAM

BUILDING A BETTER CLIMATE

In the beginning of the year, Singapore was beset with a cold snap, something that was previously unheard of on our sunny island. While official measurements put the temperature at 21 to 24 degrees Celsius, the actual "real-feel" temperature was closer to 17 degrees Celsius, taking into account all environmental factors unique to Singapore. For many Singaporeans, this is one of the most striking examples of global climate change, one that can be directly perceived by each and every individual.

Climate change has become more than just a fleeting concept perpetuated by doomsayers: it is a worldwide phenomenon with very apparent and very tangible effects that affect every nation on Earth. Even tiny Singapore is not spared from this environmental blight, with increasingly intense periods of rainfall punctuated by long dry spells only to culminate in an uncharacteristic cold snap. Indeed, each year succeeds the preceding one as the hottest year on record, and temperatures will keep going up unless we collectively take action to address climate change.

Our buildings are in a prime position for effective climate action. When a building is more efficient in its energy, water and resource use, the burden on the environment is lessened. Increased use of renewable energy to power our buildings translates to lesser fossil fuels being combusted for power generation, leading to a decrease in greenhouse gas emissions. By building and managing our buildings more sustainably, the environmental drain to maintain our buildings can be minimised.

In this issue of SG Green, we go "towards net zero", one of the most possible and pragmatic pathways for the future of our buildings. As the logical progression for modern green buildings, an emphasis on zero energy and carbon neutrality will set the foundation for high performance buildings that are good for both its occupants and the environment.

A few local building projects are also featured in this issue of the magazine, all of them constructed or fitted out to sustainable standards. From a zero energy building that was literally built from the ground up to a purpose-built smart facility intended to educate the future generation on green building and sustainability, these projects made extensive use of certified green building products and solutions to achieve their sustainability objectives.

In Singapore's year of climate action, we hope that these stories can inspire you to make more environmentally-conscious decisions for your next project towards building a better climate for this generation and beyond.

Yours sincerely,
SG Green Editorial Team

TAKING CLIMATE ACTION

Singapore has designated 2018 to be our year for Climate Action, aiming to focus attention on climate change, raise levels of national consciousness around the need to take individual and collective action to address climate change for a sustainable Singapore.

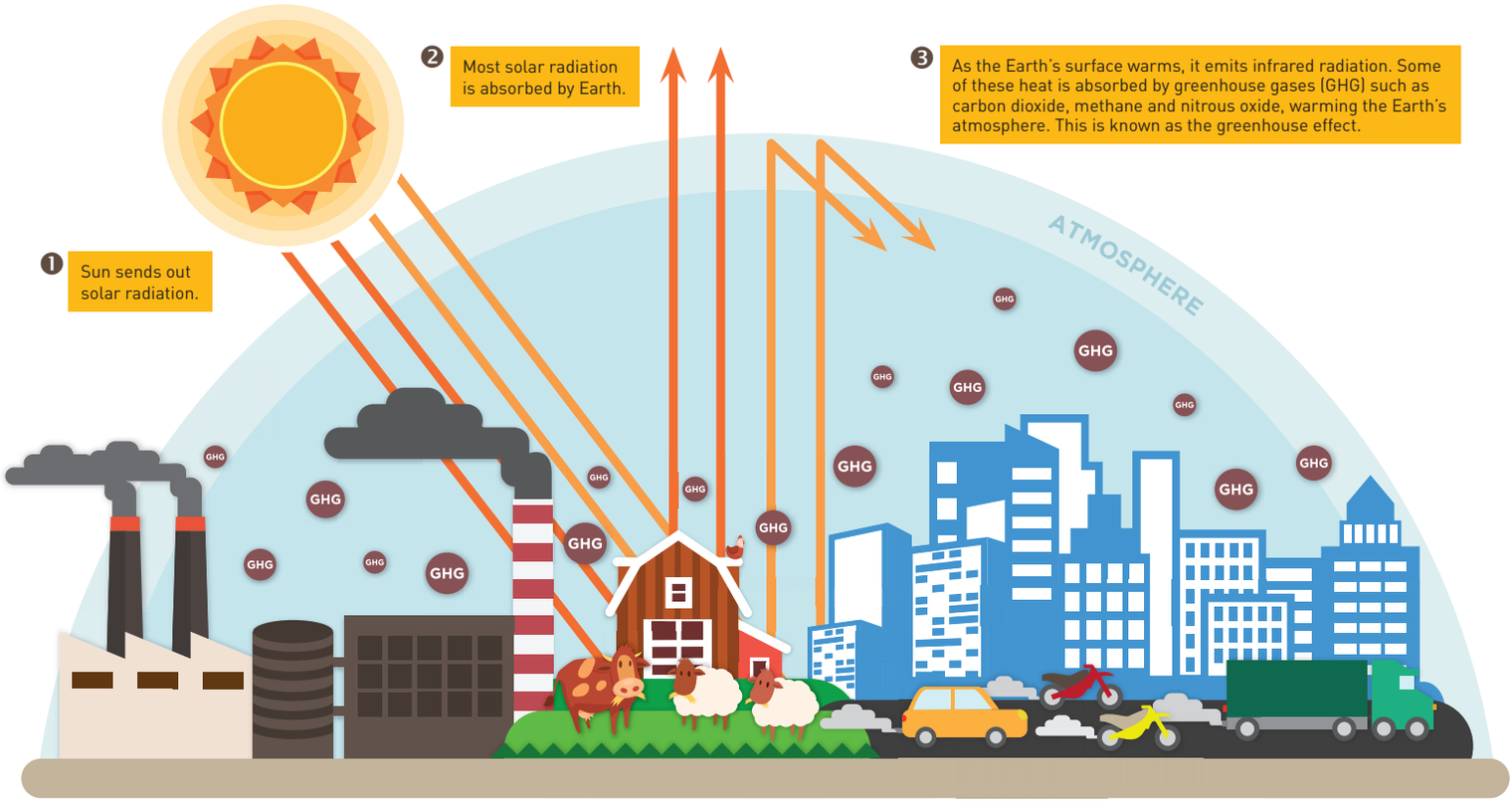
Over the past few years, we have been feeling the impact of climate change, with each year succeeding the previous one as the warmest year on record. In fact, 9 out of the 10 warmest years in Singapore have all occurred in the 21st century.

Our climate is warming at an extraordinary rate due to the excessive emission of greenhouse gases, particularly carbon dioxide, largely from the combustion of fossil fuels. Even if Singapore is responsible for only 0.11 percent of global carbon emissions, we still need to do our part as a good global citizen and reduce our carbon emissions. After all, Singapore has committed to reduce emissions intensity by 36 percent from 2005 levels by 2030 under the Paris Agreement, with the aim of stabilising emissions to peak around 2030.

Therefore, the most important climate action all of us must take is to cut back on carbon dioxide emission and reduce our carbon footprint.

The built environment can help mitigate the effects of climate change, but the industry must take collective action to accelerate the greening of our buildings to make them more energy efficient, more conducive for the occupants and more resilient to changes in climate.

CLIMATE CHANGE AND THE GREENHOUSE EFFECT



OUR ACTIVITIES ARE RELEASING HUGE AMOUNTS OF CARBON DIOXIDE.

Fossil fuels such as coal, oil and natural gas are our main sources of energy. As these fuels are burnt to produce electricity, they release large amounts of carbon dioxide. Ever since the start of the Industrial Revolution in the late 18th century, the increase in human industrial activities has led to the burning of more fossil fuels, and in turn more carbon dioxide has been released into the atmosphere. With urbanisation and population growth, more forests are also felled to make way for factories and homes. This also means that there are fewer plants to remove carbon dioxide from the air.

CARBON DIOXIDE ABSORBS HEAT.

Greenhouse gases absorb the sun's energy and trap it in the atmosphere. Carbon dioxide is one such greenhouse gas. With more carbon dioxide in the atmosphere, more heat is absorbed and trapped, hence warming the earth.

CARBON DIOXIDE LEVELS ARE RISING.

It is estimated that the amount of carbon dioxide in the atmosphere has increased from 280 parts per million to 400 parts per million in the last 150 years. The average global temperature has increased by 0.8 °C over the same period.

As temperatures increase, ice caps are melting, causing sea levels around the world to rise. Weather patterns are also changing. We are seeing more extreme weather events such as prolonged droughts and severe snowstorms happening across various parts of the world.

Eco-activist Nor Lastrina Hamid is a well-known face in Singapore's green community and recently represented the world's youth at the 2015 United Nations Climate Change Conference in Paris. She shares with us her thoughts on action for climate change.

Can you share with us one thing you have done for climate change which you feel is impactful?
Since my university days, I've made it a point not to print anything if it is not necessary. Forests are one of the world's largest carbon sinks, but we are losing them at such an alarming rate. Reports say that as much as 40% of the annual wood harvested is processed for paper and paperboards. I choose to help reduce emissions and save trees by saying "no" to printing unnecessarily.

To people who say that it seems easier not to think about climate change or take action, what would you say to them?
I agree that it is an overwhelming topic but climate change affects all our lives from our water resources and public health to food security. We don't have much time left. If we don't act now, our lives will be worse in the future. Global temperatures have been rising and April 2016 was the hottest month in Singapore in recent history. We have to act now.

Why do individual actions matter?
Individual actions = Collective power. Individual actions add up and contribute to reducing carbon emissions. There are more than 7 billion people in the world. We have the people power to protect our environment. Each time we take action for climate change, we can influence our circle of friends and family to reduce carbon emissions.

I know of a youth who started a Facebook group "Journey to Zero Waste Life in Singapore" to inspire reduction of waste. Individual actions like this can inspire more people!

Give us a few tips on what individuals can do.
Conserve energy whenever you can. The bulk of Singapore's greenhouse gas emissions comes from burning fossil fuels to produce electricity. Eat more vegetables and less beef and milk. Cattle contribute a large chunk of our greenhouse gas emissions. In school, join or start a green club. Think about how you and your school can be part of the solution for climate change. Join environmental groups, get to know the community and encourage more people to take climate action. And, if you feel strongly about an environmental issue, be courageous and email your Member of Parliament about it!

IS TAKING ACTION FOR CLIMATE CHANGE MY SOLE RESPONSIBILITY?

Addressing the climate challenge requires a concerted effort by everybody, but that is easier said than done, and may require each of us to step out of our comfort zone. Do the following statements resonate with how you feel about the issue at times?

There are 7 billion people in this world. I don't think I alone can make a difference!

If everyone thinks this way, nothing will change. But if all of us play our part, our concerted effort will help to slow down climate change.

Hmm... I feel that governments and other international organisations such as the United Nations should take charge of this issue instead.

But those policies and measures won't work if the citizens don't support or participate in them. Hence, we need to all work together to address climate change!

That still doesn't convince me that I should lead a low-carbon lifestyle. It would mean, among others, having to give up the comfort of my air-conditioning!

Think of it this way. If we make minor adjustments to lead a low-carbon lifestyle and step up our efforts over time, we would all be able to live in a sustainable and comfortable environment in the long run. In your case, you could set your thermostat to 25°C for a start, and slowly work towards using fans, instead of air-cons.

That doesn't sound like a big sacrifice. Ok, I will give it a try.

That's great! There are other simple actions that we can practise to reduce our carbon footprint too, such as switching off electrical appliances when they are not in use and taking the public transport instead of driving your own car.

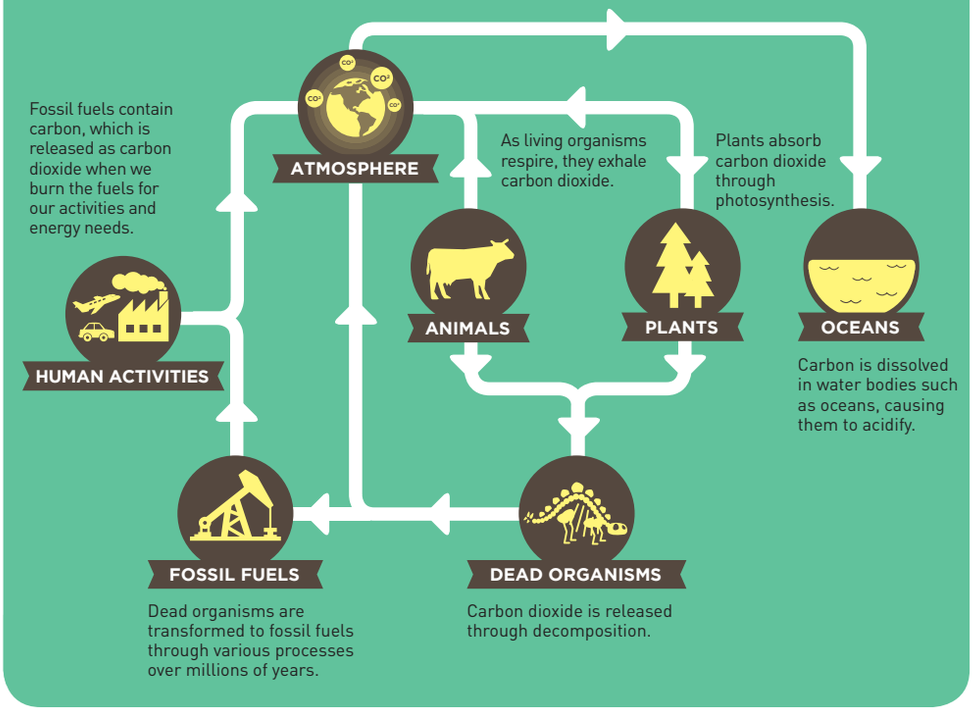
WHAT IS "CARBON FOOTPRINT"?

Your carbon footprint is the amount of carbon dioxide produced through the activities you do.

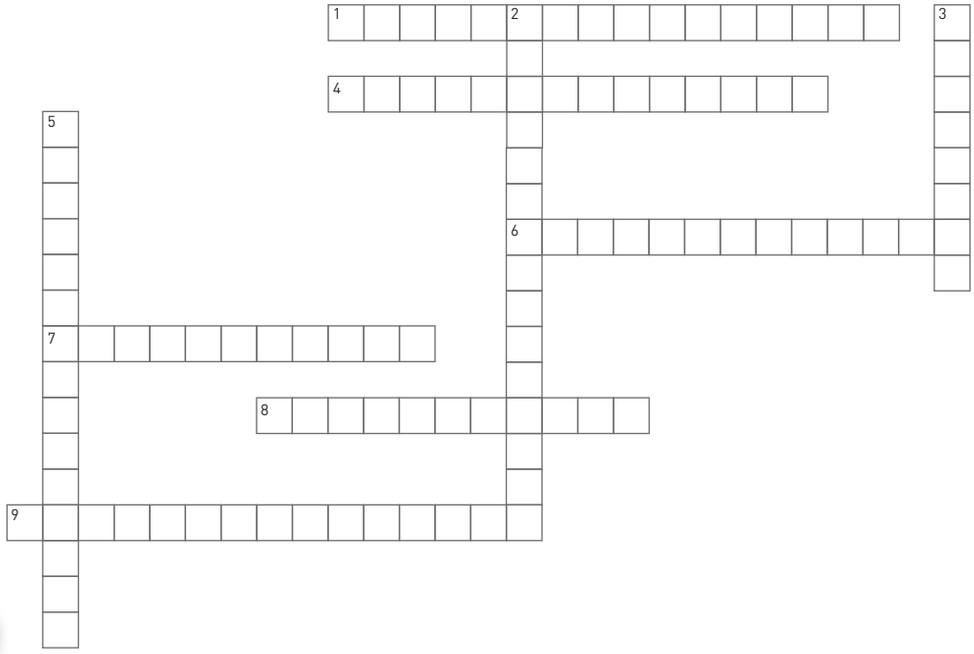
Every action counts! Find out what you can do to help slow down climate change at www.nccs.gov.sg

THE CARBON CYCLE

Do you know that carbon is one of the most abundant elements on earth? It is found in different forms in various reservoirs such as the atmosphere, oceans, plants and even rocks and soil. Through different processes, carbon moves between the reservoirs. Together, these elements form the carbon cycle.



ACTIVITY | CROSSWORD PUZZLE



Across:

1. Greenhouse gases trap heat in the atmosphere. This is known as the_____.
4. As a result of climate change, the world is experiencing more _____ events such as droughts, floods, hurricanes, heatwaves and snowstorms.
6. _____refers to changes in weather patterns over a long period of time.
7. We burn them to meet our energy needs.
8. What is rising globally as a result of too much greenhouse gases in the atmosphere?
9. Activities such as electricity generation, deforestation, farming, factory operations and transportation release _____ into the atmosphere.

Down:

2. We are 95% sure that_____are the main cause of climate change.
3. As _____rises, coastal cities face a greater risk of coastal erosion and inundation.
5. Your _____ is the amount of carbon dioxide that is released from the energy you use and activities performed. It also shows the impact you have on the environment.

Answers: 1. Greenhouse effect 2. Human activities 3. Sea level 4. Extreme weather 5. Carbon footprint 6. Climate change 7. Fossil fuels 8. Temperature 9. Greenhouse gases

Brought to you by National Climate Change Secretariat

SINGAPORE'S EFFORTS TO ADDRESS CLIMATE CHANGE

Climate change is a global issue affecting every country. Despite our small size, Singapore is committed to playing a part in battling this global challenge. Find out about Singapore's roadmap to becoming more carbon-efficient!

START

Our Emissions Intensity in 2005: 0.176 kg CO_2e/GDP S$

What does this figure mean?
CO_2e is the short form for carbon dioxide equivalent. This is an international measurement unit for the amount of greenhouse gases emitted by countries.

GDP stands for Gross Domestic Product. It represents the total dollar value of our economy. By tracking the amount of CO_2e we produce per dollar of our economy, we can tell if we are carbon-efficient in producing goods and services.

Unscramble! ❶
Hint: A key source of Singapore's carbon emissions.

RIDTNUYS
I _ D _ _ _ _ _

TAP ON THE SUN!

Funds and initiatives are rolled out to encourage more solar energy research and test-bedding.

Solar energy is one of the most promising sources of clean renewable energy for Singapore. We experience about 50% more solar radiation than temperate countries, at an annual average of solar irradiance of 1,150 kWh/m^2.

Unscramble! ❸
Hint: An unconventional place where Singapore is planning to install solar panels.

ROERRSSEVI
R _ S _ _ V _ _ _ _

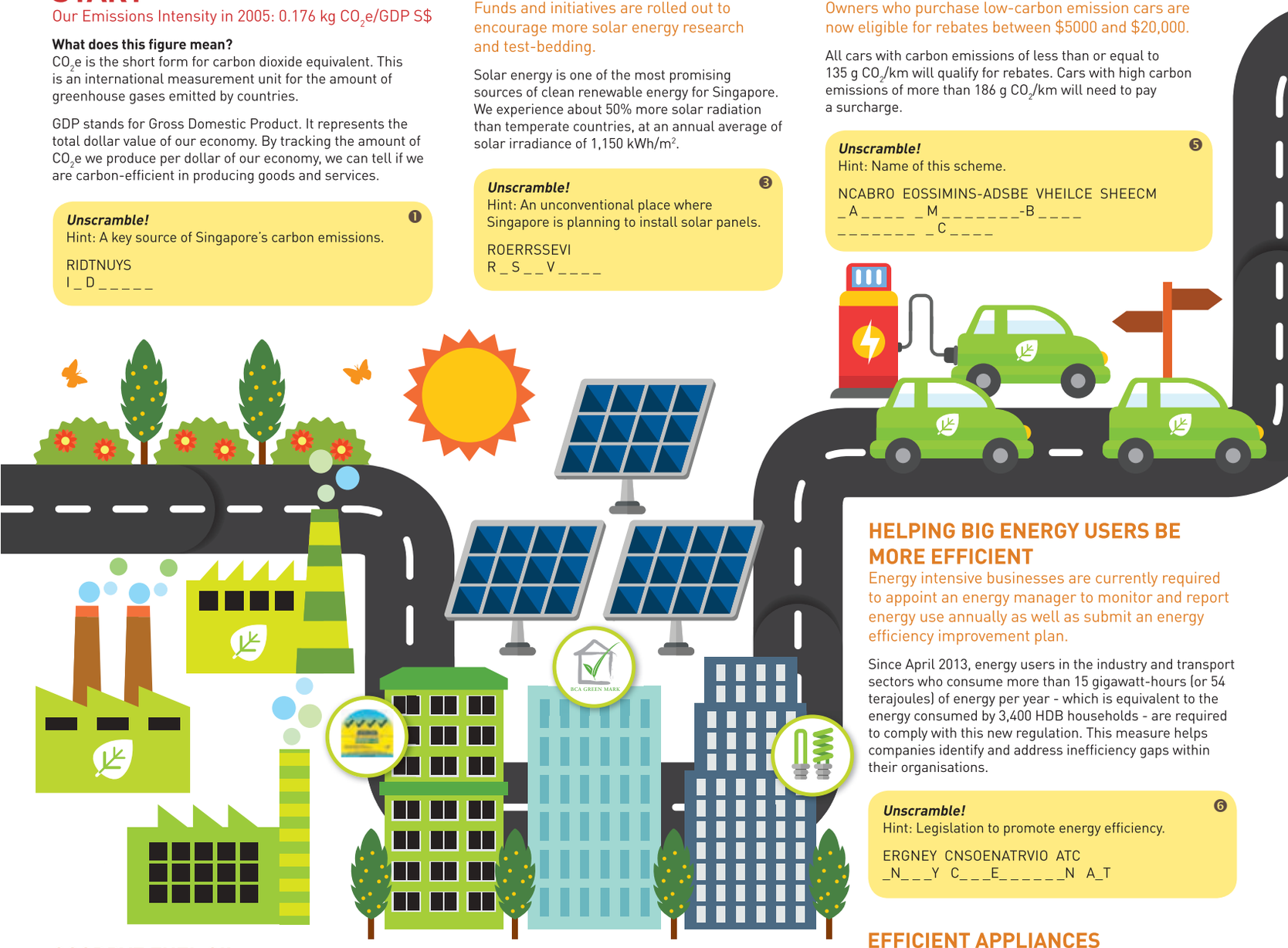
CHOOSE LOW-CARBON EMISSION CARS

Owners who purchase low-carbon emission cars are now eligible for rebates between $5000 and $20,000.

All cars with carbon emissions of less than or equal to 135 g CO_2/km will qualify for rebates. Cars with high carbon emissions of more than 186 g CO_2/km will need to pay a surcharge.

Unscramble! ❺
Hint: Name of this scheme.

NCABRO EOSSIMINS-ADSBE VHEILCE SHEECM
_ A _ _ _ _ _ M _ _ _ _ _ _ _ _ -B _ _ _ _
_ _ _ _ _ _ _ _ C _ _ _ _



HELPING BIG ENERGY USERS BE MORE EFFICIENT

Energy intensive businesses are currently required to appoint an energy manager to monitor and report energy use annually as well as submit an energy efficiency improvement plan.

Since April 2013, energy users in the industry and transport sectors who consume more than 15 gigawatt-hours (or 54 terajoules) of energy per year - which is equivalent to the energy consumed by 3,400 HDB households - are required to comply with this new regulation. This measure helps companies identify and address inefficiency gaps within their organisations.

Unscramble! ❻
Hint: Legislation to promote energy efficiency.

ERGNEY CNSOENATRVIO ATC
_N _ _ Y C _ _ _E _ _ _ _ _ N A_T

GOODBYE FUEL OIL, HELLO NATURAL GAS!

Instead of depending on fuel oil to power our energy plants, Singapore has been progressively moving to natural gas. Today, about 95% of our electricity is generated by natural gas.

Natural gas is the cleanest form of fossil fuels available. By switching to natural gas, we are reducing the amount of greenhouse gases produced in the course of generating electricity.

Unscramble! ❷
Hint: The cleanest form of fossil fuels.

RNATALU ASG
_ _ T _ _ _ _ _ A _

GREEN BUILDINGS

New buildings in Singapore will be required to attain Green Mark certification. This ensures that the buildings are environmentally friendly.

The Green Mark certification was launched in 2005 by the Building and Construction Authority to promote the construction of more environmentally-friendly buildings in Singapore. The benefits of Green Mark certified buildings include reduction in water and energy bills and a better indoor environmental quality for a healthier workplace.

Unscramble! ❹
Hint: Singapore's target for Green Mark Certified Buildings.

%08 FO IDGIBUNLS YB 3200
_ _ _ _F _U _ _D _ _G _ _Y _ _ _ _

EFFICIENT APPLIANCES

Since 2013, energy performance standards for air-conditioners and refrigerators have been tightened. Such Minimum Energy Performance Standards (MEPS) will be applied to more household appliances in the future.

Some household appliances consume a lot of energy and contribute to Singapore's carbon emissions. By using more energy-efficient home appliances we can help reduce our carbon footprint.

Unscramble! ❼
Hint: The scheme that helps consumers identify energy efficient home appliances.

NORDMAATY EERGNY LALBLIENG SHCMEE
_A _ _A _ _R _ _N _R _ _ L _ _E _ _I _ _ S _ _ _ _E

Answers:
1. Industry 2. Natural gas 3. Reservoirs 4. 80% of buildings by 2030 5. Carbon Emissions-based Vehicle Scheme 6. Energy Conservation Act 7. Mandatory Energy Labelling Scheme 8. Mass Rapid Transit 9. Park Connector Network 10. Reduce, Reuse, Recycle

SHARE JOURNEYS!

The government is expanding and improving our public transport network, with the aim of increasing public transport share to 75% by 2030.

Taking public transport is much more climate-friendly than private transport. Did you know that Singapore has a total rail network length of around 200 km? By 2030, Singapore aims to increase the rail network to more than 350 km. By then, around 80% of households in Singapore would live within 10 minutes of a railway station.

MOBILE NATION

Through campaigns and public infrastructure projects such as building more sheltered walkways, the government is encouraging more people to walk or cycle.

Transport is one of the largest sources of greenhouse gas emissions. Singapore is a pedestrian-friendly and compact nation. Walking or cycling is not only good for the environment; it is good for our health too!

Unscramble! ❾

Hint: Where you can cycle from park to park.

RAKP CNECNRTOO RNTEOKW
__R_ _O_____ _E_____

Unscramble! ❽

Hint: Name of our railway system.

MSSA RPIAD TANITRS
_A_ _ R_ _ _D _R_N_ _ _

GOAL: REDUCE EMISSIONS INTENSITY BY 36%

Target Emissions Intensity in 2030: 0.113 kg CO_2e/GDP S$

What is our role in this?

We may have a roadmap to reducing our carbon emissions, but for it to succeed, all of us have to play our part. What do you think your role is in helping Singapore to achieve its goal?

Unscramble! ❿

Hint: What you can do to help Singapore reduce its carbon footprint.

REDCEU, RSEUE, RLECCYE
__D___, __U__, __C____

HEAR IT FROM A YOUNG OFFICER COMBATING CLIMATE CHANGE!

Denise Chew, 25, joined the National Climate Change Secretariat in 2015. Together with her team, she works behind the scenes to develop policies and plans to help Singapore address climate change.

What led you to join the National Climate Change Secretariat?

I have always been concerned about environmental degradation and destruction. When I was in school, I had often wondered how individuals, organisations and governments could surmount a global issue like climate change. Working here allows me to learn how Singapore contributes to global mitigation efforts and work on an issue I care about.

What is a day's work like for you?

Much of my work involves engaging stakeholders such as other government agencies, businesses and individuals on possible solutions to reduce our greenhouse gas emissions. A typical day would include meetings with these stakeholders, for instance, engaging businesses to find out new clean technology projects. I would also brainstorm with my colleagues on new policy proposals to make Singapore more climate-friendly.

What do you find most meaningful in your work?

Most people are preoccupied with short-term challenges, so climate change does not often feature as a top priority. However, the impact of climate change is significant and requires serious attention.

It is reassuring that Singapore has an agency dedicated to this cause. Being able to witness the work behind the scenes and contribute to our domestic policies has been very rewarding and motivating.

What would you say is the most challenging climate change issue for Singapore? What can we do about it?

The lack of urgency. Many people acknowledge that climate change is a problem, but fail to internalise the problem. As a society, there are many things we can do. Organisations could track their energy consumption, look at ways to improve their energy efficiency, and invest in low carbon innovations and technologies. Individuals like us could use more energy-efficient (go for more ticks!) appliances, reduce energy consumption, and recycle waste. This would go a long way to help Singapore reduce its carbon emissions!

Read more about Singapore's Climate Action Plan at www.nccs.gov.sg

Brought to you by National Climate Change Secretariat

THE CHALLENGES WE FACE

In addition to reducing our Emissions Intensity, Singapore has also pledged to stabilise its greenhouse emissions with the aim of peaking around 2030. This is an ambitious goal given the challenges we face.

LIMITED RENEWABLE ENERGY OPTIONS

We have limited options for renewable energy due to our geography. Singapore does not have large river systems to produce hydroelectricity or strong winds to power wind turbines.

SMALL LAND AREA

With only 719 km² in land area, we have to accommodate all kinds of land uses from housing and commercial buildings to power stations and industries. We need to strike a balance between economic development and preserving green spaces.

HIGH POPULATION DENSITY

Singapore has one of the highest population densities in the world, which also means that we need to cater for the energy needs of every resident within our limited land area.

WHERE WE STAND

Even though we face serious challenges in reducing our carbon footprint, Singapore has performed relatively well when compared to other nations.

Singapore accounts for around 0.11% of global emissions

Our Emissions Intensity places us in the top 20% of countries in terms of low carbon emissions

We rank 123 out of 141 countries in Emissions Intensity*, making us one of the most climate-friendly countries in the world.
(*based on 2013 data)

Towards a Low-Carbon Economy

As part of Singapore's suite of mitigation measures to address climate change, a carbon tax will kick in from 2019. Announced by Minister of Finance Mr Heng Swee Keat during his Budget 2018 speech delivered on 19 February 2018, the carbon tax is an important step in sustaining a clean, green and liveable environment while helping Singapore to transform into a low-carbon economy.

The tax will be applied on facilities that emit more than 25,000 tCO2e (tonnes of carbon dioxide equivalent) of emissions annually, covering the six greenhouse gas (GHG) emissions that Singapore reports to the United Nations Framework Convention on Climate Change (UNFCCC) as part of the national GHG inventory.

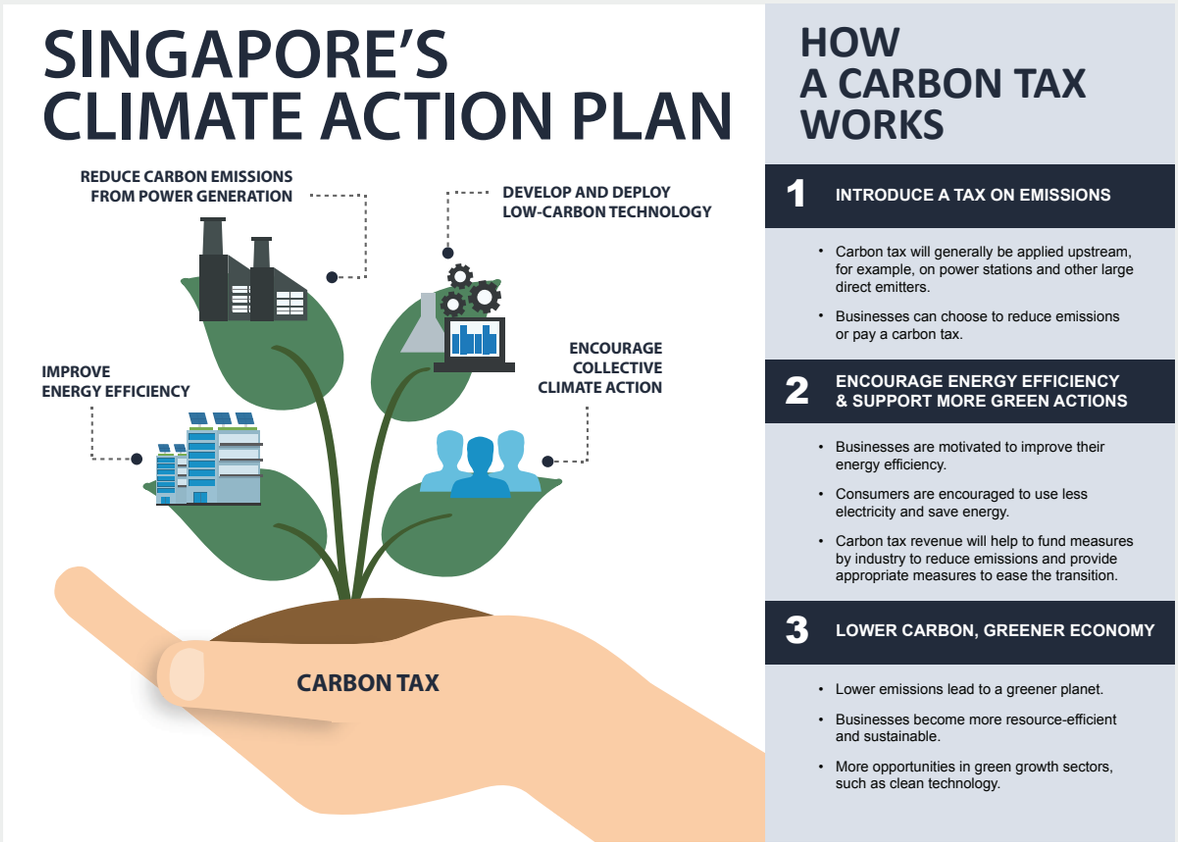
The flat rate of S$5/tCO2e implemented from 2019-2023 is to give the industry more time to adjust to the carbon tax and undertake energy efficiency projects. The carbon tax will also apply uniformly to all sectors with no exemptions, the economically efficient way to "maintain a transparent, fair and consistent carbon price across the economy to incentivise emissions reduction", according to Mr Heng Swee Keat.

Subsequent review of the carbon tax quantum in 2023 will consider international climate change developments, the progress of Singapore's mitigation efforts as well as the country's economic competitiveness before the tax is revised.

Funds will be set aside from 2019 to help small and medium-sized enterprises (SMEs) as well as power generation companies to improve their energy efficiency. These include schemes such as the Productivity Grant (Energy Efficiency) and Energy Efficiency Fund; projects with greater reduction in emissions will receive greater support.

According to SGBC Executive Director Er. Yvonne Soh, such schemes could help companies overcome cost barriers to energy efficiency projects, "A number of such incentive funds or assistance schemes already exist, but more support is always welcomed as energy efficiency is usually not on the top of most companies' minds."

The simple and uniform carbon tax will have a multi-faceted effect on the building sector: advanced low-carbon technology can be developed and deployed into our buildings at an accelerated rate, organisations are spurred to improve the energy efficiency of their building portfolios and it will also encourage collective climate action as well as effect positive behavioural change in the long term.



Infograhic courtesy of National Climate Change Secretariat

Carbon Tax

What it means for companies

FROM 2019 1 JANUARY

Singapore will introduce a carbon tax on the emission of greenhouse gases from 2019 as part of its efforts to combat climate change. A carbon tax provides an economy-wide price signal to encourage households and companies to reduce emissions by being more energy-efficient.

Facilities that produce 25,000 tonnes or more of greenhouse gases annually

$5 per tonne of greenhouse gas emissions from 2019 to 2023

First payment will be in 2020, based on emissions in 2019

Around 30 to 40 companies are expected to be directly affected

The Government intends to increase the rate to between $10 and $15 per tonne of emissions by 2030

Factors such as our economic competitiveness will be taken into account

All other companies

May be indirectly impacted through higher electricity costs

About 1% increase based on current regulated electricity tariffs

All companies can take measures to improve energy efficiency and reduce carbon emissions

This will reduce costs and contribute to a higher-quality living environment for all

From 2019, there will be enhanced support for companies, including SMEs and power generation companies, to improve energy efficiency

Details will be shared at a later date

Existing energy efficiency grants and incentives that companies, including SMEs and power generation companies, can apply for

- Productivity Grant (Energy Efficiency)
- Energy Efficiency Fund (E2F)
- Energy Efficiency Financing Programme

Visit www.e2singapore.gov.sg for more information on the existing incentives

Infograhic courtesy of Ministry of Trade & Industry.

UNDERSTANDING NET ZERO ENERGY, NET ZERO CARBON AND CARBON NEUTRAL BUILDINGS

The race is on globally to decarbonize by 2050, with the unprecedented commitment of 195 nations at the Paris Climate Agreement. While buildings account for over 40percent of primary energy use and 30percent of global greenhouse gas (GHG) emissions, energy efficiency in buildings has historically lagged behind the growth of energy use caused by population and economic gains.

The Net Zero concept is the next logical step in the evolution of our buildings, to reduce our carbon emissions in the building sector. World Green Building Council's (WorldGBC) Advancing Net Zero is one of many global projects, aiming to promote and support the acceleration of net zero carbon buildings to 100 percent by 2050.

While generally understood conceptually, **no international consensus has been reached on the definitions** of a Net Zero Energy Building (ZEB), a Net Zero Carbon Building (ZCB) and even a Carbon Neutral Building (CNB), to highlight just some of the similar terms used in literature. The way these terms are defined can affect significantly the way buildings are designed to achieve the goal. Despite this, countries are enacting policies and national targets based on their specific interpretation of the concept, which may not be comparable across countries. For instance, the United States (US) Department of Energy (DOE) has set the target of achieving zero energy homes by 2020 and zero energy commercial buildings by 2025, while the European Union (EU) Energy Performance

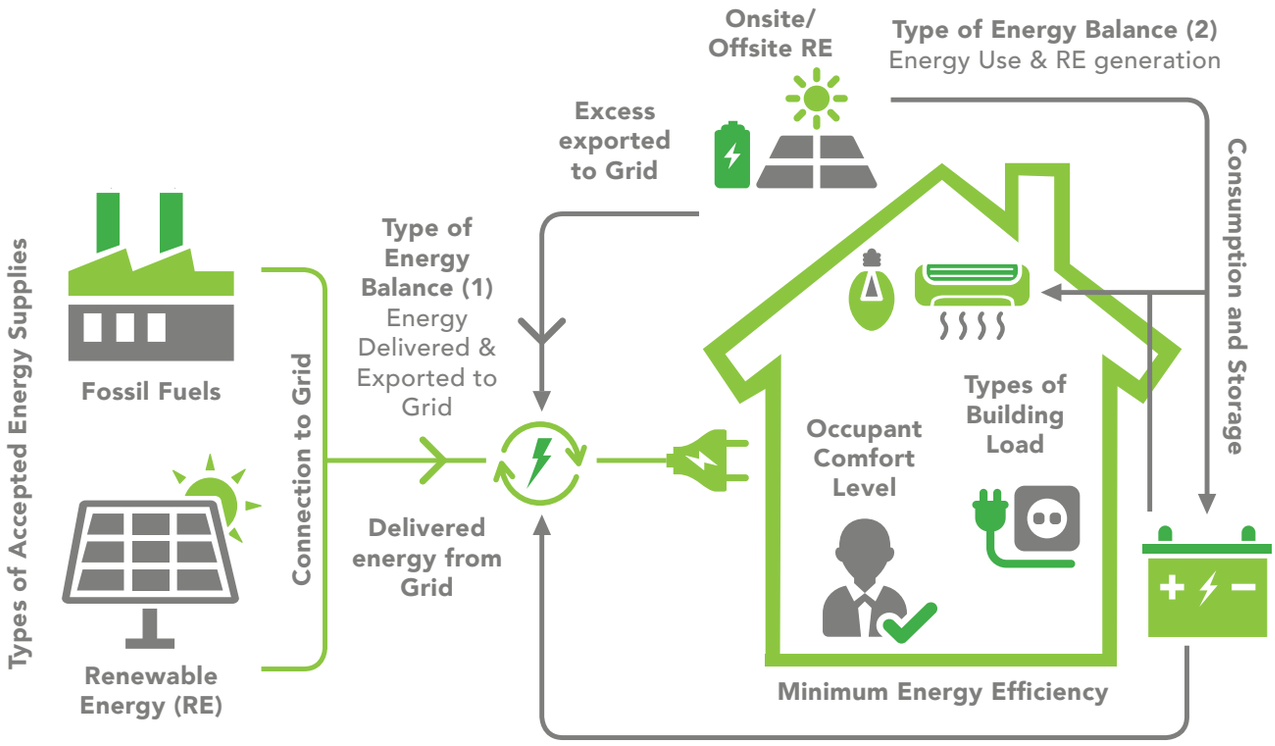
Note: Images used in this article are for illustration only and do not constitute the described building types.

of Buildings Directive (EPBD) specified for all new buildings to be nearly zero energy by 2020. The United Kingdom (UK) had also set the ambitious target for the all new homes to be zero carbon from 2016 (withdrawn in 2015).

Undoubtedly, the International Standards Organization (ISO) and the European Standards Committee (CEN) have made strong headway in developing standards to evaluate the energy performance of both new and existing buildings in a holistic approach. These are reflected in the recently launched ISO 52000 series and the formation of technical committee CEN/TC 371. On the carbon front, ISO has also developed the ISO 16745 series to provide a globally comparable set of methods to calculate, report, communicate and verify carbon metrics for emissions arising from measured energy use during building operations.

However, the **definitions for ZEB/ZCB/CNB buildings remain fragmented globally:**

- **CEN** Draft European Standard prEN 15603 has defined Nearly Zero Energy Buildings for the EU building sector
- **US DOE** has defined ZEBs referencing American National Standards Institute (ANSI) and ASHARE Vision 2020 [a collaboration of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the American Institute of Architects (AIA), the U.S. Green Building Council (USGBC), and the Illuminating Engineering Society of North America (IESNA)]
- **Architecture 2030** in collaboration with New Buildings Institute and Rocky Mountain Institute in the US has developed a definition for ZCB



Infographic 1: Factors considered in ZEB definitions

- **World Green Building Council (WorldGBC)** has adopted an umbrella term for ZCB based on 4 key principles
- **Canada Green Building Council (CaGBC)** has developed a ZCB Standard and a certification scheme for ZCBs
- **British Standards Institute (BSI)** PAS2060 Standardisation Document for Carbon Neutrality has developed a framework for quantifying, reducing and offsetting carbon emissions, and can be applied to buildings to achieve CNBs
- **The Australian Government** has developed the National Carbon Offset Standard for Buildings to certify CNBs
- **Natural Capital Partners** has developed the Carbon Neutral Protocol which lays out the requirements to achieve CarbonNeutral® certification

As such, this article aims to do a deep dive to understand the commonly adopted definitions for ZEBs, ZCBs and CNBs, and discuss the differences between them. Ultimately, this can help organisations identify clear goals in mapping their pathways towards sustainability.

NET ZERO ENERGY BUILDINGS

A net Zero Energy Building (ZEB) is commonly defined as an energy efficient building that **generates enough renewable energy (RE) on site to equal or exceed its annual energy use (Figure 1).**

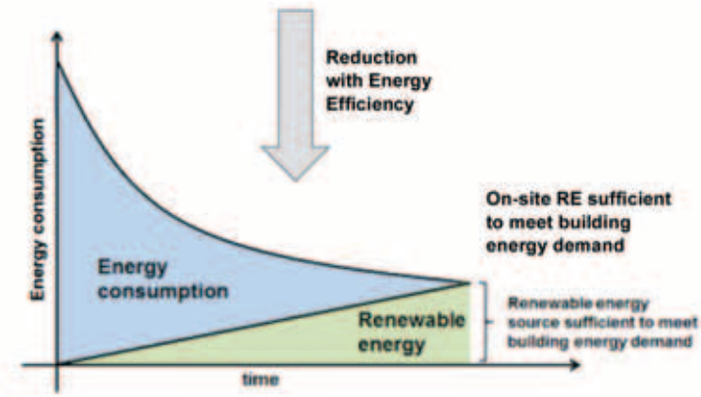


Figure 1: Net Zero Energy Building Concept (referencing Pike Research)

X - Energy Generated from on-site RE over a year
Y - Energy Consumption on-site over a year
Z - Energy used to generate and deliver any energy drawn from grid

Infographic 2: Difference between site and source ZEBs

The pathway to achieve a ZEB generally consists of two steps: 1) reduce energy demand by means of energy efficiency measures, and 2) generating enough energy to achieve the balance with energy consumption by building loads.

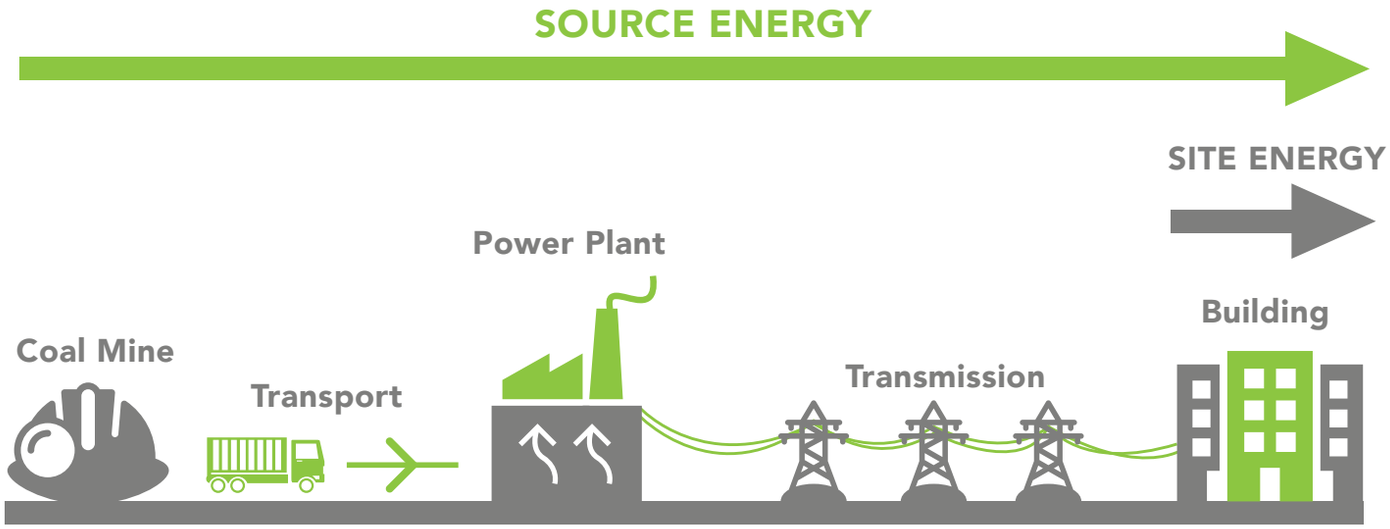
Technically, differences in ZEB definitions (see Infographic 1) arise mainly due to:

- Accepted energy supply options (only renewables or also from fossil fuels, on-site/ off-site RE)
- Connection to grid energy infrastructure
- Type of loads included in energy balance
- Type of energy balance measured based on building-grid interactions (energy use & RE generation or energy delivered from & exported into the grid)
- Period of Energy Balance (usually on an annual basis)
- Requirements for energy efficiency and indoor comfort levels

A **net zero Site Energy building** is commonly defined as one which produces as much energy on-site as it uses on-site over the course of a year. There may or may not be grid connections; hence RE generated on-site can either be stored in batteries or supplied to the grid when there is a surplus, and energy can be supplied from batteries or the grid to the building when there is insufficient RE produced. Energy used in producing and transmitting grid supplied electricity from source to site are not accounted for in the energy balance.

A **net zero Source Energy building** on the other hand adopts a whole-systems approach, where off-site delivery of energy from the grid is allowed on the condition that on-site RE produced must offset the delivered energy, including energy used in generation and transmission (see Table 1 definition on Source Energy).

A connection to the grid for energy balances is usually required in seasonal countries; for building with limited storage capabilities; or in situations where building energy usage demands do not



Infographic 3: Site vs Source energy

coincide with renewable energy generation periods. See Infographic 3 for Site vs Source energy.

The US DOE has established such definitions and measurement guidelines for ZEBs, referencing ANSI/ASHRAE/IESNA Standard 90.1 and Energy Performance of Buildings Directive (EPBD), EU's main legislation covering the reduction of the energy consumption of buildings. DOE's ZEB definitions are included in Table 1 below.

Standard	Definitions
US Department of Energy (DOE)	**Zero Energy Building:** An energy efficient building where, on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy. A ZEB may only use on-site RE in offsetting the delivered energy.
	Source Energy: Site Energy plus the energy consumed in the extraction, processing and transport of primary fuels such as coal, oil and natural gas; energy losses in thermal combustion in power generation plants; and energy losses in transmission and distribution to the building site.

Table 1: U.S. Department of Energy's definition of Zero Energy Building

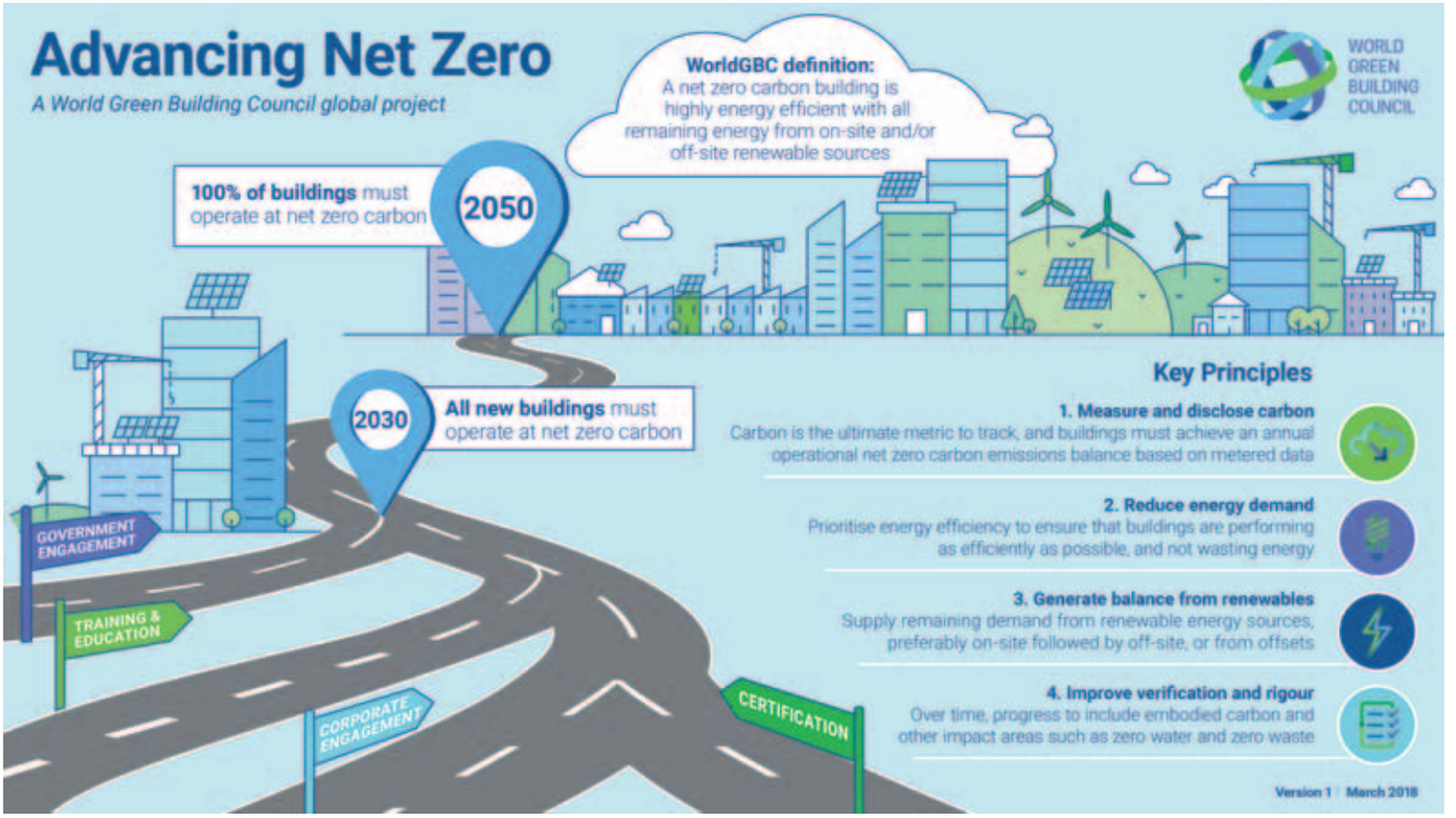
ISO 52000 Standards to provide frameworks and methodologies for measuring overall building energy performance

In supporting the move towards ZEB, the ISO/TC 163 has developed and published in 2017 the ISO 52000 series to calculate and comprehensively assess the overall energy performance of a building. By moving beyond energy performance requirements set at the component level, assessing the overall building energy performance allows the use of any combination of technologies in a systems perspective. This encourages the innovative use of building technologies in systems in order to achieve bold improvements to energy efficiency and bring buildings one step closer towards zero energy.

NET ZERO CARBON BUILDINGS

Globally, various definitions are aligned for a net Zero Carbon Building (ZCB), using different wordings as summarised in Table 2. Key characteristics include: being **highly energy efficient** and being **able to meet annual operational energy consumption with RE preferably produced on-site, but also procured off-site,** if needed.

For ZCBs, there is also an option to include embodied emissions of building materials used, to encourage off-setting by RE generated. For instance, under the Canada Green Building Council (CaGBC) ZCB Standard, applicants must conduct a cradle-to-grave life cycle assessment (LCA) of the building project but the embodied carbon requirement is currently only limited to reporting. As the energy efficiency of buildings increases, the proportion of operational carbon emissions in the LCA of a building will decrease while embodied carbon will become a more significant contributor. As such, there is potentially the move towards the inclusion of embodied carbon in the future.



Standards	Definitions
Architecture 2030	**Zero Net Carbon Building:** a highly energy efficient building that produces on-site, or procures, enough carbon-free RE to meet building operations energy consumption annually.
CaGBC Zero Carbon Building Standard	**Zero Carbon Building:** a building that is highly energy efficient and produces onsite, or procures, carbon-free RE in an amount sufficient to offset the annual carbon emissions associated with operations.
WorldGBC Advancing Net Zero	**Net Zero Carbon Building*:** a highly energy efficient building with all remaining operational energy use from RE, preferably on-site but also off-site production, to achieve net zero carbon emissions annually in operation. **This is an umbrella definition meant to provide a framework that has more flexibility to be applied globally, and allows each country to further develop specific ZCB definitions. This definition allows for carbon offsets, but energy supply should still follow a general hierarchical preference of on-site, off-site and then offset (see Infographic 4).*

Table 2: Definitions of net Zero Carbon Buildings

Infographic 4: Hierarchical preference of renewable energy sources for ZCBs

ISO 16745 Standards to provide methodologies to calculate, report and verify GHG emissions of existing buildings based on operational energy use

The ISO 16745 series has been developed and published in 2017 to provide a globally comparable set of methods to calculate, report, communicate and verify carbon metrics for emissions arising from the measured energy use during the operation of an existing building.

In principle, accurate and precise reporting can only be achieved if GHG emissions (and removals) from all life cycle stages of buildings are quantified. However, there are often resource limitations to use and apply LCA methodologies. Hence, the carbon metric is used in ISO 16745 as a measure based on energy use data and related building information for an existing building in operation (where energy use typically accounts for 70 percent to 80 percent of energy use over the building life cycle).

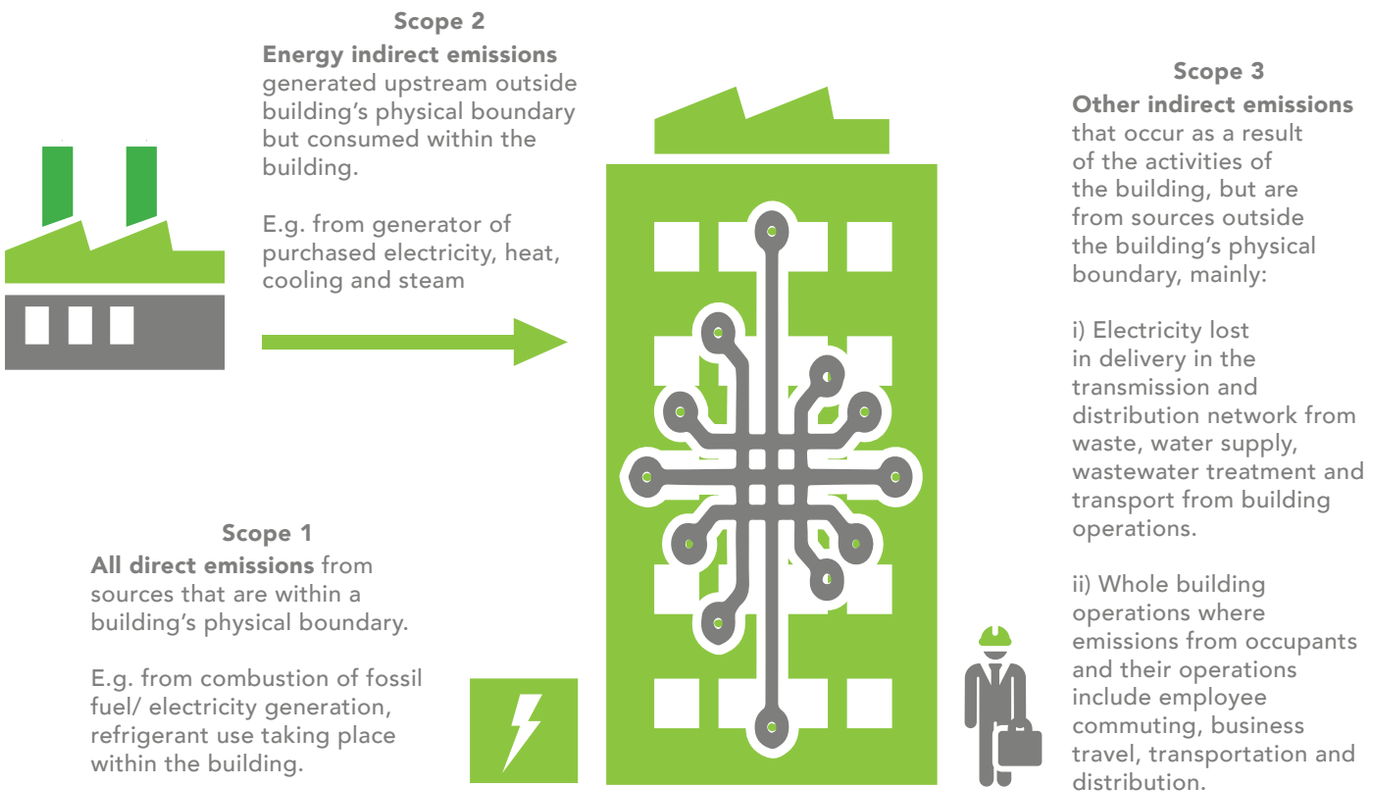
CARBON NEUTRAL BUILDINGS

Carbon Neutrality Concept

Carbon neutrality is a concept that can essentially be applied beyond buildings, at an organisation, project, individual or product level. Under the British Standards Institute (BSI) Standardisation Document PAS2060 for Carbon Neutrality, carbon neutrality is defined simply as:

" a condition in which there is no net increase in the global emission of greenhouse gases to the atmosphere as a result of greenhouse gas emissions associated with the subject."

One existing carbon neutral framework is the Greenhouse Gas (GHG) Protocol, developed by the World Resources Institute and the World Business Council on Sustainable Development, which sets the standard for how to measure, manage, and report greenhouse gas emissions. It can provide organisations with a framework to prepare a carbon



Infographic 5: Overview of Scope 1, Scope 2 and Scope 3 GHG emissions for buildings

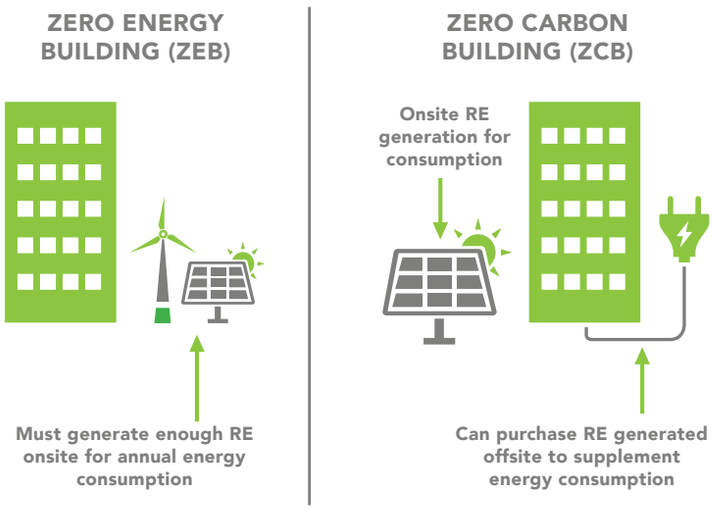
inventory of their business operations. Similar to the GHG Protocol, BSI PAS2060 also defines a consistent set of measures and requirements for entities to demonstrate carbon neutrality

Applying the Carbon Neutrality Concept to Buildings

The term 'Carbon Neutral Building' is increasingly being used corresponding with the rise of voluntary labelling schemes like the Carbon Neutral Protocol which lays out the requirements to achieve CarbonNeutral® certification under Natural Capital Partners (a solutions provider for carbon offsetting schemes), as well as the recently launched National Carbon Offset Standard for Buildings by the Australian government. There are also other smaller-scale programmes like the Carbon Neutral Design Project by the American Institute of Architects (AIA) and its partners, as well as the CSA Registered Carbon Neutral™ Program by the Canadian Standards Association (CSA) Group.

Technically from a carbon accounting perspective referencing the Australian National Carbon Offset Standard, a CNB can also be understood as one **where net GHG emissions is equal to zero, achieved by a transparent process of calculating GHG emissions, reducing where possible and compensating for the residual emissions through investing in verified carbon offset projects.**

Many discrepancies continue to exist in CNB definitions today, depending on the scope of emissions sources included (Infographic 5), specific requirements relating to the system boundary, use of renewable energy, as well as the use of and 3rd party certification of carbon offsets. As a result, ZCBs and CNBs are terms often used interchangeably in practice.



Infographic 6: Difference between ZEBs and ZCBs

DIFFERENCES BETWEEN ZEB, ZCB AND CNB

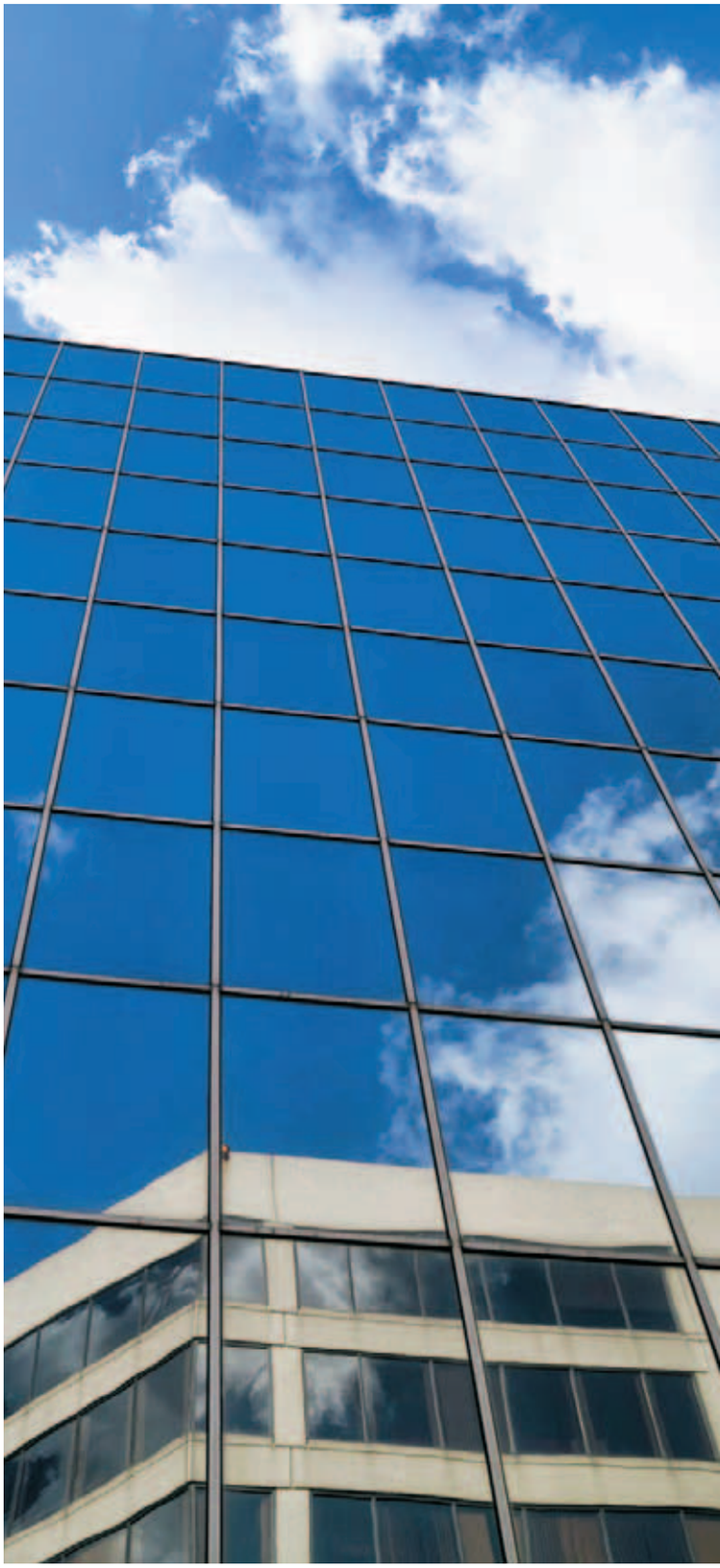
Based on the common definitions outlined in each section, some key differences have been identified between 1) Site and Source ZEBs, 2) ZEBs and ZCBs, and 3) ZCBs and CNBs. While these differences do not apply to all cases due to the lack of universal definitions, they can help to better frame some of the current discussions towards reducing GHG emissions in the building sector.

Between site and source energy categories of ZEBs, the main difference is:

When drawing on off-site delivered energy, Source ZEB must include in its energy consumption the energy used in generation and any transmission losses but Site ZEB do not need to, and only account for the amount of energy delivered at the Site.

As for ZEBs and ZCBs, the main difference is:

ZEBs have to produce enough on-site RE for all of its energy needs while ZCBs do not need to, and can supplement energy consumption with RE procured off-site (see Infographic 6).



Differences	Net Zero Site Energy	Net Zero Source Energy	Net Zero Carbon
Is the building allowed to draw on non-renewable energy from the grid?	Yes (energy used in generation and transmission losses of the procured energy not accounted for)	Yes	No, only RE*
Does the building need to produce RE on-site that is at least equivalent to total energy consumption, including any energy drawn from the grid/ off-site?	Yes	Yes	No
Is the building allowed to procure carbon credits as offsets?	No	No	No**

* *Based on definitions but usually provisions are given in standards which recognise the need for grid energy (non-RE sources) in some cases*

** *Yes under WorldGBC's Net Zero Carbon umbrella definition, which provides the flexibility for offsets.*

Table 3: Differences between Net Zero Site Energy, Net Zero Source Energy and Net Zero Carbon Buildings

Comparisons	CaGBC ZCB	WorldGBC Net ZCB	Australia's National Carbon Offset Standard
Minimum amount of RE generated on-site	5percent (by design)	Not compulsory	Not compulsory
Scopes of emissions considered to calculate carbon balance	1,2	Not defined	1,2,3
Purchase of eligible carbon offset units to compensate for remaining emissions	Not allowed	Allowed	Allowed
Embodied carbon	Only reporting, optional for inclusion in carbon balance	Not covered, could be included in future versions	Not covered, could be included in future versions

Table 4: Comparison between National Carbon Offset Standard for Buildings and CaGBC Zero Carbon Building Standard

Hence, ZCBs are more similar to buildings defined as 'Nearly Net Zero Energy' as defined under the EU EPBD. For a detailed comparison, see Table 3.

Without international standards harmonising Zero Carbon Building and Carbon Neutral Building definitions, there are potentially key differences depending on how individual Zero Carbon and Carbon Neutral Standards for buildings are defined.

For example, a comparison between the CaGBC Zero Carbon Building Standard, the WorldGBC Net Zero Carbon Building definition and Australia's National Carbon Offset Standard for Buildings (to certify Carbon Neutral buildings) yields 3 key differences (Table 4).

Positive Energy Building	Zero Energy Building	Super Low Energy Building
A highly energy efficient building which **consumes less energy than it collects** from renewable sources	A highly energy efficient building which **consumes as much as or less energy than it collects** from renewable sources	A highly energy efficient building (at least 60percent based on 2005 Building Code level), with no requirements for RE generation.

Table 5: Positive Energy, Zero Energy, and Super Low Energy (PE-ZE-SLE) Buildings in Singapore

DEVELOPMENTS IN SINGAPORE

In Singapore, the Building and Construction Authority (BCA) has set a long-term aspiration of achieving 'Positive Energy, Zero Energy, and Super Low Energy (PE-ZE-SLE) Buildings in the Tropics'. All PE-ZE-SLE buildings are required to have a minimum of 60percent Energy Efficiency (based on 2005 Building Code). Based on the requirements, definitions can be summarised in Table 5.

In Singapore's context, the majority of residential and commercial buildings are high-rise with limited roof-top space. In addition, solar is the only renewable energy that is viable in local setting which is high-density city in the tropics. Hence, super low energy buildings are expected to be widely adopted by the industry moving forward, while positive or zero energy buildings are positioned to push boundaries through technological and innovative green building solutions.

CONCLUSION

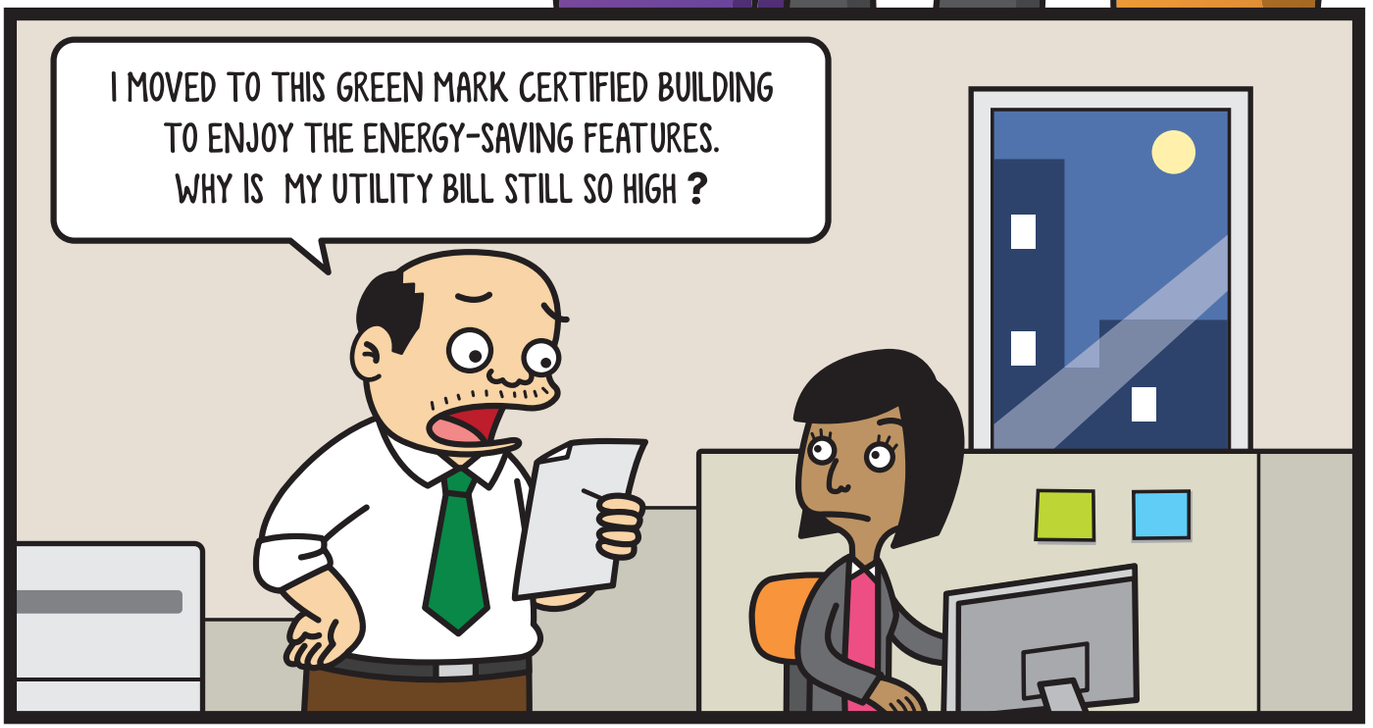
With a myriad of terms in the Net Zero Energy/ Carbon Buildings space, having an international framework or at least country-specific definitions for key terminologies would be very useful to better map out the different design, construction and technological pathways towards realising Net Zero buildings. This could also help to raise minimum standards in national building codes, and strengthen comparability in tracking global commitments.

However, regardless of the differences in current definitions between ZEBs, ZCBs and CNBs, there is a strong alignment towards the end goal of reducing carbon emissions from buildings. For practitioners, there remains a common emphasis on the importance of energy efficiency in achieving a net zero building, before considering RE generation on-site, procuring off-site and carbon offsets.

Ultimately, net zero buildings reinforce the business case for building owners in reducing operational costs. It is encouraging to see increasing interest, with various national standards being developed to best suit the physical and regulatory environments that buildings in each country operate in, as well as ISO standards to guide the methodologies for quantifying and verifying energy performance and GHG emissions.

It is thus timely for building professionals to get involved, and equip themselves with the relevant knowledge in order to play a part- from improving energy efficiency in existing buildings, monitoring and tracking carbon emissions, and revolutionising the design of new buildings.

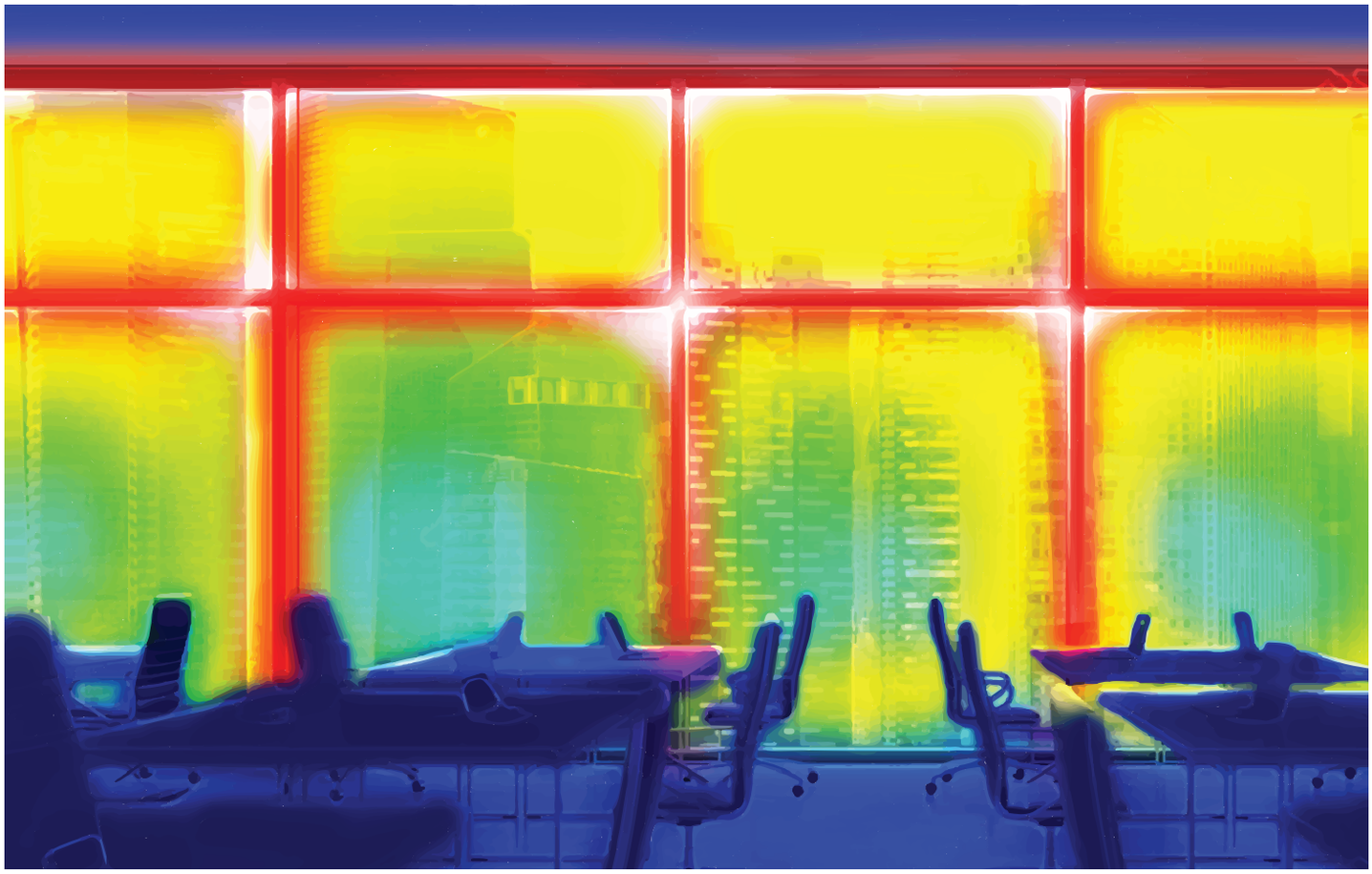
Let's Join Hands to Fight Climate Change



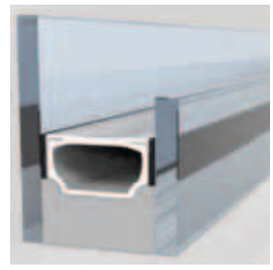
CLIMATE CHANGE SG

Green buildings can help reduce our carbon footprint. The occupants do, however, need to switch off appliances when not in use.

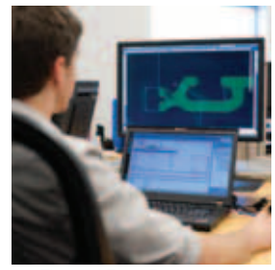
Courtesy of National Climate Change Secretariat.



Engineered with
Technoform Thermal Break



Engineered with
Technoform Warm-Edge Spacer



Thermal Zone Engineering:
Design and Simulation

RE-ENGINEERING THE BUILDING FACADE

USING TECHNOFORM SOLUTIONS

• Sustainability • Quality • Occupant Comfort

Today, curtain wall facades in the tropics are typically using advanced double glazed units with Low-E coating. Using a thermal imaging camera, the un-insulated aluminium curtain wall framing and the edge of glass are identified as areas of thermal bridging. These areas are capable of transmitting large amount of heat indoors.

At Technoform, we work with our partners to develop thermal insulation solutions for the building facade, reducing energy consumption and CO_2 emissions. Technoform is a strong advocate of sustainability and we fulfil our environmental responsibility through our products and processes. Technoform solutions have a real positive impact and improve quality of life in a holistic way.

Are you designing an energy efficient building façade in the tropics? Let's work together!

Your Asia Pacific Partner Onsite
Technoform Bautec Asia Pacific Pte Ltd - A member of Technoform Group
6 Temasek Boulevard, #28-06, Suntec Tower Four, Singapore 038986
+65 6273 9595 | www.technoform.sg | enquiry@technoform.sg

FROM THE GROUND UP

In our modern highly urbanised concrete jungle, it may take some effort to go back to nature. While the Singapore government has taken active steps to ensure that greenery can be readily accessed through parks and park connectors, these are still built in the general vicinity of built-up areas.

The Ground-Up Initiative, or GUI, is a non-profit organisation dedicated to cultivating holistic solutions for a happier, liveable and sustainable future for modern society. With a suite of programmes for families, schools and young adults, GUI activities takes one back to the simpler times when crops were harvested from backyard gardens and new furniture were created with your own two hands.

GUI runs its activities on a 2.6 hectare plot of land off Sembawang road, aptly named Kampung Kampus. Within this complex, collaborative spaces and activity zones are interspersed with lush greenery and verdant foliage, harmoniously blending nature with man-made elements. In the middle of the Kampus stands the GUI Heart-Quarters, a literal heart from which all GUI activities flow.

Responsible for coordinating and administating all of GUI's activities, the HeartQuarters is an important building. It serves as the central planning node for GUI's personnel and is also a nexus for community engagement. With the organisation's onus on environmental sustainability and conservation, an ordinary office building would not adequately convey this sentiment. Therefore, a special type of building was needed as the GUI's HeartQuarters.

With assistance from the Singapore Green Building Council (SGBC) and its member companies, the GUI now has a green building certified to the BCA Green Mark Platinum standard as their Heart Quarters. More than just a Green Mark building, the Heart-Quarters is also a net zero energy building, meaning that it generates more than enough energy for its use on-site through renewable means rather from tapping into the power grid. This is the perfect building to house the heart of GUI, strongly aligned with their values, goals and objectives.

Rising from the footprint of the previous building, the GUI HeartQuarters features simple geometry and works neatly with the elements. Designed as a net zero energy building with a low carbon footprint right from the design phase, the building makes use of passive design strategies to maintain comfort within the building. Natural daylight and ventilation is maximised while the generous ceiling allowance lets heat and humidity escape.

Working with SGBC certified environmental sustainability design consultant Building System & Diagnostic Pte Ltd, the GUI HeartQuarters is fitted out with certified green building solutions from the Singapore Green Building Product (SGBP) certification scheme to truly create a sustainable, healthy facility. For example, all of the HeartQuarters' light fixtures and fittings are of energy efficient LEDs, achieving a lighting power consumption improvement of more than 70 percent.

A host of green building materials went into the construction of the HeartQuarters. A selection of hollow core **Joe Green Concrete Panels (SGBP ✓✓✓)** from JOE Green Pte Ltd went into the walls of the structure. As a sustainable green concrete panel produced with at least 30-50 percent recycled concrete aggregate, the products offer better buildability and quality while minimising wastage. For the internal and external walls of the building, **Easi Plaster ECO (SGBP ✓✓✓)** supplied by Emix Industry (S) Pte Ltd was used. A specially formulated premixed thin plaster, Easi Plaster ECO makes use of recycled materials in its manufacture.

Cement for the raft foundation made use of **Phoenix Portland-composite cement (SGBP ✓✓✓)** supplied by LaFarge Cement Sdn. Bhd. As a general purpose blend, the cement provides improved surface finish with reduced bleeding while ensuring that hazardous


Haiku I Series Ceiling fans
(SGBP ✓✓)

emissions are kept to a minimum. Waterproofing in the washrooms are applied with **Quicseal 104 (SGBP ✓✓)** provided by Quicseal Construction Chemicals Pte Ltd. These non-toxic liquid-applied waterproof products are easy to mix and apply, quickly granting excellent waterproofing qualities. Even the termiticide used in the HeartQuarters is environmentally friendly: **Premise 200 SC (SGBP ✓✓)** supplied by Bayer (South East Asia Pte Ltd) is a non-repellent anti-termite solution that provides maximum estate protection with minimal environment impact.

Dulux Professional Weathershield and Diamond Care paint products (both SGBP ✓✓✓✓) provided by Akzo Nobel Paints (Singapore) Pte Ltd were extensively used in the project. Certified to the highest-possible rating under the SGBP, these paints have virtually no VOCs and help protect buildings from all weather conditions, along with strong resistance to mould, direct and stains.

To help the HeartQuarters maintain comfortable temperatures for its occupants, Sunergy low-emissivity (Low-E) glass supplied by AGC Asia Pacific Pte Ltd is used throughout the complex. Low-E glass helps to minimise the amount of ultraviolet and infrared light from penetrating the material while still allowing visible light to pass through. This reduces the urban heat island effect while still providing enough illumination to occupants within the building.

Haiku I Series Ceiling fans (SGBP ✓✓) supplied by Big Ass Fans Singapore Pte Ltd were used within the HeartQuarters, providing occupants with optimal airflow and low noise. Combining form with function, these sleek looking fans operate more efficiently than conventional ones, with different preset speeds for maximum occupant comfort.

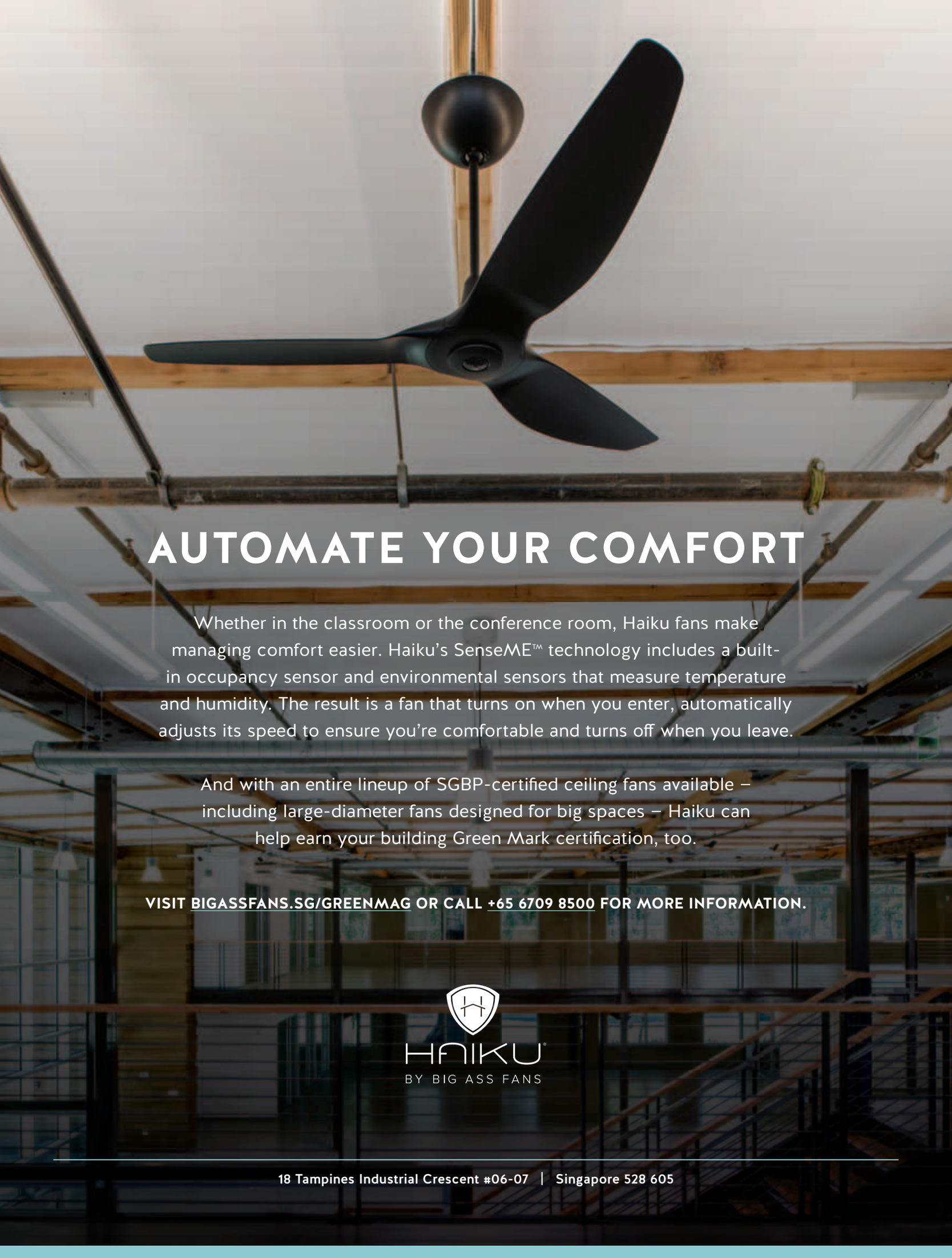
For air-conditioning, the HeartQuarters makes use of energy efficient unitary air-conditioners with variable refrigerant flow technology provided by

Mitsubishi Electric Asia Pte Ltd. With an inverter driven compressor, the amount of refrigerant can be regulated according to the load on the indoor units by the compressor in the outdoor unit, resulting in greater system efficiency.

Towards its zero energy objectives, the roof of the HeartQuarters houses a solar panel array provided by Narada Asia Pacific Pte Ltd. Working in conjunction with all of the HeartQuarters' energy efficient features and appliances, the solar panels are able to generate about 12,409 kWh of energy annually, against an annual total building energy consumption of 11,926 kWh. The building is also expected to reap about 8,500 kWh in energy savings per year, translating to about 42 percent energy savings against the benchmark.

With great assistance from the green building industry, the GUI now has an expressive building that mirrors their philosophy and focus, one that was built with a collaborative, ground-up effort.

Building Owner: Ground-Up Initiative (GUI)
Architect: APDS Architects LLP
M&E Engineer: ICON Engineers LLP
Structural Engineer: JS Tan Consultants Pte Ltd
ESD Consultant: Building System & Diagnostic Pte Ltd
Main Contractor: Builders 265 Pte Ltd



AUTOMATE YOUR COMFORT

Whether in the classroom or the conference room, Haiku fans make managing comfort easier. Haiku's SenseME™ technology includes a built-in occupancy sensor and environmental sensors that measure temperature and humidity. The result is a fan that turns on when you enter, automatically adjusts its speed to ensure you're comfortable and turns off when you leave.

And with an entire lineup of SGBP-certified ceiling fans available – including large-diameter fans designed for big spaces – Haiku can help earn your building Green Mark certification, too.

VISIT BIGASSFANS.SG/GREENMAG OR CALL +65 6709 8500 FOR MORE INFORMATION.

HAIKU®
BY BIG ASS FANS

18 Tampines Industrial Crescent #06-07 | Singapore 528 605

REALISING GREEN LIVING

Completed in 2017, the D'Nest condominium project adds life to its adjoining residential developments along Pasir Ris Grove. A name synonymous with timeless panache that has gone beyond living as one with nature, D'Nest features the unique characters of 'Green Habitat' and timeless elegance.

Set within the eastern region of Singapore, D'Nest features a stunning private residential development with a stylish façade featuring 12 blocks of residential towers of 11, 12, and 13 storey with a total of 912 units, one and a half basements for parking lots, and provision of communal facilities. The land parcel is 41,275.51 square metres and has a total Gross Floor Area (GFA) of 86,677.71 square metres.

A UNIQUE MODERN ECO RESORT LIVING

Inspired by the concept of a 'Green Habitat', the architecture is designed to be environmentally sustainable and integrates well with nature. Residents and visitors enter the development through a pleasant driveway accompanied by interesting interplay of light and shadow. Upon arrival at the sunken courtyard in the basement, one is instantly greeted with animated 'water walls' and lush landscapes, creating an impressive cinematic sense of entry. Visitors who are new to the premises can also catch a glimpse of the clubhouse hovering above upon arrival at the sunken courtyard.

The development is designed with compact block massing to create generous interstitial space for landscape features. The slender blocks also help to create shallow residential units plans which allow better daylight penetration and wind ventilation; hence the passive architecture.

The blocks have a comfortable mix of 1-4 bedroom apartments and penthouses, carefully positioned to maximise macro and micro wind ventilation, while at the same time reducing façades facing the east and west directions. Premium residential units, namely 3-bedroom, 4-bedroom, 5-bedroom apartments, and penthouses are strategically positioned to face expansive central landscape areas.

In addition to private transport, the development is well connected to both modern conveniences and pleasures of life, with the bustling White Sands Shopping Centre just minutes away, along with the Pasir Ris Mass Rapid Transit (MRT) station as well as bus interchange. This ensures that the residents are never far from the action, wherever it takes place in Singapore. Hybrid/electric vehicle refuelling/recharging stations are provided at the site's basement carparks further enhances the development's 'green' approach to transportation and other amenities. Electric charging outlets for

electric/hybrid vehicles are also provided for in the development.

AESTHETIC INTEGRATION

Communal Sky Terraces and green walls are prominently expressed along Tampines Expressway (TPE) and Pasir Ris Drive 8, creating an interesting and unique signature to the development, accentuating the concept and image of a 'Green Habitat'.

These communal sky terraces are designed to connect with the lift lobbies. The lush landscape on each terraces not only provide vertical green reliefs for the residents, they are also ideal community spaces for residents to mingle and gather.

The elevation design emphasises on fine proportion to achieve the desired finesse. Rhythmic horizontal reinforced concrete (RC) ledges not only accentuate the sense of exclusivity to each individual unit, but also provide adequate sun shading for the interior. The harmonious juxtaposition of horizontality (reinforced concrete ledges) and verticality (green walls) presents a design of timeless elegance.

Efforts were spent to refine the design composition of the solid and transparent elements on the façade while complying with the Window to Wall Ratio (WWR). Ultimately, high greyish brown tinted heat-strengthened glazing was used to achieve Residential Envelope Transmittance Value (RETV) requirements. A combination of greyish brown tinted heat-strengthened and low-E glass was featured at the west facing facades. Horizontal reinforced concrete ledges that are part of the architecture feature also double up as sun-shading devices that help to cut down on the heat and glare to the residential units.

SUSTAINABLE APPROACH AND GREEN FEATURES

In line with the design intent of a 'Green Habitat', the development is equipped with a comprehensive variety of active features to help save energy and water consumption. To name a few, energy efficient LED light fittings are used at the back-of-house areas; motion sensors are installed at common areas like staircase half landings and gas water heaters are provided for the majority of apartment unit types.

Apartment units are fitted with a careful selection of water-efficient sanitary fittings and sustainable products approved by local certification bodies. Other green features include the use of a pneumatic waste collection system, siphonic rainwater discharge system, prefabricated bathroom units (PBU) and provision of a double refuse chute system. Usage of a water-efficient irrigation system provides for more than 50 percent of the development's landscaping area.

The most notable green feature at D'Nest is none other than the photovoltaic (PV) panels installed on the maintenance roof of nine residential blocks. PV panels model REC260PE are manufactured by REC Solar Pte Ltd were supplied and installed on site by Phoenix Solar Pte Ltd. All PV panels are elevated from the roof floor to optimise their efficiency. The total PV capacity installed on site is 200.2 kWp, the highest capacity for a private residential development in Singapore. The solar energy harvested is used to supply and replace part of the electricity required to power the common area of the development.

Residential Blocks with Photovoltaic Panels

Photovoltaic Panels Elevated from Roof Floor

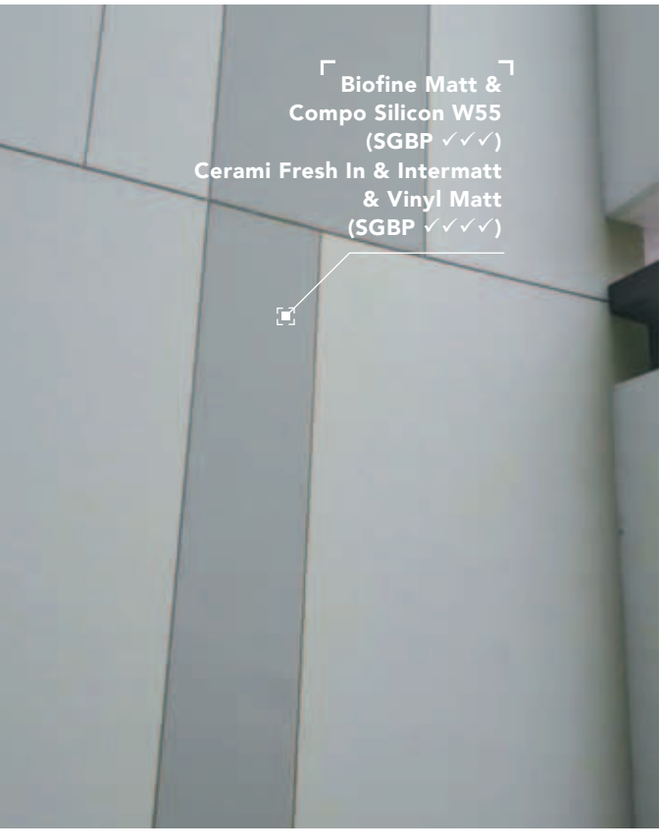
According to Phoenix Solar Pte Ltd, 240,000 kWh of renewable energy was harvested for the very first year of its commissioning since January 2017; which amounted to 6.2 percent replacement of electricity of the Energy Efficiency Index (EEI) for common facilities and expected to contribute to estimated cost saving of $51,744.00/year excluding GST based on the current tariff rate of 21.56 ¢/kWh by Singapore Power.

Green building products and materials certified by the Singapore Green Building Product (SGBP) certification scheme were extensively utilised in many areas of the development. **Low Volatile Organic Compound (VOC) Laticrete 316 Cementitious Adhesive (SGBP ✓✓), Laticrete 282 Mortar Adhesive (SGBP ✓✓), Laticrete 317 & Wall Thinset Mortar (SGBP ✓✓), Laticrete 1600 Tri-Poly Fortified Unsanded Grout & Laticrete 1776 Grout Enhance (SGBP ✓✓)** supplied by Laticrete South East Asia Pte Ltd were used for adhesive, mortar, and grout in the development.

All waterproofing products applied at D'Nest have achieved the SGBP Very Good rating **(SGBP ✓✓)** namely **Quicseal 104, 124, 111, 124 ECO. Turfpave (SGBP ✓✓✓✓)** grass pavers supplied by Elmich Pte Ltd were installed at the softscape areas of the development. These structural modules are made from 100 percent recycled materials and are engineered to allow healthy plant growth, contributing to a verdant greenscape.

A range of Thermalrock S models supplied by **Rockwool South East Asia (SGBP ✓✓ & SGBP ✓✓✓)** were used in the development for general insulation purposes. These products are non-combustible and fire safe with excellent thermal conductivity, and are also manufactured with high recycled content.

The development also makes use of a non-chemical termite treatment system to safeguard the property against termite damage. Supplied by Ensystex (Singapore) Pte Ltd, the **Trithor Termite Protection System (SGBP ✓✓)** is essentially a physical barrier designed to prevent termites from penetrating. More importantly, the product is completely concealed from view once installed and is non-hazardous to anyone who comes in contact with the product. In addition, **REHAU RAUTITAN potable water pipes (SGBP ✓✓)** supplied by REHAU Pte Ltd were installed in all residential units.



For attractive and sustainable interiors, **Ecoworx Modular Tile (SGBP ✓✓✓✓)** carpet supplied by Shaw Industries Asia Pte Ltd are used at the Clubhouses. These SGBP Leader (the highest SGBP rating possible) products have very low VOC-content, are PVC-free and use 40 percent less energy in production as compared to traditional carpet tiles. Ecoworx carpet tiles also come with an environmental guarantee for reclamation and recycling, providing environmental sustainability at no additional cost.

Low VOC paints and coatings supplied by SKK (S) Pte Ltd, namely **Biofine Matt & Compo Silicon W55 (SGBP ✓✓✓)** and **Cerami Fresh In & Intermatt & Vinyl Matt (SGBP ✓✓✓✓)** were applied to the indoor walls of residential units and communal spaces. With excellent resistance against fungus in addition to their low VOC content, these water-based paints are not only friendly to the environment, they also ensure that indoor air quality is kept to optimum, healthy levels.

D'Nest successfully obtained a GOLDPLUS rating under the Building and Construction Authority's (BCA) Green Mark Scheme (New Residential Certification Version 4.0 category). With its well-considered and innovative blend of natural features with the various range of green features, D'Nest is set to be a new benchmark for a highly sought-after tranquil and 'green' living environment.

Developer: Hong Realty (Private) Limited

Architect: Architects 61 Pte Ltd

Civil & Structural Engineer: Parsons Brinckerhoff Pte Ltd

Mechanical & Electrical Engineer: Parsons Brinckerhoff Pte Ltd

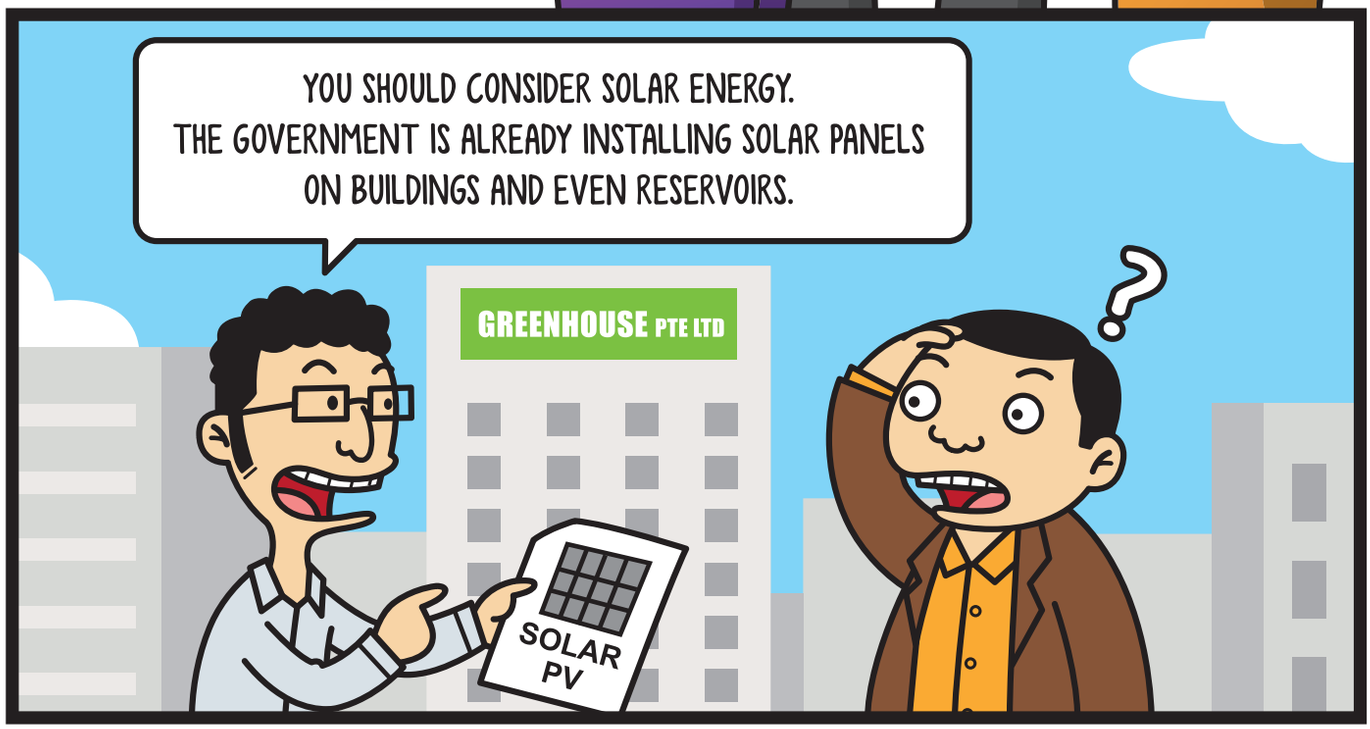
Quantity Surveyor: Arcadis (Singapore) Pte Ltd

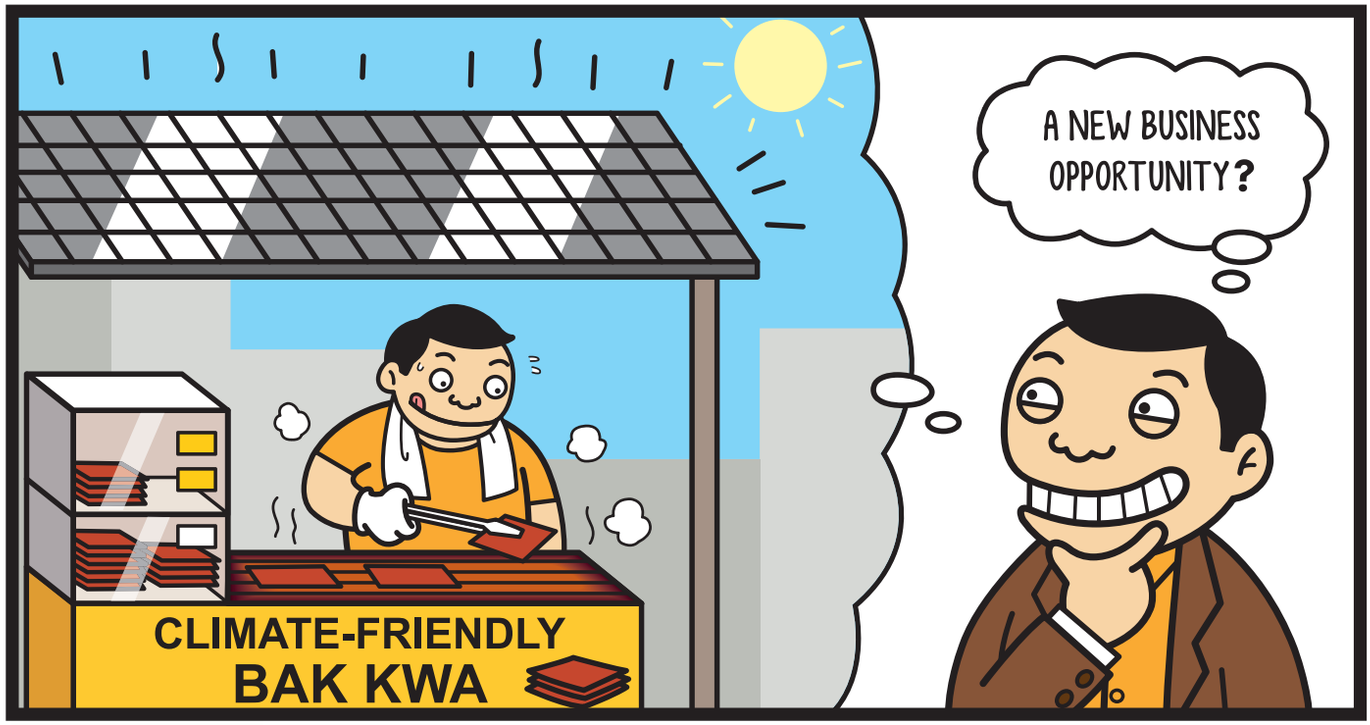
Landscape Architect: COEN Design International Pte Ltd

Interior Designer: ADDP Architects LLP

Main Contractor: Daewoo Engineering & Construction Co., Ltd

Let's Join Hands to Fight Climate Change





CLIMATE CHANGE SG

Find out how you can tap on solar energy at bit.ly/SolarPV_SG

Courtesy of National Climate Change Secretariat.


"The Future is Green Energy,
Sustainability, Renewable Energy."
- Arnold Schwarzenegger

SUSTAINABILITY PRACTISED

Environment sustainability in schools might seem a little far removed for the regular students, but that has not stopped local schools from developing and implementing their own environmental programmes. From club activities involving recycling to school-wide enrichment events on environmental conservation and stewardship, these programmes are as varied and diverse as the schools themselves.

To help schools develop or improve their own environmental programmes, the Singapore Green Building Council (SGBC) rolled out the Green Schools Initiative (GSI) in 2015. Focused on green building, the GSI is designed as a resource bank that provides educators and students with ready materials to begin their own environmental sustainability programmes. The resources available include lesson slides that concisely explain key green building concepts such as indoor air quality and sick building syndrome, an animated video that summarises the main points of green building as well as bringing students on learning journeys to green buildings. So far, the GSI has reached out to more than 50 primary schools, secondary schools and tertiary institutions.

AN ENVIRONMENT CHAMPION

Bukit View Secondary School (BVSS) is one such school with a big focus on environmental sustainability. A strong environment champion and advocate, the school won the President's Award for the Environment in 2016 and implements the Junior Outstanding Leaders in Environment for Sustainability or JOULES programme, a distinctive curriculum that is unique to the school.

Focusing on Science, Technology, Engineering and Mathematics (STEM), the four-year programme enriches all students with knowledge and application in design thinking, coding, programming, environmental science and sustainable energy. Student learning is focused around the four main areas of Power Generation, Transport, Buildings and Water, key elements that contribute to Singapore's vision of becoming a smart city by 2050.

To further enhance the JOULES programme, BVSS decided to convert one of their technical workshops measuring 240 square meters into a purpose-built facility for the conducting of JOULES activities. Instead of going for a regular renovated classroom, the school wanted to create a special learning environment that is able to better educate their students on key environmental issues and developments. After all, it is more effective for

students to see sustainability in action rather than just telling them about it. Through the GSI, BVSS worked with various like-minded environmentally-conscious industry partners to make the facility a reality.

A GREEN LEARNING FACILITY

The JOULES Smart Centre can be likened to a next generation classroom, fitted out with sustainable materials and fixtures that have been certified by SGBC's certification schemes. Right from the beginning, BVSS wanted the facility to have a strong environmental focus, therefore, the room is packed with green building products and materials. These will not only contribute to a conducive and healthy classroom, it also serves to educate students and visitors on the functionalities of green building products, allowing them to observe the products in action first-hand.

Designed with sustainability in mind, the JOULES Smart Centre counted on the expertise of ONG & ONG Pte Ltd, one of the largest home-grown architectural practices in Singapore and one of the first firms to be certified under the Singapore Green Building Services certification scheme. Blending spatial elements and the co-deployment of the various green building products, the numerous fittings and materials work together to create an eye-catching place of learning.

3M Channel Lighting System

Net Effect with CushionBacRE (SGBP ✓✓✓✓)

A FOCUS ON SUSTAINABILITY

"When we first started on this endeavour, we were hoping to find building products that were suitable for our needs," recounted Mr Vasuthevan K Ramamurthy, Principal of BVSS. "Through SGBC, we were able to gain access to a pool of certified building solutions that helped us to create a Smart Centre that exceeded our expectations."

All of the materials and products that have gone into the JOULES Smart Centre have either cleared the stringent requirements of the Singapore Green Building Product (SGBP) certification scheme or are contributed by SGBC Member companies.

Right at the entrance of the Smart Centre, beautiful Net Effect collection carpet tiles backed by **CushionBacRE (SGBP ✓✓✓✓)** supplied by Interface adorn the floor space, interplaying with the colourful furniture to encourage collaborative and co-creation activities. These carpet tiles have achieved the highest possible SGBP rating, bearing very low volatile organic compound (VOC) levels and being manufactured from 90 percent recycled raw materials. The product is also fully recyclable, ensuring zero wastage and totally closing the manufacture, usage and final recovery cycle loop.

A lush, verdant indoor vertical green wall is one of the most striking features of the JOULES Smart Centre. Composed of **GWSTM Advanced Green Modules (SGBP ✓✓)** supplied by GWS Living Art (the innovative arm of Chop Ching Hin Pte Ltd), the green wall not only continually cleanses the indoor air, it also helps to reduce noise levels by absorbing acoustic energy, giving students a positive place for learning. The modules themselves are made from UV stabilised recycled polypropylene and are designed to allow for easy maintenance and upkeep.

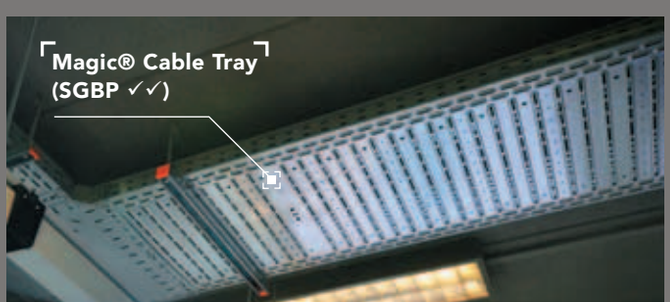
The open ceiling of the facility is dotted with **Haiku I - Series ceiling fans (SGBP ✓✓)** provided by Big Ass Fans Singapore Pte Ltd. Designed with onboard technology, the fans automatically detects changes in occupancy, humidity and temperature, adjusting to the occupant's pre-set comfort preference. Its specially engineered motor and patented air-foils bring energy efficiency to a higher level.

These fans are connected to a **Wisqo wireless control system (SGBP ✓✓)** provided by Innocity Solutions Pte Ltd, which also wirelessly links the room's LED light fixtures. Integrated with the Amazon Alexa intelligent personal assistant, the system allows the JOULES Smart Centre's fans and lights to be remotely operated in three ways: via a mobile app, with voice commands or through a more conventional control device that does not require batteries. The solution also ensures that the least amount of energy is used to deliver the most light, in addition to allowing the room's lights and fans to be closely monitored and controlled anytime, anywhere, reducing energy consumption.

For the facility's air-conditioning, the **Therm-Aire STA-012SPWM (SGBP ✓✓)** solar thermal air-conditioning system supplied by Ecoline Solar Pte Ltd was used. Engineered to be the first dual power (heat and electricity) AC system, Therm-Aire is designed to be a reliable and cost-effective cooling solution that utilises solar, ambient and waste heat to power the system. This reduces the workload of the compressor and prolongs its lifespan, generating substantial energy savings.

Some of the green building products deployed in the facility achieved sustainability synergy. By using a combination of ceiling fans with air-conditioning set to higher temperatures, occupant comfort can still be maintained while reducing energy consumption. This will also avoid over-reliance on air-conditioning to achieve comfort.

Throughout the inner expanse of the JOULES Smart Centre, **Armstrong Natural Creations vinyl flooring (SGBP ✓✓✓)** provided by Goodrich Global Pte Ltd creates a durable, attractive learning space. Matching well with the desks upcycled from repurposed wooden pallets, the vinyl flooring is certified to emit very low volatile organic compounds, keeping the indoor space healthy, productive and beautiful.



A building product that often goes unnoticed, cable trays hold and organise the metres of various cables and wiring that power any modern building. Obo Bettermann South East Asia Pte Ltd provided the JOULES Smart Centre with their **Magic® Cable Tray (SGBP ✓✓)**. Manufactured with high recycled content and low energy use, the cable tray is designed to be installed without the use of screws, snapping together easily through a patented connection system. This drastically improves productivity and cuts down the time and manpower needed to install the entire system.

The paint used within the JOULES Smart Centre was provided by household name Nippon Paint (S) Pte Ltd. The **Odourless All-In-1 and Aqua Bodelac interior paint products (both SGBP ✓✓✓✓)**, these maximum-rated SGBP products are not only good for buildings and interior spaces but are also good for building occupants. Certified to contain near zero volatile organic compounds, low formaldehyde levels and good anti-bacterial properties, the paint products are also non-toxic with no traces of lead, mercury or heavy metal content.

Additionally, SGBC Member 3M Technologies (S) Pte Ltd provided the frontal area of the JOULES Smart Centre with channel lighting that features uniformly distributed lights while reducing the number of electrical/ lighting points needed. Nitto Denko (Singapore) Pte Ltd also supplied the facility with whiteboard film that turns any vertical surface into a writable one for ideas to be better promulgated and shared. Lastly, Samwoh Corporation has partnered with BVSS to provide a Samwoh-JOULES Scholarship, aiming to motivate students who demonstrate leadership in environmental advocacy and sustainability.

SUSTAINABILITY PRACTISED

The JOULES Smart Centre was officially opened on 22 February 2018 by Mr Masagos Zulkifli, Minister for the Environment and Water Resources.

As an example of how the gap in green building consciousness between the community and the industry can be bridged, Mr Masagos said, "The JOULES Smart Centre, with its green products and features, is a good example of sustainability practised. I hope the facility will inspire students to think about incorporating sustainable living in every aspect of their life, and to turn some of these ideas into action."

Echoing his sentiments, Mr Tan Swee Yiow, President of SGBC, highlighted, "Green building should not be adopted by just the building and construction industry alone. Research has shown that Green Mark-certified buildings are not only better for the environment, but also have positive effects for the building occupants. In the case of the JOULES Smart Centre at Bukit View Secondary School, it also serves as an invaluable learning opportunity to students."

The JOULES Smart Centre will be used for BVSS' special curricular classes, as well as other school events and functions. Furthermore, plans are in the pipeline to enable community usage of the JOULES Smart Centre for neighbouring residents. SGBC is also looking into developing a case study using the JOULES Smart Centre as a benchmark to showcase greener, healthier classrooms. In the meantime, students of BVSS can look forward to having lessons in a green classroom that is conducive and healthy.

GRUNDFOS E-PUMPS
– IN A CLASS OF THEIR OWN

"This results in lower energy and lifecycle costs and exceeds the IE4 level in IEC60034-30-1"

As a world leading manufacturer of pumps and pump equipment, we make electrical motors of exceptional quality.

For decades, we have been manufacturing our own motors with integrated frequency converters that match the very high standard of our electronic controlled pumps (E-pumps) in building services, industry and water supply applications.

Grundfos iSOLUTIONS delivers the optimal combination of pumps, drives and auxiliary components for the specific application, incorporating special features and functions and building on application knowledge and experience. Grundfos iSOLUTIONS allows easy integration of pumps, drives, measurement, controls, protections, and communication, saving you valuable engineering, installation and commissioning time.
Learn more on grundfos.com/isolutions

be
think
innovate

GRUNDFOS

MAKING A CONNEXE-TION

The Singapore Green Building Council (SGBC) recently took up additional office space to support its many activities and programmes. More than just a simple working area, this new space is meant to complement the existing office by providing a collaborative space for fluid discussion, private zones for tasks that require utmost attention as well as a teleconferencing pod for long distance dialogues with international counterparts.

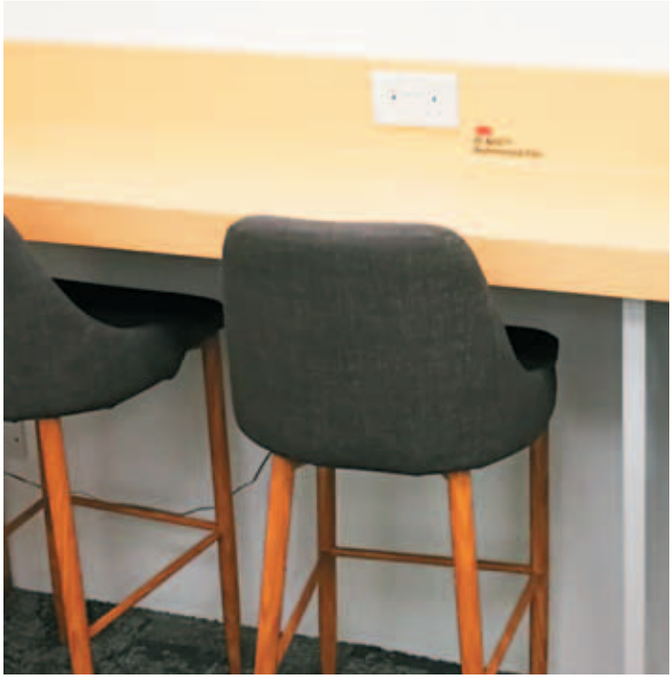
The SGBC Connexe occupies a small floor space within King's Centre, a few doors away from the main SGBC office. As an operational location for staff to work out from, measures were taken to ensure that the indoor environment remains positive, conducive and healthy. SGBC worked with several Member Companies to create a modern working space.

The floor of SGBC Connexe is lined with beautiful Net Effect collection carpet tiles backed by **CushionBacRE (SGBP ✓✓✓✓)** supplied by Interface. These carpet tiles feature earthy tones that are easy on the eyes, both in the aesthetic sense and the literal sense as Interface's backing systems feature almost no volatile organic compound emissions, contributing to a healthy indoor environment. Furthermore, the carpet tiles themselves are fully recyclable while being made from 90 percent recycled raw materials.

The surfaces of all furniture within SGBC Connexe is finished with two colours of **DI-NOC™ Architectural Finishes** supplied by 3M Technologies (S) Pte Ltd. A self-adhesive, flexible laminate film that is able to replicate a range of textures such as wood grain, metal and natural stone, **DI-NOC™** is also highly durable and resistant to scratches or other impacts. In line with 3M's onus on environmental conservation, the product is not produced from trees or metal-bearing ores and are also easy to maintain once installed.


3M
DI-NOC™
Architectural Film


Photizo Global
Human-Centric Lighting




3M Fasara™
Glass Finishes

3M also supplied SGBC Connexe with **Fasara™ Glass Finishes** to its glass doors, which were provided and fabricated by Meng Heng Glass Pte Ltd. The decorative films to help create open feels in confined spaces by allowing light in while still maintaining privacy retention. These glass finishes easily transform plain glass into the look of cut or texturised glass for a fraction of the price. **Fasara™ Glass Finishes** also block 99 percent of ultraviolet radiation, protecting furniture from fading.

In lieu of traditional office cubicles, staff operating within SGBC Connexe have open-concept workstations with shared tabletops lined with **DI-NOC™** mimicking the texture of wood grain. In front of these tabletops are panes of **Lacobel (SGBP ✓✓)** painted glass provided by AGC Asia Pacific Pte Ltd. Clear float glass covered with paint on one side, the paint used are environmentally friendly and emit very levels of VOCs as well as formaldehyde. While serving to enhance the green aesthetic within SGBC Connexe, Lacobel also provides for an excellent writing surface not unlike a whiteboard!

The SGBC Connexe is also equipped with human-centric lighting which follows the human circadian rhythm provided by Photizo Global Pte Ltd. In its simplest terms, the circadian rhythm is the body's biological clock: telling the body when to wake up, eat, sleep as well as regulates my physiological processes. Environmental factors such as daylighting and temperature can disrupt this rhythm and hence affect eating and sleeping patterns. The lighting installed in SGBC Connexe combines physiological, visual and psychological elements to elicit positive impact on occupants.

Thanks to SGBC Members, staff can work out of a workspace that is healthy to mind and body.

THE "SUSTAINABLE" EPC: ENSURING ENERGY EFFICIENCY

The upfront cost for retrofitting buildings has always been a barrier for building owners looking to improve their building's energy efficiency. This is a sound business decision as much as a sustainable one, as improving energy efficiency is one of the most cost effective ways of reducing energy costs and greenhouse gas emissions. Energy performance contracting can help building owners realise their energy efficiency goals without giving them a hard financial pill to swallow.

WHAT IS ENERGY PERFORMANCE CONTRACTING (EPC)?

EPC is a method for retrofitting existing buildings by using guaranteed operational energy savings to pay for the upgrades. For EPC retrofits, building owners are assured that the retrofits are effective and generate enough cost savings to pay for itself. Savings can be generated from use reduction in electricity, heating fuels, water and/or wastewater.

WHAT ARE THE BENEFITS OF EPC FOR BUILDING RETROFITS?

1 Building owners can focus on other aspects of the business while leaving building energy efficiency and performance to the professionals. Turnkey services offered by EPC firms include helping owners design retrofit solutions to achieve the desired level of BCA Green Mark certification (e.g. to meet requirements for aircon system efficiency, Singapore Standards 554 Indoor Air Quality standards, etc), as well as to apply for applicable government incentives/grants. In addition, EPC firms can advise owners on the latest technological advancements for higher sustainability targets.

2 For EPC projects where the building owner takes on a bank loan, the loan amount is usually capped at up to 90 percent, with an upfront payment of 10 percent or above. However, for EPC projects with Zero Capital Partnership (ZCP) arrangements, there can be no capital outlay by the building owner, as the EPC firm will arrange for and bear the financing needed (i.e. any loans will not be on the balance sheets of the building owner). This ensures that building upgrades are not deferred due to competition of capital against other allocations, and hence avoid incurring higher operating costs over time. Should utility costs rise, EPC projects will also provide additional cost savings.

3 There is the option to include maintenance works in the EPC contract to sustain long term operational savings, where most EPC firms are able to offer such services as well.

HOW IS AN EPC PROJECT FOR BUILDINGS STRUCTURED?

An agreement is made between the EPC firm and a building owner that will outline the terms of the project, namely how cost savings are shared, measured, and verified, as well as the contract (payback) period. Based on the owner's needs/ goals of retrofitting (e.g. to meet Green Mark Rating requirements), the EPC firm will perform a baseline energy audit of the building, identify relevant retrofits and structure the project together with the owner/ the appointed M&E coordinators/facilities managers. Retrofits could also be structured together with tenders calling for other items to increase the ease of raising a tender.

WHAT DO CLIENTS LOOK FOR IN AN EPC PROJECT?

- Amount/percentage of guaranteed savings
- Overall cost (payback period) and financing model
- Track record of EPC firm
- Implementation process of EPC project

HOW ARE EPC PROJECTS FINANCED?

In financing an EPC project, several approaches can be taken depending on each client's preferences and project specifications. Common sources of funding include:

- Management Corporation Strata Title (MCST) Sinking Fund
- Bank loans taken up by building owners to be repaid with energy savings guaranteed by EPC firm (Guaranteed Savings model), or in the case of Zero Capital Partnerships (ZCPs), energy savings will be paid to EPC firms which take on the bank loan on behalf of the client (Shared Savings model)

- Green Mark Incentive Scheme for Existing Buildings and Premises (GMIS-EBP): co-funds up to 35 percent, 40 percent and 50 percent, for achieving Gold, Gold Plus and Platinum GM ratings respectively and meeting the minimum aircon system efficiency (kW/RT) for each rating
- Pilot Building Retrofit Energy Efficiency Financing (BREEF) Scheme: covers the cost of retrofit equipment, installation and professional fees for buildings that attain the minimum GM certification.
    - Through the scheme, the building retrofits can be financed from a loan from participating banks/ financial institutions, which is paid off through the energy savings reaped.
    - BREEF covers the cost of equipment, installation and professional fees
- Zero Capital Partnership Scheme (ZCP): bridges building owner with the expertise of an accredited EPC firm. The EPC firm serves as a one-stop solution for both minor and major retrofit options, can provide financing options and also facilitate the application of relevant grants or incentive schemes to fund the retrofit works.

IS EPC SUITABLE FOR ALL RETROFITTING PROJECTS?

No, not all retrofitting projects will be suitable for EPC. In rare cases, the guaranteed savings from upgrades are too small to justify a reasonable payback period, taking into account higher interest rates charged by financial institutions for loans that will require a long repayment duration.

As a ballpark estimation, the payback period for retrofitting an old chiller is about five to eight years, with savings in the range of $50,000 per month.

BRIDGING ENERGY EFFICIENCY

The Singapore Green Building Council accredits energy performance contracting firms under the Singapore Green Building Services certification scheme to ease the industry into energy efficiency retrofits.

Evaluated and assessed based on track record, financial net worth, EPC project amount and bizSAFE accreditation levels, these EPC firms will be able to help building owners implement sound and fruitful building retrofit arrangements. Additionally, SGBS-certified EPC firms can help green building projects gain bonus points if the firm has been engaged to implement suitable projects that guarantee operational system efficiency over a minimum of 3 years (Green Mark 2015, Section 4.03d).

+65 6732 5518 membership@sgbc.sg www.sgbc.sg

Established Member of WORLD GREEN BUILDING COUNCIL

We need the buildings we live in to be buildings we can live with

SINGAPORE GREEN BUILDING COUNCIL

+65 6732 5518 membership@sgbc.sg www.sgbc.sg

Established Member of WORLD GREEN BUILDING COUNCIL