

Singapore Green Building Masterplan – A roadmap to decarbonise the Built Environment

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1

Climate change and the impetus for Singapore's Built Environment



Singapore moved early on climate mitigation targets in 2020

In early 2020, we enhanced our 2030 Nationally Determined Contribution (NDC) and submit a Long-Term Low-Emissions Development Strategy (LEDS), against the backdrop of “2°C safe limit”.

Subsequently in end 2022, we submitted our revised commitments to the United Nations Framework Convention on Climate Change (UNFCCC).



Source: NCCS



The realisation of the Singapore Green Building Masterplan (SGBMP) will be important to meet Singapore's sustainability ambitions and international commitments

SINGAPORE'S AMBITIONS AND COMMITMENTS

Singapore Green Plan 2030

- Greener Infrastructure and Buildings under 'Energy Reset' pillar

Singapore will raise our national climate target to achieve net zero emissions by 2050 and reduce emissions to around 60 million tonnes of carbon dioxide equivalent (MtCO₂e) in 2030 after peaking emissions earlier

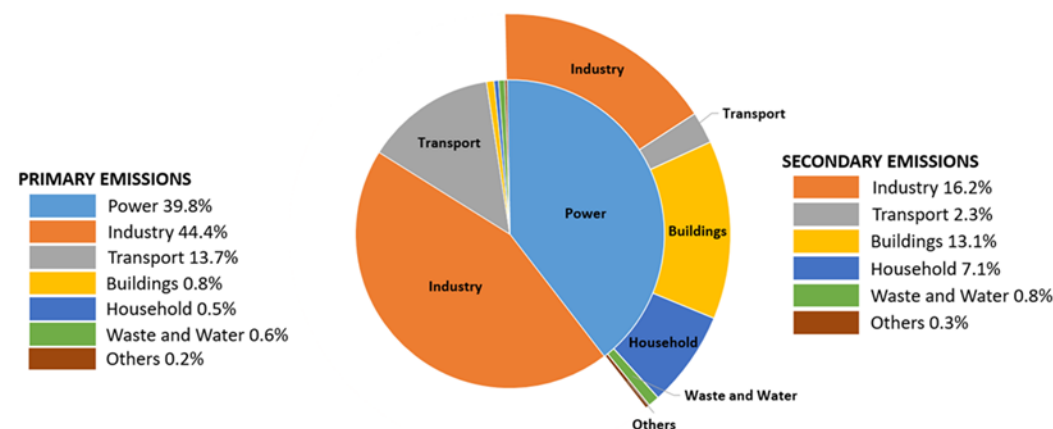
Buildings contribute about 20% of Singapore's carbon emissions.

Green buildings can contribute a big part in our transition to a low-carbon and climate resilient future.



Emissions Profile (2020)

Emissions: 49.7 MtCO₂e



The emissions profile above excludes estimated hydrofluorocarbons (HFCs) emissions of around 3.1 MtCO₂e from the Refrigeration and Air-conditioning (RAC) sector in 2020. When more robust estimates are established, the national emissions profile will be updated in accordance with the United Nations Framework Convention on Climate Change (UNFCCC) and Intergovernmental Panel on Climate Change (IPCC) guidelines on continual improvement of national GHG inventories.

Source: NCCS



The Singapore Green Building Masterplan (SGBMP) aims to deliver the 3 key outcomes of '80-80-80 in 2030'

SGBMP Tagline & Vision

Tagline: "Build our green future together"

Vision: "A leading green built-environment sector mitigating climate change and providing a healthy, liveable and sustainable built-environment for all"

SGBMP Key Outcomes: 80-80-80 in 2030

Outcome 1:

80% of buildings (by floor area) to be green by 2030

- Step up the pace of greening our buildings
- Raise the sustainability standards of our buildings

~55% Green Building GFA

Outcome 2:

80% of new developments (by floor area) to be SLE from 2030

- Mainstream Super Low Energy (SLE) performance of new buildings so that from 2030, large majority of new development would be achieving today's SLE energy performance standards

~20% of new developments certified as SLEBs

Outcome 3:

Best-in-class Green building to achieve 80% EE improvement by 2030 through R&I compared to 2005 levels

- Push boundaries in energy efficiency for best in class green buildings through research, innovation and implementation

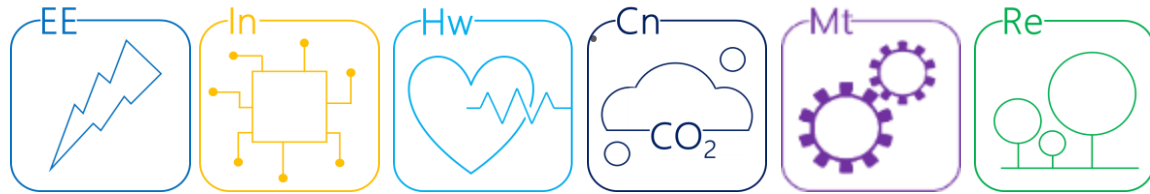
71% EE improvement for best-in-class green buildings

Key Enablers

- Green Mark 2021 as a sustainability framework to mitigate carbon emissions and enable access to green financing
- Solar deployment to accelerate energy transformation
- Build industry capability in new growth areas; Create good jobs and opportunities for the built environment sector

As part of SGBMP, we have raised the sustainability standards with the revised Green Mark scheme – Green Mark 2021 (GM: 2021)

GREEN MARK 2021



The GM: 2021 is launched!

For more info, please visit <https://go.gov.sg/gm2021>

*Update: 62 projects completed certification
(~35% obtained Platinum SLE/ZE/PE)**

**As at end May 2023*

Green Mark 2021 is a key lever that facilitates high performance and climate action in buildings

- Higher energy performance requirements and longer term sustainability outcomes
- It is aligned to the wider Green Plan, SGBMP's '80-80-80 in 2030' and a driver of the Construction ITM (Smart, Productive and Green)
- It supports and prepares the value chain for the future green economy - towards climate resilience, carbon neutrality and transition plans, whilst championing SLE, DfM, Smart FM, IDD, DfMA & SC, Healthy buildings.

Keppel Infrastructure – Changi
GM Platinum PE



NUS Frontier
GM Platinum ZE with Re badge



80 Anson Road
– Non Residential
GM Platinum SLE



Copen Grand
GM Platinum SLE with WLC, HW & Mt badge



2

**Green buildings are a worthwhile investment;
Super Low Energy Buildings are a necessary step in
decarbonising the built environment**



Over the years, the built environment sector has collectively reaped significant cost savings and played a prominent role in Singapore's sustainability efforts

Since the Paris Agreement in 2015



172 GM certified commercial buildings

Annually,

SG\$ 100 Million energy savings

Carbon absorption/abatement equivalent to,

**Having 80,000 hectares of forest, or
Removing 30,000 ICE cars off road**



90 GM certified private residential buildings

Annually,

SG\$ 50 Million energy savings

Carbon absorption/abatement equivalent to,

**Having 40,000 hectares of forest, or
Removing 15,000 ICE cars off road**

Source: Energy disclosure from Green Mark

Green buildings are a smart investment with good payoffs derived from energy savings over the building life cycle, especially Green Mark Super Low Energy buildings (SLEBs)

New Developments

Adopt SLE standards for new developments given the reasonable payback period

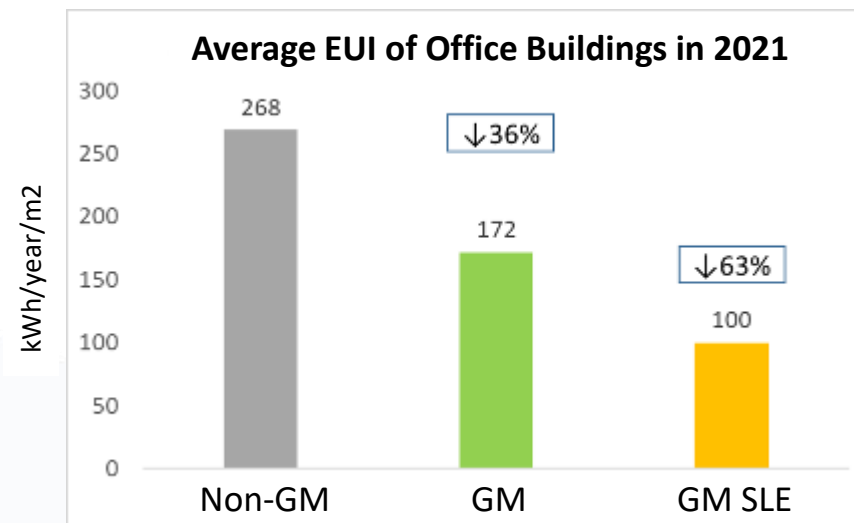


- ✓ A new commercial building that achieved the highest **GM SLE** standard can get payback on its investment in sustainability within **4.5 - 6.5 years**

Source: Green Mark, [GM Independent Consultancy Study](#)

Existing Buildings

Retrofit existing buildings to SLE standards to enjoy higher energy savings

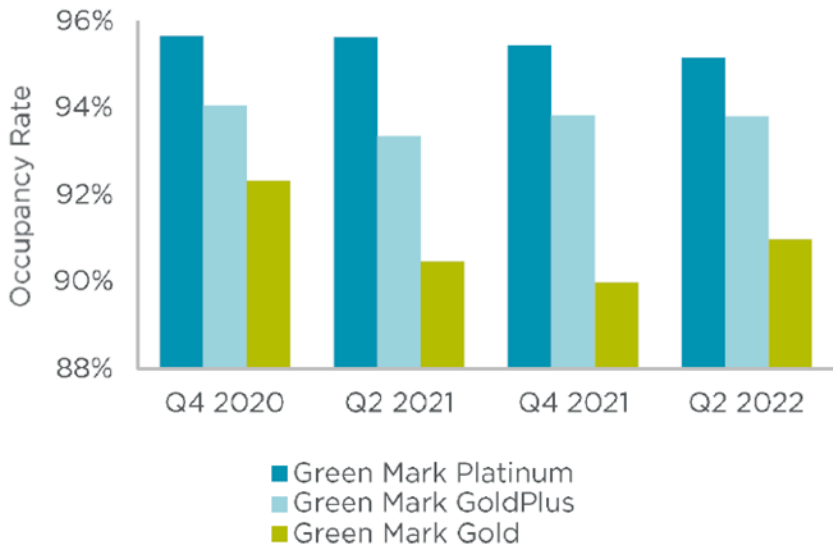


- ✓ Latest data in 2021 has shown that **GM SLE** office buildings are **63%** more energy efficient than non-GM office buildings

Source: Building Energy Submission System

Green Mark office buildings are more highly sought after and valuable

Occupancy of Office Buildings (all grades) in CBD With Green Mark Rating



Source: Cushman & Wakefield Research

CBD Grade B Office Rents by Buildings with and without Green Mark Rating



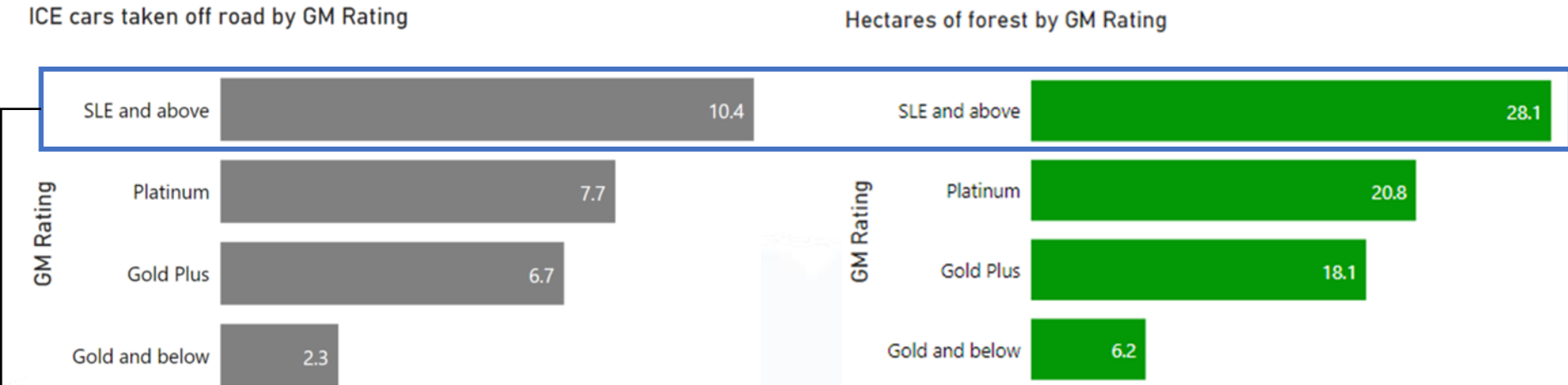
Source: Cushman & Wakefield Research

- ✓ **Higher occupancy and rents** for green office buildings with higher GM ratings
 - Tenants/businesses are putting **greater emphasis on sustainability** and committing to sustainability goals, hence are willing to pay premium
 - There is **competitive edge** for building owners/landlords with green office buildings of higher GM ratings

Businesses have more choices and can reduce their carbon footprint by choosing to lease from Green Mark SLEBs

Commercial Buildings

- Attain higher carbon reduction by going for a higher GM rating for your commercial building or unit



By choosing a **GM SLE** commercial building, it is predicted to achieve **>115MWh/year** energy saving per 1,000 m² Carbon absorption/abatement equivalent to, **Having 28 hectares of forest** or **Removing 10 ICE cars off road**

Source: Energy disclosure from Green Mark. Figures calculated per 1,000sqm GFA

Individuals have more choices now and can play their part by choosing to live in a Green Mark Super Low Energy residential development

Private Residential Buildings

- Make a real difference in the fight against climate change by buying/renting a unit in a Private Residential development with higher Green Mark rating
- On average, the annual carbon absorption/abatement from GM SLE condominium unit is equivalent to:

Having 0.7 hectare of forest for every unit



Removing 1 ICE car off road for every 4 units



Source: Energy disclosure from Green Mark. Figures account for total energy saving in entire condominium divide by number of units

Green buildings have better indoor environment quality

- Research by BCA and NUS has shown **greater satisfaction with indoor environment and lower risk of sick building syndrome in GM buildings**



1

Better for health

- Occupants have less risk of experiencing sick building syndrome – 59% less likely for headaches and 58% less likely for irritated skin



2

Filter fine particulates e.g. PM2.5, bacteria and fungi more effectively

- Higher-performance filters remove particulates more effectively, hence lower concentrations

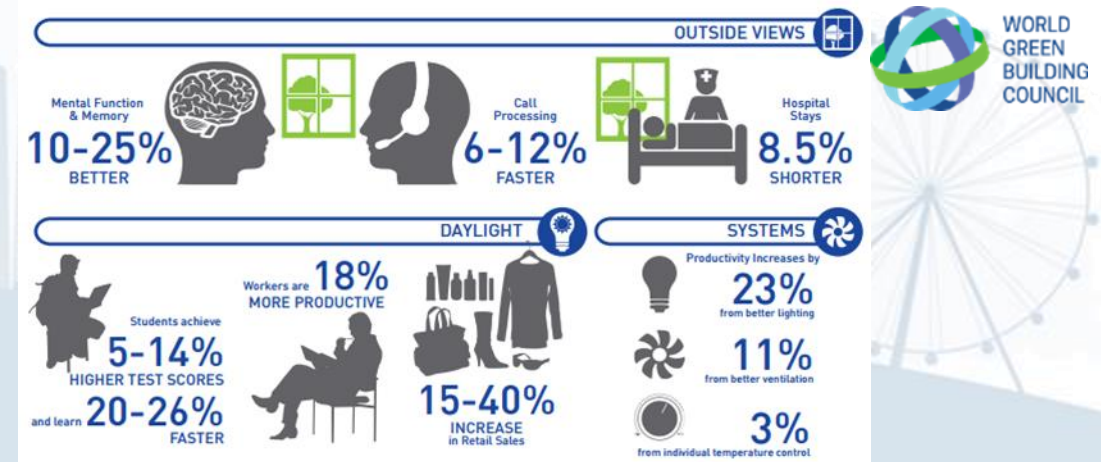
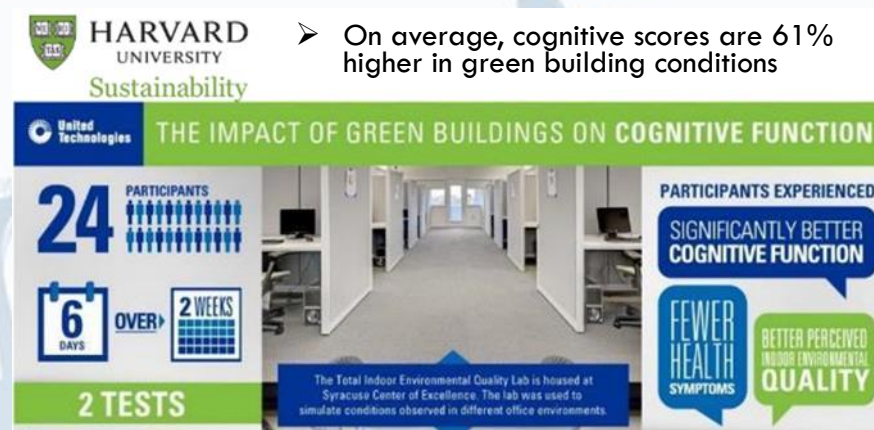


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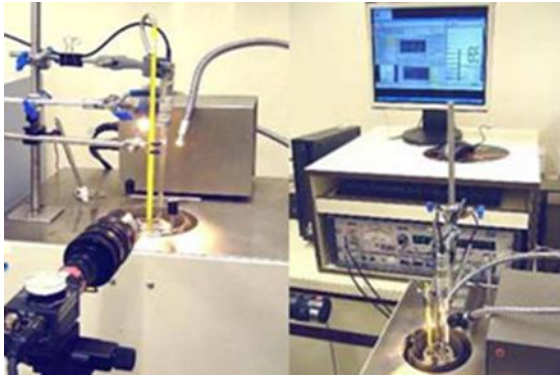
More comfortable to be in

- Occupants were more satisfied with temperature, humidity, lighting, air quality and indoor environment, as demand control ventilation system maintains conditions more consistently

- These findings are aligned with results from international studies from Harvard and WorldGBC



Amid heightened attention on greenwashing, industry can leverage robust green building rating tools that have emphasis on M&V and O&M to sustain high performance over lifecycle



1. Strong emphasis on measurement and verification (M&V)

- Requirement for M&V to monitor chiller plant performance and for VRF system with aircon area $>2,000\text{m}^2$
- Dedicated power meters for air distribution system
- Display both chiller plant and air distribution system efficiency on building management system (BMS)
- Sub-metering requirement for major energy use equipment



2. Inclusive of tenant engagement

- Tenants and users account for about 50% of building's energy consumption according to our Building Energy Benchmarking Report (BEBR)
- In addition to designing and operating for low-carbon in common areas, engaging tenants through green lease and user engagement activities (part of GM criteria) will support businesses in achieving their sustainability commitments

✓ *The BCA Green Mark framework has a strong emphasis on the buildings' actual performance during operation and provides the robustness to give credibility and assurance to investors and consumers. Green Mark credentials are therefore a valuable accolade to mitigate greenwashing.*

Adopting design for maintainability principles and smart FM technologies will maintain the performance of green buildings over the life cycle.

Green Mark 21 Maintainability Section:

- Design for maintainability - First step of an effective, sustainable maintenance program, **linking maintenance goals and desired outcomes to design process**
- Resulting in **lower operational energy & embodied carbon** throughout building's lifespan

Ease of access for
Maintenance

=

Better Operational Energy
Efficiency, reliability & IAQ

Good Design
Detailing & Material
Selection

=

Reduced Embodied
Carbon



Lack of Access. Access to fan coil unit obstructed by other services despite access panel provision



Poor Choice of material. Non-weatherproof fire-rated materials for wet riser pipe



Inappropriate detailing. Floor at lift landing sloping towards lift door

3

Decarbonisation post-2030



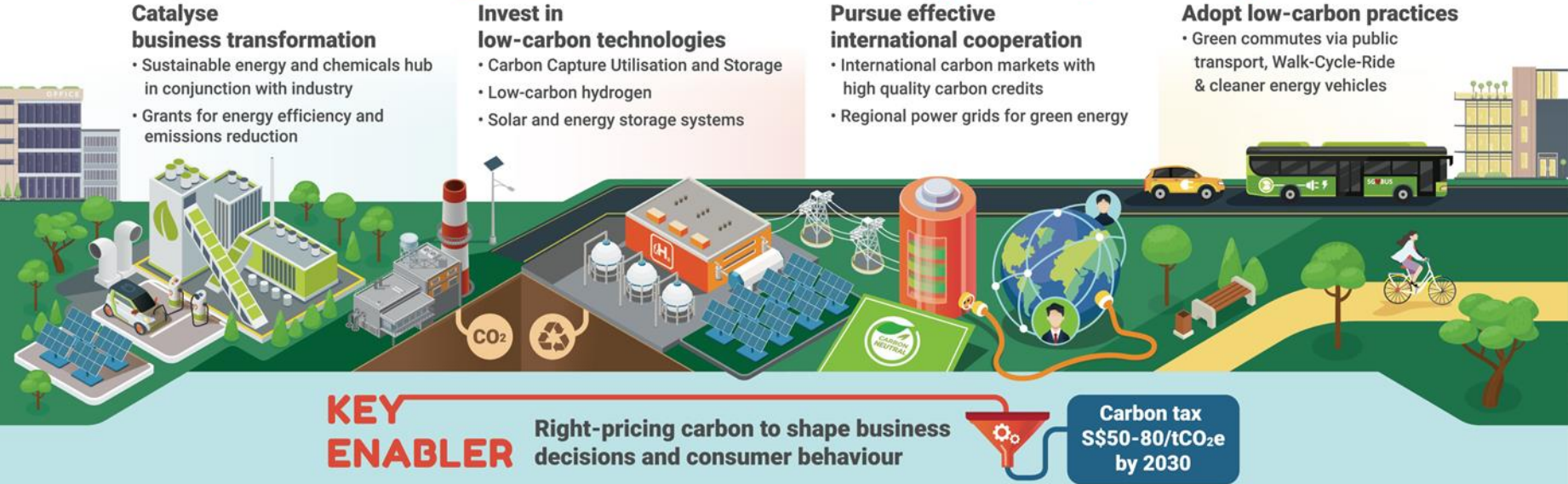
Singapore has started making plans towards our net zero targets

Charting Singapore's Net Zero Future

Achieve net zero emissions by 2050
Long-Term Low-Emissions Development Strategy (LEDS)

Reduce 2030 emissions to 60 MtCO₂e
after peaking emissions earlier
2030 Nationally Determined Contribution (NDC)

Accelerating Low-Carbon Transition in Industry, Economy and Society



EVERYONE CAN PLAY A PART

Public sector
Achieve net zero emissions across public sector around 2045 as part of GreenGov.SG



Private sector
Develop and adopt low-carbon solutions, and pursue green growth opportunities



Individuals
Contribute to climate friendly initiatives

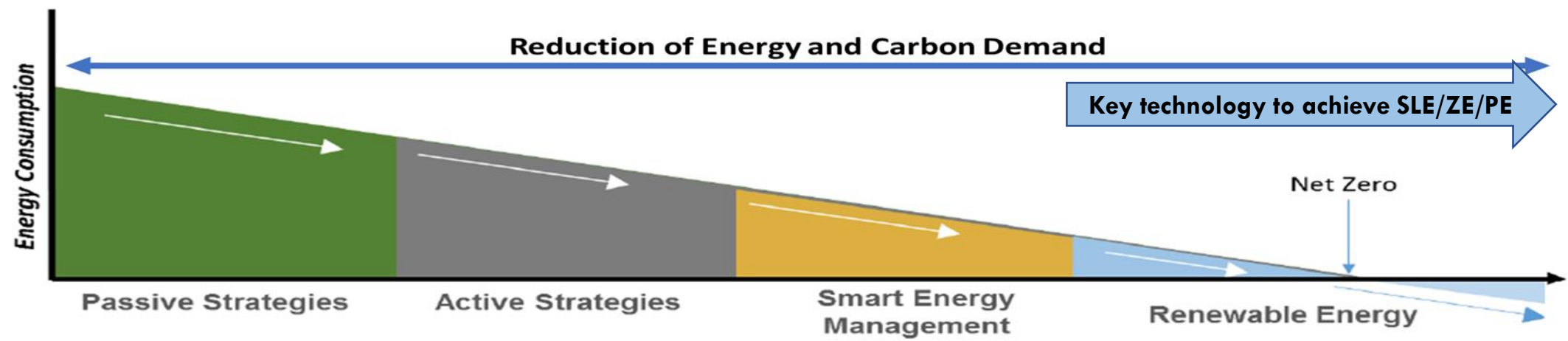


To contribute towards Singapore's net zero target, the BE sector can adopt emerging solutions to maximise the EE improvement potential and on-site RE in buildings

Key strategies under SLE Tech Roadmap

DECARBONISATION STRATEGIES

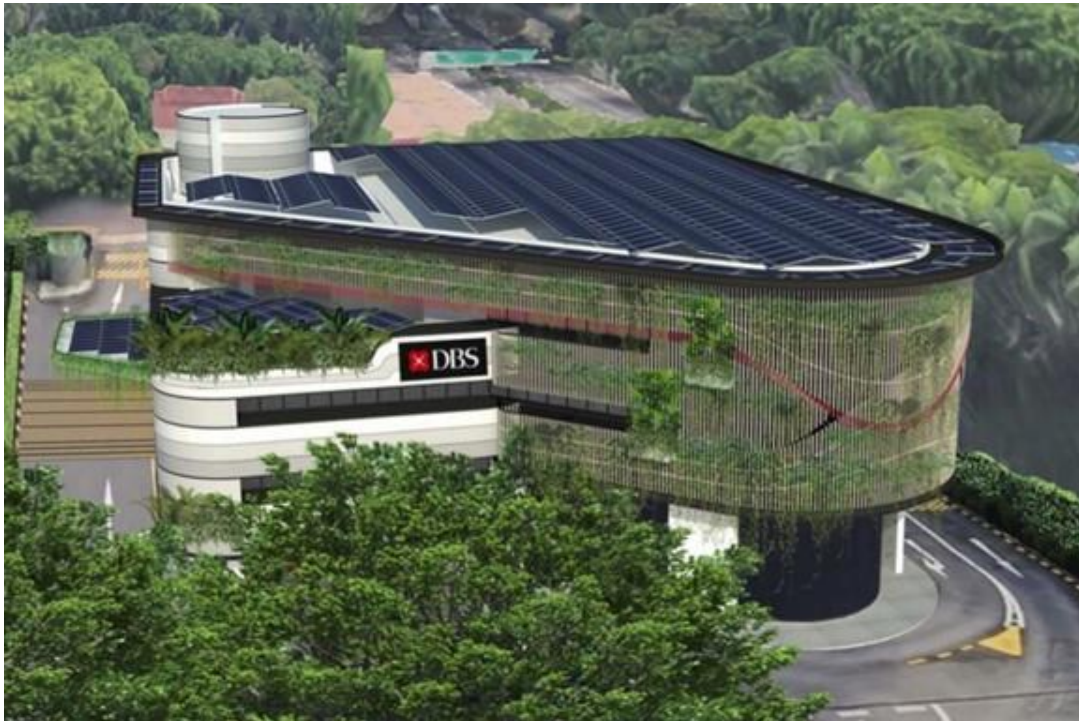
- 1. Minimise cooling needs from onset
- 2. Maximise energy efficiency of active systems
- 3. Offset remaining consumption with clean energy



KEY SOLUTIONS IDENTIFIED

- 1** More naturally ventilated (NV) spaces i.e. transient areas
- 2B** Hybrid Cooling
Elevated air-conditioned (AC) temp (~27deg) + Fans
- 2C** Passive Displacement Cooling (PDC)
 Chilled Beams/Radiant Panels System
- 2A** Mixed-Mode Ventilation (MMV)
Flexible to enable transition between different modes i.e. natural ventilation + fans, spot cooling, hybrid cooling
- 3** Façade Solar Photovoltaics (PV)
[i.e. Building Integrated Photovoltaics (BIPV) / Building Attached Photovoltaics (BAPV)]

Increase in naturally ventilated spaces at DBS Newton Green



Green Mark 2016

- Rating: Platinum ZE
- GFA: 3,508m²
- No. of storeys: 4-storey office building

Key Green Features

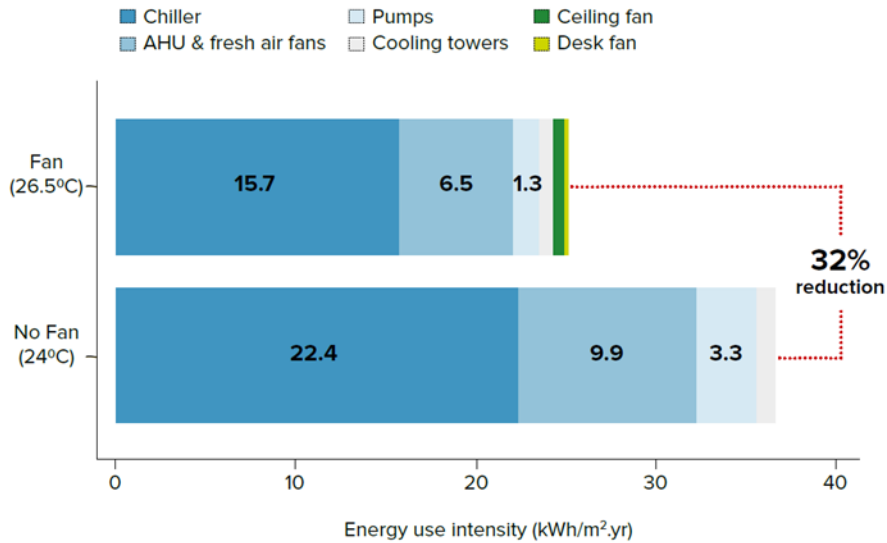
- Reduced air-con spaces by 17% (30% of floor area naturally ventilated)
- High efficient variable refrigerant flow (VRV) system
- Intelligent occupancy-based lighting and air-conditioning systems
- Heat pump water heater for pantries and water efficient fittings
- Slatted façade made of bamboo to shade building
- >1,000sqm of rooftop space with bi-facial PV modules equipped with AI-enabled optimizers

Overall Environmental Impact

- Total Energy Saving = 454.6MWh/year or SGD\$90.9k/year
- Total Carbon Reduction = 227tCO₂e/year

Adoption of hybrid cooling at BCA Office @ ZEB Plus

Cooling Energy Saving Results



Direct influence of raising temperature setpoint from 24 to 26.5°C and provision of supplementary air movement

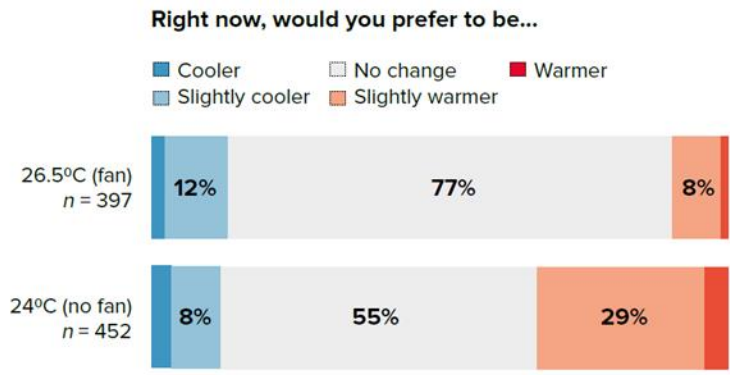
- Elevated air movement with a temperature setpoint of 26.5°C has resulted in reduced cooling energy requirements by 32%
- Improvement in occupant comfort acceptability from 55% to 77%

Source: SinBerBEST's study

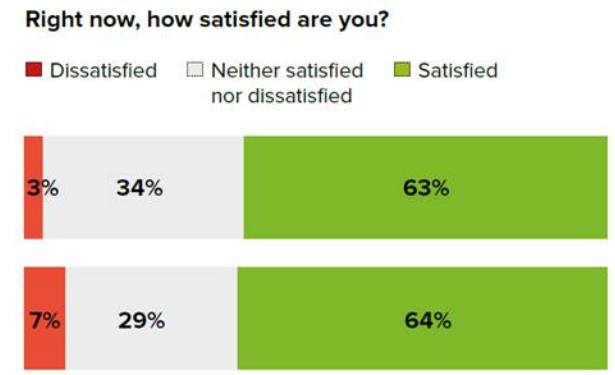
Scan QR code for publication on ZEB Plus building or go to <https://go.gov.sg/bca-zebplus>



Comfort Acceptability and Satisfaction Results



Improved acceptability at higher set-point temperature with ceiling fans



Better thermal satisfaction was established



Adoption of sustainable features in housing projects such as Tembusu Grand



Green Mark 2021

- Rating: Platinum SLE
- Badges: Health and Wellbeing, Whole Life Carbon and Maintainability
- GFA: 54,789m²
- No. of units: 638

Key Green Features

- 5-ticks AC for dwelling units and common area facilities
- LED lighting for common area facilities
- Demand control for AC and lighting in designated common areas
- Onsite solar PV system to offset 30% of energy consumption in designated common areas (115MWh/year)
- >40% recovery rate of crushed concrete waste from demolished building
- Good selection of concrete, glass and steel with 30% reduction in embodied carbon
- Lush greenery with accessible rooftop gardens
- SGBC 4 ticks for material finishes for common areas

Overall Environmental Impact

- Total Energy Saving = 1.1GWh/year or SGD\$219k/year
- Total Carbon Reduction = 447tCO₂e/year

86% of housing projects certified in 2022 prioritizes 5-ticks AC, energy/water efficient features, sustainable construction, green products, improved indoor air quality/comfort/well-being

Key Takeaways

1

Singapore Green Building Masterplan's 80-80-80 by 2030

- Net zero emissions by 2050 and reduce emissions to around 60 MtCO₂e in 2030 after peaking emissions earlier

2

Green buildings are a worthwhile investment; Super Low Energy Buildings are a necessary step in decarbonising the built environment

- Tremendous benefits in energy cost savings, carbon reduction, health and well-being in GM buildings, especially SLEBs

3

For decarbonisation post-2030, alternative cooling solutions will be key

- Important to have holistic considerations of sustainability and maintainability for buildings and explore emerging decarbonisation strategies

Thank You

