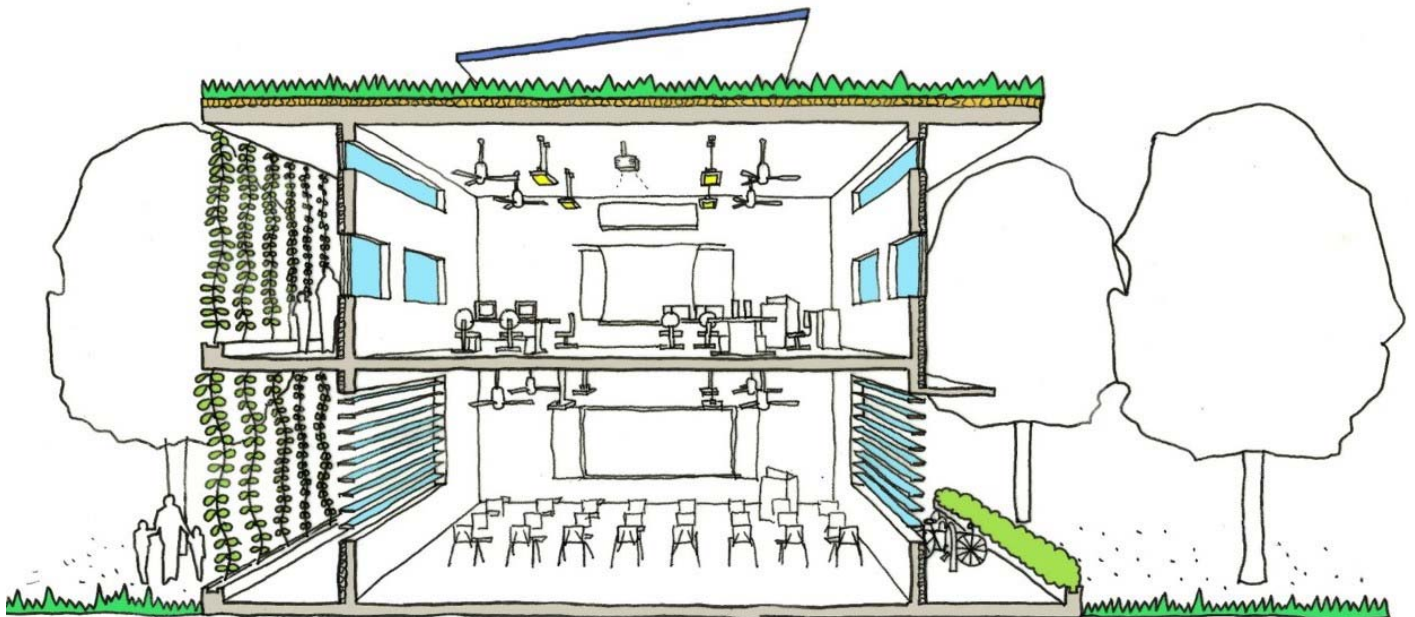




GM NRB: 2015

GREEN MARK FOR NON-RESIDENTIAL BUILDINGS NRB: 2015

including Hawker Centres, Healthcare Facilities, Laboratory Buildings and Schools



Revision	Description	Date Effective
R0	Launch for Pilot	02/09/2015
R1	Revised Version for Implementation	31/08/2016
R2	Revised Version for Implementation: Minor wording amendments to: Pg 9, 15, 19, 22 - 24, 29, 32, 34, 37, 42, 53-55, 58, 62, 69, 71 - 74, 76	02/11/ 2016
R3	Revised Version to include annexes for specific building types Hawker Centres, Healthcare Facilities, Laboratory Buildings and Schools. Alternate option for scoring of Energy related items and other minor changes. Minor text amendments (in grey highlight) from period Aug 2018 to Dec 2018.	01/08/2018

Introduction

What is BCA Green Mark?

The Building and Construction Authority (BCA) Green Mark scheme was launched in 2005 and is an internationally recognised green building rating system tailored for the tropical climate. Green Mark sets parameters and establishes indicators to guide the design, construction and operation of buildings towards increased energy effectiveness and enhanced environmental performance.

BCA Green Mark comprises a number of distinct rating tools that together holistically rate the built environment for its environmental performance. These include:

- **New Buildings:** Non-Residential, Residential, Data Centres and Landed Housing
- **Existing Buildings:** Non-Residential, Residential, Data Centres and Schools
- **User Centric:** Office Interior, Retail, Supermarket, Restaurant and Laboratories
- **Beyond Buildings:** Districts, Parks, and Infrastructure

Introducing Green Mark NRB: 2015

Green Mark for Non-Residential Buildings NRB: 2015 is the 5th edition of the Green Mark scheme for new non-residential buildings, such as commercial (office, retail and hotel), industrial and institutional buildings as well as specialised buildings Hawker Centres, Healthcare Facilities, Laboratories and Schools. This version delivers:

- A streamlined rating scheme that addresses sustainability in a more balanced and holistic manner.
- Greater emphasis on climatically contextual design, energy effectiveness, health and wellbeing of building occupants, smart buildings, and a systematic approach to addressing embodied energy and resource usage.
- Recognition of the design processes which respond to site context and facilitate sustainability considerations at the early project stages where there is the greatest opportunity for low cost, high reward options to be implemented.
- A collaborative framework with more than 130 industry members and academics involved in the setting of metrics, assessment methods and performance levels.

The Green Mark NRB: 2015 Criteria should be read in conjunction with the following accompanying handbooks and tools:

- Green Mark NRB: 2015 Technical Guide and Requirements
- BCA Carbon Calculator
- BCA Energy Performance Points Calculator

Why Green Mark NRB: 2015?

Green Mark provides a consistent method to assess and verify buildings for their overall environmental performance, assisting project teams to deliver a more sustainable built environment and encouraging best practices and market transformation. It is a design guide that can be referenced to understand the attributes of what makes buildings truly sustainable. Green Mark NRB: 2015 aims to further stretch building outcomes to substantially reduce the environmental impacts and increase the life-cycle quality of projects. Moreover, it provides a platform to recognise and make mainstream the leadership needed to drive creative, organisational & technical improvements to the overall environmental credentials of projects.

Outcomes of Green Mark NRB: 2015

The indicators within the Green Mark criteria are mapped to internationally recognised sustainability outcomes. Driving these outcomes through the Green Mark scheme can ensure buildings awarded under Green Mark will truly be high quality environmentally sustainable developments for our current and future generations.

Climate

Buildings should demonstrate emissions reduction and resilience to the effects of climate change.



Resources

As stewards of the earth's resources, buildings should use resources in an efficient manner to reduce its environmental footprint over the building life cycle.



Wellbeing

Liveable built environments are vital for our health and well-being.



Ecology

Buildings should consider their wider impact on the biosphere through the integration of nature and protection of natural systems including flora and fauna.



Assessment Process

The BCA Green Mark Certification Process is as follows:

Application

- Submittal of application with relevant supporting documents for certification upon finalisation of building design.
- Upon acceptance of application and fee payable, a BCA Green Mark Assessor will be assigned for the duration of the project.

Assessment

- To be conducted when design and documentary evidences are ready.
- Comprises design and documentary reviews to verify if the building project meets the intents of the criteria and certification level; as well as the prerequisite requirements.
- For projects with potential BCA Green Mark Gold^{PLUS} and Platinum rating, a presentation to BCA panel for evaluation is required.

Verification

- To be conducted upon project completion.
- Includes review of delivery records, updated documents on green features and building energy performance data. Site inspection and measurement will be conducted.
- For projects with BCA Gold^{PLUS} and Platinum rating, energy savings based on the actual building operating data and parameters will be required to ascertain the energy performance of the building.

Green Mark NRB: 2015 Ratings

The environmental performance of a building development shall be determined by the numerical scores (i.e Green Mark points) achieved in accordance with the applicable criteria using the scoring methodology and the prerequisite requirements on the level of building performance as specified in this Green Mark scheme document. Under this assessment framework, points are awarded for incorporating sustainable design features and practices, which would add up to a final Green Mark Score. Depending on the level of building performance and Green Mark Score, the building development will be eligible for certification under one of the ratings, namely BCA Green Mark Gold, Gold^{PLUS} or Platinum. The design of the building development shall also meet all the relevant mandatory requirements regulated under the Building Control Regulations.

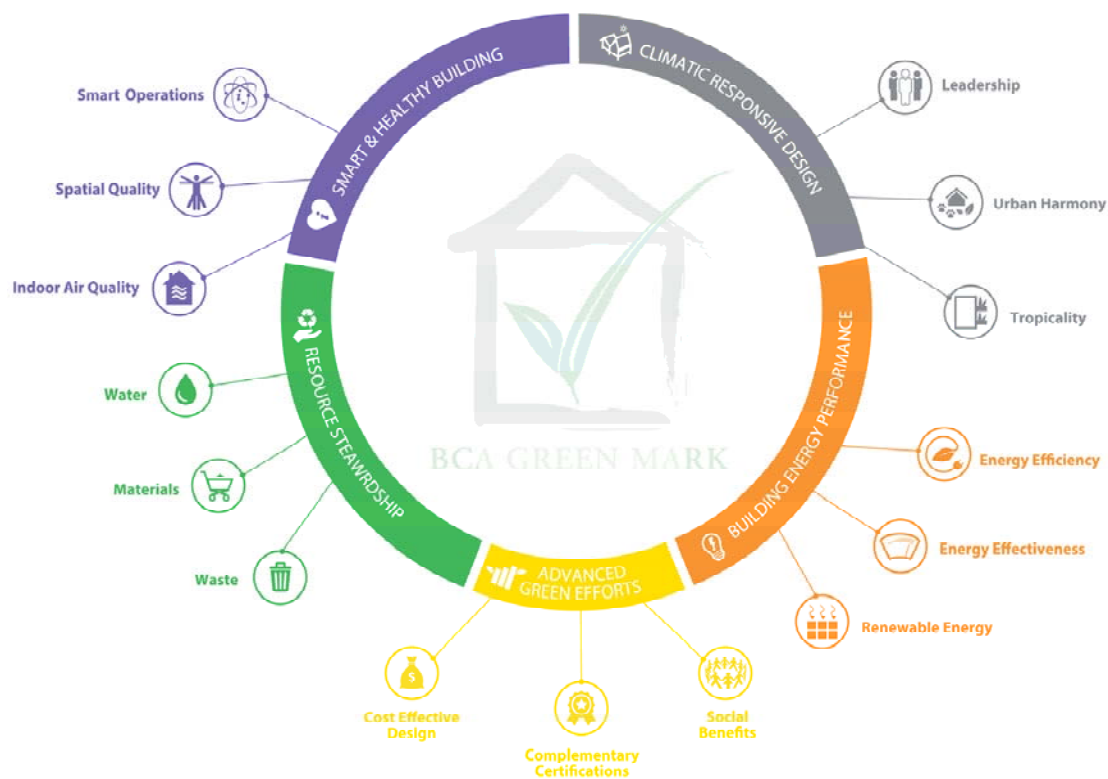
The Green Mark Score of the building design is the total of all the numerical scores assigned based on the degree of compliance with the applicable criteria. The following table states the corresponding Green Mark Score to attain the respective Green Mark ratings. Buildings must also fulfil their respective pre-requisite requirements to be awarded Green Mark. The total points scored include the bonus points scored under Advanced Green Efforts, as well as in the respective Annexes for buildings classified as hawker centres, healthcare, laboratories or schools.

BCA Green Mark Award Rating Scores

Green Mark Rating	Green Mark Score
Green Mark Platinum	70 and above
Green Mark Gold ^{PLUS}	60 to < 70
Green Mark Gold	> 50 to < 60

Criteria Overview

To dovetail the criteria with the sustainable outcomes of Green Mark NRB: 2015, the criteria has been re-structured into 5 sections, with 16 criteria and 52 sustainability indicators. Each of the 4 main sections is equally weighted in terms of points. The total point is 140 points, inclusive of 20 points from Section 5: *Advanced Green Efforts* as well as additional credits scored under Annexes for specialised building types : hawker centres, healthcare facilities, laboratory buildings and schools.



Within the main criteria, criteria within the grey boxes with the 'Advanced Green Efforts' icon are scored under 5.01 *Enhanced Performance*.

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GM NRB: 2015 Criteria Summary

Prerequisite Requirements
Prerequisites P.1 to P.15: Parked under main criteria
Minimum Points Prerequisites
Energy Modeling Prerequisite

Elective Requirements	
Part 1 - Climatic Responsive Design	30 points
P.1 Envelope and Roof Thermal Transfer	
P.2 Air Tightness and Leakage	
P.3 Bicycle Parking	
1.01 Leadership	10 points
1.1a Climatic & Contextually Responsive Brief	1 point
1.1b Integrative Design Process	4 points
<i>4D, 5D & 6D BIM (Advanced Green Efforts)</i>	2 points
1.1c Environmental Credentials of Project Team	2 points
1.1d User Engagement	3 points
1.2 Urban Harmony	10 points
1.2a Sustainable Urbanism	Up to 5 points
(i) Environmental Analysis	2 pts
<i>Creation of possible new ecology and natural ecosystems (Advanced Green Efforts)</i>	1 pt
(ii) Response to Site Context	3 pts
(iii) Urban Heat Island (UHI) Mitigation	1 pt
(iv) Green Transport	1.5 pts
1.2b Integrated Landscape and Waterscape	Up to 5 points
(i) Green Plot Ratio (GnPR)	3 pts
<i>GnPR ≥ 5.0 (Advanced Green Efforts)</i>	1 pt
(ii) Tree Conservation	1 pt
(iii) Sustainable Landscape Management	1.5 pts
(iv) Sustainable Storm Water Management	1 pt
1.3 Tropicality	10 points
1.3a Tropical Façade Performance	3 points
<i>Low heat gain façade (Advanced Green Efforts)</i>	1 pt
<i>Greenery on the East and West Façade (Advanced Green Efforts)</i>	1 pt
<i>Thermal Bridging (Advanced Green Efforts)</i>	1 pt
1.3b Internal Spatial Organisation	3 points
1.3c Ventilation Performance	4 points
<i>Wind Driven Rain Simulation (Advanced Green Efforts)</i>	1 pt

Part 2 – Building Energy Performance		30 points
P.4 Air Conditioning Total System and Component Efficiency		
P.5 Lighting Efficiency and Controls		
P.6 Vertical Transportation Efficiency		
2.1 Energy Efficiency		22 points
Option 1: Energy Performance Points Calculator		
2.1a Air Conditioning Total System Efficiency		5 points
2.1b Lighting System Efficiency		3 points
2.1c Carpark System Efficiency		2 points
2.1d Receptacle Efficiency		1 points
2.1e Building Energy		11 points
<i>Further Improvement in Design Energy Consumption (Advanced Green Efforts)</i>		2 pts
Option 2: Performance-Based Computation		
2.1f Space Conditioning Performance		10 points
<i>Efficient space conditioning energy design (Advanced Green Efforts)</i>		1 pt
2.1g Lighting Performance		6 points
<i>Efficient lighting design (Advanced Green Efforts)</i>		1 pt
2.1h Building Systems Performance		6 points
<i>Additional Energy Efficient Practices and Features (Advanced Green Efforts)</i>		2 pts
2.2 Renewable Energy		8 points
2.2a Solar Energy Feasibility Study		0.5 point
2.2b Solar Ready Roof		1.5 points
2.2c Adoption of Renewable Energy		6 points
<i>Further Electricity Replacement by Renewables (Advanced Green Efforts)</i>		5 pts
Part 3 – Resource Stewardship		30 points
P.7 Water Efficient Fittings		
3.1 Water		8 points
3.1a Water Efficient Systems		3 points
(i) Landscape irrigation		1 pt
(ii) Water Consumption of Cooling Towers		2 pts
<i>Better Water Efficient Fittings (Advanced Green Efforts)</i>		1 pt
3.1b Water Monitoring		2 points
(i) Water Monitoring and Leak Detection		1 pt
(ii) Water Usage Portal and Dashboard		1 pt
3.1c Alternative Water Sources		3 points

3.2 Materials	18 points
3.2a Sustainable Construction	8 points
(i) Conservation and Resource Recovery	1 pt
(ii) Resource Efficient Building Design	4 pts
<i>Use of BIM to calculate CUI (Advanced Green Efforts)</i>	1 pt
(iii) Low Carbon Concrete	Up to 3 pts
<i>Use of Advanced Green Materials (Advanced Green Efforts)</i>	1 pt
3.2b Embodied Carbon	2 points
<i>Provide Own Emission Factors with Source Justification (Advanced Green Efforts)</i>	1 pt
<i>Compute the Carbon Footprint of the Entire Development (Advanced Green Efforts)</i>	2 pt
3.2c Sustainable Products	Up to 8 points
(i) Functional Systems	12.5 pts
(ii) Singular Sustainable Products outside of Functional Systems	2 pts
<i>Sustainable Products with Higher Environmental Credentials (Advanced Green Efforts)</i>	2 pts
3.3 Waste	4 points
3.3a Environmental Construction Management Plan	1 point
3.3b Operational Waste Management	3 points
Part 4 – Smart & Healthy Building	30 points
P.8 Thermal Comfort	
P.9 Minimum Ventilation Rate	
P.10 Filtration Media for Times of Pollution	
P.11 Low Volatile Organic Compound (VOC) Paints	
P.12 Refrigerants	
P.13 Sound Level	
P.14 Permanent Instrumentation for the Measurement and Verification of Chilled Water Air-Conditioning Systems	
P.15 Electrical Sub-Metering & Monitoring	
4.1 Indoor Air Quality	10 points
4.1a Occupant Comfort	2 points
(i) Indoor Air Quality (IAQ) Surveillance Audit	1 pt
(ii) Post Occupancy Evaluation	0.5 pt
(iii) Indoor Air Quality Display	0.5 pt
<i>Indoor Air Quality Trending (Advanced Green Efforts)</i>	2 pts
4.1b Outdoor Air	3 points
(i) Ventilation Rates	1.5 pts
(ii) Enhanced Filtration Media	1 pt
(iii) Dedicated Outdoor Air System	0.5 pt
4.1c Indoor Contaminants	5 points
(i) Local Exhaust and Air Purging System	2 pts
(ii) Ultraviolet Germicidal Irradiation (UVGI) System	0.5 pt
(iii) More Stringent VOC Limits for Interior Fittings and Finishes	2 pts
(iv) Use of Persistent Bio-cumulative and Toxic (PBT) free lighting	0.5 pt
<i>Zero ODP Refrigerants with Low Global Warming Potential (Advanced Green Efforts)</i>	1 pt

4.2 Spatial Quality	10 points
4.2a Lighting (i) Effective daylighting for common areas (ii) Effective daylighting for occupied spaces (iii) Quality of Artificial Lighting 4.2b Acoustics (i) Sound Transmission Reduction (ii) Acoustic Report 4.2c Wellbeing (i) Biophilic Design (ii) Universal Design (UD) Mark	Up to 6 points 2 pts 4 pts 1 pt 2 points 0.5 pt 1.5 pt Up to 2 points 3 pts 1 pt
4.3 Smart Building Operations	10 points
4.3a Energy Monitoring (i) Energy Portal and Dashboard (ii) BAS and Controllers with OpenProtocol <i>Permanent M&V for VRF Systems (Advanced Green Effort)</i> <i>Permanent M&V for Hot Water systems (Advanced Green Efforts)</i> 4.3b Demand Control (i) ACMV Demand Control (ii) Lighting Demand Control 4.3c Integration and Analytics (i) Basic Integration and Analytics (ii) Advanced Integration and Analytics <i>Additional Advanced Integration and Analytical Features (Advanced Green Effort)</i> 4.3d System Handover and Documentation <i>Expanded Post Occupancy Performance Verification by a 3rd Party (Advanced Green Effort)</i> <i>Energy Performance Contracting (Advanced Green Effort)</i>	3 points 2 pts 1 pt 2 pts 1 pt 2 points 2 pts 1 pt 3 points 0.5 pt per feature 1 pt per feature 1 pt 1 point 2 pts 1 pt
Part 5 – Advanced Green Efforts	20 points
5.1 Enhanced Performance 5.2 Demonstrating Cost Effective Design 5.3 Complementary Certifications 5.4 Social Benefits	Up to 15 points 2 points 1 point 2 points
Annexes for specialised buildings	10 to 15 points
Annex 1: Energy Efficiency Features for Specialised Building [Hawker Centres]	15 points
Annex 2: Energy Efficiency Features for Specialised Building [Healthcare Facilities]	10 points
Annex 3: Energy Efficiency Features for Specialised Building [Laboratories]	10 points
Annex 4: Energy Efficiency Features for Specialised Building [Schools]	10 points

Part 1 – Climatic Responsive Design				Green Mark Points
P.1 Envelope and Roof Thermal Transfer				Prerequisite
	Gold	Gold ^{PLUS}	Platinum	
ETTV (W/m²)	45	40	38	
P.2 Air Tightness and Leakage Comply with SS 212: 2007 – Specification for Aluminium Alloy Windows and SS 381: 1996 (2007) – Materials and Performance Tests for Aluminium Curtain Walls				Prerequisite
P.3 Bicycle Parking Meet the minimum quantity of bicycle parking lots required for the development, in line with URA circular URA/PB/2018/03-DCG (or prevailing circular) and LTA's Code of Practice - Street Work Proposal Relating to Development Works (or prevailing COP)				Prerequisite
1.1 Leadership				
1.1a Climatic & Contextually Responsive Brief				
Create climatic and culturally responsive brief including target setting				1 point (Up to 1 point for 1.1a)
1.1b Integrative Design Process				
(i) Demonstrate Integrated design process <ul style="list-style-type: none"> Appointment of all relevant consultants early in the design phase Identification of responsible parties within the team to implement relevant sustainability goals and targets Detailing of sustainable design methodology action plans and progress Addressing of opportunities and challenges with integrative team strategies to achieve the targets Organising of design charrettes at key stages within the project design 				2 points
(ii) Involve Facility Manager (FM) in the design stage and incorporating his inputs into design.				1 point
(iii) Use of BIM				1 point
				(Up to 4 points for 1.1b)
1.1c Environmental Credentials of Project Team				
This pertains to the appointment of environmental specialists at building design, construction and operations stages.				
Green Individuals: <ul style="list-style-type: none"> Certified Green Mark Manager (GMM) or Green Mark Facilities Manager (GMFM) with valid Refresher Course Certification (valid for 2 years) 				0.25 point with at least one GMM or GMFM
<ul style="list-style-type: none"> Green Mark Professional (GMP) or Green Mark Facilities Professional (GMFP). 				0.5 point with at least one GMP or GMFP (Up to 0.5 point for Green Individuals)

Part 1 – Climatic Responsive Design	Green Mark Points
<p>Green and Gracious Builder:</p> <ul style="list-style-type: none"> The main builder is a BCA Certified Green and Gracious Builder. <p>Green Companies:</p> <ul style="list-style-type: none"> Following companies with ISO14001 certification: Architect, M&E Engineer, C&S Engineer, Developer and Main Contractor. SGBC Green Services Certified Firm. 	<p>0.25 point for Certified or Merit; or 0.5 point for Excellent or Star rating (Up to 0.5 point for Green & Gracious Builder)</p> <p>0.25 point each per consultant type ISO14001</p> <p>0.25 point each (Up to 1.5 points for Green Companies)</p> <p>(Up to 2 points for 1.1c)</p>
<p><u>1.1d User Engagement</u></p> <p>Provision of relevant information and guidance to building occupants so that they can contribute positively to the reduction of the building's environmental impact</p> <ul style="list-style-type: none"> Building user guide Sustainability Education Corner Sustainability Awareness & Education Programme Green fit out guidelines Displaying Green Mark credential Green lease <ul style="list-style-type: none"> ➤ ≥ 25% of the net lettable area ➤ ≥ 60% of the net lettable area 	<p>0.5 point each</p> <p>1 point each</p> <p>1 point 3 points</p> <p>(Up to 3 points for 1.1d)</p>
1.2 Urban Harmony – Part A	
<p><u>1.2a Sustainable Urbanism</u></p> <p>Minimise environmental impact to the surroundings through site analysis</p> <p>(i) Environmental Analysis</p> <ul style="list-style-type: none"> Environmental Study Comprehensive Environmental Impact Assessment (EIA) by 3rd party <p>(ii) Response to Site Context</p> <ul style="list-style-type: none"> Level 1 site analysis and design that demonstrates sensitivity to the site condition Level 2 site analysis optimised design with at least 2 types of iterative simulations <p>(iii) Urban Heat Island (UHI) Mitigation</p> <ul style="list-style-type: none"> ≥ 50% site coverage (at plan view) with mitigation measures ≥ 80% site coverage (at plan view) with mitigation measures 	<p>1 point</p> <p>2 points (Up to 2 points)</p> <p>1 point</p> <p>3 points (Up to 3 points)</p> <p>0.5 point</p> <p>1 point (Up to 1 point)</p>

Part 1 – Climatic Responsive Design	Green Mark Points												
<p>(iv) Green Transport</p> <ul style="list-style-type: none"> • Provision of electrical vehicle charging and parking infrastructure (at least 1 lot per 100 lots (Up to 5 lots) • Reduction of car parking provision up to 20% below the prevailing car park standard, subject to LTA's approval of 'Range Based Car Parking Standard (RCPS)' • Provision of bicycle lots over and above requirements stated in LTA's Code of Practice - Street Work Proposal Relating to Development Works with at least 1 bicycle parking lot per 1,500m² of GFA (Up to 30 lots) • Additional features to promote bicycle usage (at least 2 features to score) 	<p>0.5 point each</p> <p>(Up to 5 points for 1.2a)</p>												
<p>1.2 Urban Harmony – Part B</p>													
<p>1.2b Integrated Landscape and Waterscape</p> <p>Integrate a verdant landscape and waterscape into their building design, to enhance the biodiversity around the development and provide visual relief to building occupants and neighbours.</p> <p>(i) Greenery Provision</p> <p>(ii) Tree Conservation</p> <ul style="list-style-type: none"> • Preservation of existing trees on-site • Replant an equivalent number of similar or native species of equivalent LAI <p>(iii) Sustainable Landscape Management</p> <ul style="list-style-type: none"> • Certified under NParks Landscape Excellence Assessment Framework (LEAF) certification • Adoption of native species of greenery > 50% of the flora selected • Provision of landscape management plan <p>(iv) Sustainable Stormwater Management</p> <ul style="list-style-type: none"> • Certified under PUB Active, Beautiful and Clean Waters (ABC Waters) certification • Treatment of stormwater run-off <ul style="list-style-type: none"> ➢ ≥ 10% of run-off of total site area ➢ ≥ 35% of run-off of total site area 	<table border="1" data-bbox="824 894 1422 1100"> <thead> <tr> <th>GnPR</th><th>Points</th></tr> </thead> <tbody> <tr> <td>0.5 to <1.0</td><td>0.5</td></tr> <tr> <td>1.0 to <2.0</td><td>1.0</td></tr> <tr> <td>2.0 to <3.0</td><td>2.0</td></tr> <tr> <td>3.0 to <4.0</td><td>2.5</td></tr> <tr> <td>≥ 4.0</td><td>3.0</td></tr> </tbody> </table> <p>0.5 point</p> <p>0.5 point</p> <p>1.5 point</p> <p>0.5 point</p> <p>0.5 point (Up to 1.5 point)</p> <p>1 point</p> <p>0.5 point 1 point</p> <p>(Up to 5 points under 1.2b)</p>	GnPR	Points	0.5 to <1.0	0.5	1.0 to <2.0	1.0	2.0 to <3.0	2.0	3.0 to <4.0	2.5	≥ 4.0	3.0
GnPR	Points												
0.5 to <1.0	0.5												
1.0 to <2.0	1.0												
2.0 to <3.0	2.0												
3.0 to <4.0	2.5												
≥ 4.0	3.0												
<p>1.3 Tropicality</p>													
<p>1.3a Tropical Façade Performance</p> <p>Holistic consideration of façade performance can reduce direct sunlight into the building and minimise thermal heat gain, enhancing indoor comfort and lowering the energy for conditioning the indoor environment.</p>													

Part 1 – Climatic Responsive Design			Green Mark Points																													
<div>Simulation Method</div> <table><tr><th>Overall Weighted Values</th><th>Industrial Buildings</th><th>Other building types</th></tr><tr><td>Window U-Value</td><td>5.4 W/m²K</td><td>2.8 W/m²K</td></tr><tr><td>Wall U-Value</td><td>1.5 W/m²K</td><td>0.7 W/m²K</td></tr><tr><td>Overall Envelope U-value</td><td>2.4 W/m²K</td><td>1.6 W/m²K</td></tr><tr><td>Window-to-Wall Ratio (Each façade)</td><td>0.2</td><td>0.4</td></tr><tr><td>Total Effective Glass Shading Coefficient (SC1 x SC2)</td><td>0.6</td><td>0.4</td></tr><tr><td>Roof U-Value</td><td>1.1 W/m²K</td><td>0.8 W/m²K</td></tr><tr><td>Sky light/ Roof window U-Value</td><td>4.3 W/m²K</td><td>2.2 W/m²K</td></tr><tr><td>RTTV (where there are sky lights for AC areas)</td><td>50 W/m²K</td><td>50 W/m²K</td></tr></table>			Overall Weighted Values	Industrial Buildings	Other building types	Window U-Value	5.4 W/m ² K	2.8 W/m ² K	Wall U-Value	1.5 W/m ² K	0.7 W/m ² K	Overall Envelope U-value	2.4 W/m ² K	1.6 W/m ² K	Window-to-Wall Ratio (Each façade)	0.2	0.4	Total Effective Glass Shading Coefficient (SC1 x SC2)	0.6	0.4	Roof U-Value	1.1 W/m ² K	0.8 W/m ² K	Sky light/ Roof window U-Value	4.3 W/m ² K	2.2 W/m ² K	RTTV (where there are sky lights for AC areas)	50 W/m ² K	50 W/m ² K	1 point for meeting notional façade stated 1 point for every 5% heat load reduction		
			Overall Weighted Values	Industrial Buildings	Other building types																											
			Window U-Value	5.4 W/m ² K	2.8 W/m ² K																											
			Wall U-Value	1.5 W/m ² K	0.7 W/m ² K																											
			Overall Envelope U-value	2.4 W/m ² K	1.6 W/m ² K																											
			Window-to-Wall Ratio (Each façade)	0.2	0.4																											
			Total Effective Glass Shading Coefficient (SC1 x SC2)	0.6	0.4																											
			Roof U-Value	1.1 W/m ² K	0.8 W/m ² K																											
			Sky light/ Roof window U-Value	4.3 W/m ² K	2.2 W/m ² K																											
			RTTV (where there are sky lights for AC areas)	50 W/m ² K	50 W/m ² K																											
<div>Non-Simulation Checklist for Industrial Buildings</div>			<table><tr><th>Overall Weighted Values</th><th>Baseline</th><th>Points for meeting or reduction from baseline</th></tr><tr><td>Envelope U-Value (Up to 2 points)</td><td>2.4 W/m²K</td><td>0.5 points for every 0.4 W/m²K reduction</td></tr><tr><td>WWR (Excludes Façade openings/voids) (Up to 2 points)</td><td>0.2</td><td>0.5 pt for meeting baseline 0.5 pt for every 0.05 reduction</td></tr><tr><td>Glass Shading Coefficient (SC1) (Up to 2 points)</td><td>0.5</td><td>1 pt for meeting baseline 0.5 pt for every 0.05 reduction from baseline</td></tr><tr><td>Effective Sun Shading (Up to 2 points)</td><td>-</td><td>1 pt for ≥ 10% effectiveness (North and South) 1 pt for 30% effectiveness (East and West)</td></tr><tr><td>Roof U-Value (Up to 2 points)</td><td>1.0 W/m²K</td><td>0.5 pt for every 0.1 W/m²K reduction</td></tr><tr><td>Sky light/ Roof window U-Value (Up to 1 point)</td><td>4.0 W/m²K</td><td>0.5 pt for meeting baseline 1 pt for U-Value of 2 W/m²K</td></tr></table>	Overall Weighted Values	Baseline	Points for meeting or reduction from baseline	Envelope U-Value (Up to 2 points)	2.4 W/m ² K	0.5 points for every 0.4 W/m ² K reduction	WWR (Excludes Façade openings/voids) (Up to 2 points)	0.2	0.5 pt for meeting baseline 0.5 pt for every 0.05 reduction	Glass Shading Coefficient (SC1) (Up to 2 points)	0.5	1 pt for meeting baseline 0.5 pt for every 0.05 reduction from baseline	Effective Sun Shading (Up to 2 points)	-	1 pt for ≥ 10% effectiveness (North and South) 1 pt for 30% effectiveness (East and West)	Roof U-Value (Up to 2 points)	1.0 W/m ² K	0.5 pt for every 0.1 W/m ² K reduction	Sky light/ Roof window U-Value (Up to 1 point)	4.0 W/m ² K	0.5 pt for meeting baseline 1 pt for U-Value of 2 W/m ² K								
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			<div>Non-Simulation Checklist for Other Buildings Types</div>			<table><tr><th>Overall Weighted Values</th><th>Baseline</th><th>Points for meeting or reduction from baseline</th></tr><tr><td>Envelope U-Value (Up to 2 points)</td><td>1.6 W/m²K</td><td>0.5 pt for meeting baseline 0.5 points for every 0.2 W/m²K reduction</td></tr><tr><td>WWR (Excludes Façade openings/voids) (Up to 2 points)</td><td>0.4 (East, West facades not to exceed 0.3)</td><td>1 pt for meeting baseline 0.5 pt for every 0.05 reduction</td></tr><tr><td>Glass Shading Coefficient (SC1) (Up to 2 points)</td><td>0.4</td><td>0.5 pt for meeting baseline 0.5 pt for every 0.05 reduction from baseline</td></tr><tr><td>Effective Sun Shading (Up to 2 points)</td><td>-</td><td>1 pt for ≥ 10% effectiveness (North and South) 1 pt for 30% effectiveness (East and West)</td></tr><tr><td>Roof U-Value (Up to 1 point)</td><td>0.8 W/m²K</td><td>1 pt for meeting baseline</td></tr><tr><td>Sky light/ Roof window U-Value (Up to 0.5 point)</td><td>2.2 W/m²K</td><td>0.5 pt for meeting baseline</td></tr></table>	Overall Weighted Values	Baseline	Points for meeting or reduction from baseline	Envelope U-Value (Up to 2 points)	1.6 W/m ² K	0.5 pt for meeting baseline 0.5 points for every 0.2 W/m ² K reduction	WWR (Excludes Façade openings/voids) (Up to 2 points)	0.4 (East, West facades not to exceed 0.3)	1 pt for meeting baseline 0.5 pt for every 0.05 reduction	Glass Shading Coefficient (SC1) (Up to 2 points)	0.4	0.5 pt for meeting baseline 0.5 pt for every 0.05 reduction from baseline	Effective Sun Shading (Up to 2 points)	-	1 pt for ≥ 10% effectiveness (North and South) 1 pt for 30% effectiveness (East and West)	Roof U-Value (Up to 1 point)	0.8 W/m ² K	1 pt for meeting baseline	Sky light/ Roof window U-Value (Up to 0.5 point)	2.2 W/m ² K	0.5 pt for meeting baseline					
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(Up to 4 points under 1.3a)																																

Part 1 – Climatic Responsive Design	Green Mark Points																						
<p>1.3b Internal Spatial Organisation</p> <p>Adopting passive design strategies in the internal spatial organisation of a building provides opportunities to enhance building performance.</p> <p>(i) Location of non-air-conditioned spaces, e.g. lift cores, staircases, toilets, electrical plantrooms etc that covers</p> <ul style="list-style-type: none">• 1/3 of the east and west facades• 2/3 of the east and west facades <p>(ii) Prorating the number of transient common spaces, e.g. toilets, staircases, corridors, lift lobbies and atriums by the mode of ventilation against the total number of applicable spaces</p>	<p>0.5 point 1 point</p> <p>Point scored = $\frac{\text{No. of NV spaces} \times 2 + \text{No. of MV spaces} \times 0.5 + \text{No. of AC spaces} \times 0}{\text{Total no. of spaces}}$</p> <p>(Up to 2 points)</p> <p>(Up to 3 points under 1.3b)</p>																						
<p>1.3c Ventilation Performance</p> <p>Naturally ventilated functional areas should be effectively designed to be thermally comfortable and healthy for the building occupants.</p> <p>(i) Ventilation Performance Checklist</p> <ul style="list-style-type: none">• Openings towards prevailing wind directions• Depth of room vs opening<ul style="list-style-type: none">➤ Single sided ventilation: $W \leq 2H$➤ Cross Ventilation: $W \leq 5H$ <p>A factor of 1.5 can be applied to the W-H ratio for atria.</p> <p>(ii) Full Ventilation Simulation</p>	<p>0.1 point for every 10% of units or rooms with openings facing towards the prevailing winds (North & South) (Up to 1 point)</p> <p>≥50% of applicable spaces – 1 point ≥70% of applicable spaces – 2 points (Up to 2 points)</p> <table><tr><th rowspan="2">Wind velocity</th><th rowspan="2">Thermal Comfort</th><th colspan="2">Air Quality</th><th rowspan="2">Points</th></tr><tr><th>Air Change Rate</th><th>Air Exchange Efficiency</th></tr><tr><td>0.2 m/s</td><td>-</td><td>-</td><td>-</td><td>3</td></tr><tr><td>0.4 m/s</td><td>-1.0 < PMV < +1.0</td><td>≥ 4</td><td>≥ 1</td><td>4</td></tr><tr><td>0.6 m/s</td><td>-0.8 < PMV < +0.8</td><td>≥ 10</td><td>≥ 1.2</td><td>4</td></tr></table> <p>(Up to 4 points under 1.3c)</p>	Wind velocity	Thermal Comfort	Air Quality		Points	Air Change Rate	Air Exchange Efficiency	0.2 m/s	-	-	-	3	0.4 m/s	-1.0 < PMV < +1.0	≥ 4	≥ 1	4	0.6 m/s	-0.8 < PMV < +0.8	≥ 10	≥ 1.2	4
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0.6 m/s	-0.8 < PMV < +0.8	≥ 10	≥ 1.2	4																			

Part 2 – Building Energy Performance						Green Mark Points	
P.4 Air Conditioning Total System and Component Efficiency						Prerequisite	
Green Mark Rating	Air Cooled Chilled-Water System/ Unitary Air-Conditioning System		Water Cooled Chilled Water System		District Cooling System (DCS)		
	Peak Building Cooling Load (RT)						
	<500	≥500	<500	≥500			
	Minimum DSE η_t (kW/RT)						
Gold	NA (0.9, N.A.)	NA	NA (0.75, N.A.)	NA (0.68, NA)	0.9 (0.65, N.A.)		
GoldPLUS	1.10 (0.85, 0.25)		0.95 (0.7, 0.25)	0.9 (0.65, 0.25)	0.9 (0.65, 0.25)		
Platinum	1.03 (0.78, 0.25)		0.93 (0.68, 0.25)	(0.65, 0.25)	(0.65, 0.25)		
(ηc, ηa) shall meet their respective thresholds. ηc: System kW/ton excluding the air distribution equipment or DCS system kW/ton ηa: Air distribution equipment kW/ton ηt= ηc+ηa							
P.5 Lighting Efficiency and Controls							Prerequisite
Comply with SS 530 : 2014 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment.							
P.6 Vertical Transportation Efficiency						Prerequisite	
Lifts and escalators shall be equipped with AC variable voltage and variable frequency (VVVF) motor drive and sleep mode features.							
2.1 Energy Efficiency							
Option 1: Energy Performance Points Calculator						Section 2.1a to 2.1e	
2.1a Air Conditioning Total System Efficiency						Points scored = 0.2 x % improvement from baseline (Computed by Energy Performance Points Calculator) (Up to 5 points for 2.1a)	
The use of energy efficient air-conditioning systems can optimise their total system performance, and reduce the energy needed to produce and distribute conditioned air into building spaces.							
Peak Building Cooling Load (RT)		Baseline for Total Design System Efficiency (kW/RT)					
<500 RT		1.08					
≥500RT		0.98					
For district cooling plants under Path B scenario, where the plant is excluded from the computation, the baseline reference for the building air distribution equipment can be taken as 0.28 kW/ton for the purposes of points computation here.							
2.1b Lighting System Efficiency							Points scored = 0.1 x % improvement from baseline (Computed by Energy Performance Points Calculator) (Up to 3 points for 2.1b)
The use of energy efficient lighting can reduce the energy needed to illuminate a space. Baseline: SS 530: 2014 - Code of Practice for Energy Efficiency Standard for Building Services and Equipment Design to comply with SS 531 – 1: 2006 (2013)– Code of Practice for Lighting of Workplaces							
2.1c Carpark System Efficiency							Points scored = 0.05 x % improvement from baseline (Computed by Energy Performance Points Calculator) (Up to 2 points for 2.1c)
The use of energy efficient carpark ventilation and lighting systems can reduce the energy needed for carpark operations.							
2.1d Receptacle Load Efficiency						Points scored = 0.025 x % improvement from baseline x % of functional areas (Computed by Energy Performance Points Calculator) (Up to 1 point for 2.1d)	
The use of energy efficient receptacle equipment can reduce their energy consumption.							
2.1e Building Energy						Points scored = $\frac{\% \text{ improvement from baseline}}{3}$ (Computed by Energy Performance Points Calculator) (Up to 11 point for 2.1e)	
Encourage effective design of building systems to reduce building's overall energy consumption.							

Part 2 – Building Energy Performance			Green Mark Points													
Option 2: Performance-Based Computation			Section 2.1f to 2.1h													
2.1f Space Conditioning Performance Efficient use of energy to maintain a thermally acceptable indoor environment, by effective design of natural ventilation, energy efficient mechanical ventilation and air-conditioning systems. Proration based on mode of ventilation in functional spaces Natural Ventilation As per scoring Mechanical Ventilation			 <div>Total points scored = % of NV areas x points scored under NV + % of MV areas x points scored under MV + % of AC areas x points scored under AC</div> <div>Natural Ventilation Points scored = 6 points for design for NV + scoring in section 1.3c (Up to 10 points)</div> <div>Mechanical Ventilation Points scored = 0.15 x % improvement from baseline stated in SS553 (Up to 10 points)</div> <div>Air-Conditioning Efficient air-conditioning system Points scored = 0.4 x (% improvement from baseline) (Up to 8 points)</div> <div>(Up to 10 point for 2.1f)</div>													
<table><tr><td>Systems</td><td colspan="2">Constant Volume & Variable Volume</td></tr><tr><td>Fan systems with nameplate motor power</td><td>≥ 4kW</td><td>< 4kW</td></tr><tr><td>Option 1: Fan system motor nameplate</td><td>0.35</td><td>No baseline</td></tr><tr><td>Option 2: Fan system input <small>*Applicable pressure drop adjustments can be considered based on SS553 in accordance to GM NRB: 2015 Technical Guide and Requirements, subjected to BCA's evaluation</small></td><td>0.3</td><td>0.17</td></tr></table>			Systems	Constant Volume & Variable Volume		Fan systems with nameplate motor power	≥ 4kW	< 4kW	Option 1: Fan system motor nameplate	0.35	No baseline	Option 2: Fan system input <small>*Applicable pressure drop adjustments can be considered based on SS553 in accordance to GM NRB: 2015 Technical Guide and Requirements, subjected to BCA's evaluation</small>	0.3	0.17		
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Air-conditioning Efficient air-conditioning system																
<table><tr><td>Peak Building Cooling Load (RT)</td><td colspan="2">Baseline for Total Design System Efficiency (kW/RT)</td></tr><tr><td><500 RT</td><td colspan="2">1.08</td></tr><tr><td>≥500RT</td><td colspan="2">0.98</td></tr></table> <small>*TDSE refers to combined efficiency of the cooling and air distribution components</small> <small>*For district cooling plants under Path B scenario, where the plant is excluded from the computation, the baseline reference for the building air distribution equipment can be taken as 0.28 kW/ton for the purposes of points computation here.</small>			Peak Building Cooling Load (RT)	Baseline for Total Design System Efficiency (kW/RT)		<500 RT	1.08		≥500RT	0.98						
Peak Building Cooling Load (RT)	Baseline for Total Design System Efficiency (kW/RT)															
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2.1g Lighting System Performance The use of energy efficient lighting can reduce the energy needed to illuminate a space. Baseline: SS 530: 2014 - Code of Practice for Energy Efficiency Standard for Building Services and Equipment Design to comply with SS 531 – 1: 2006 (2013)– Code of Practice for Lighting of Workplaces			 Points scored = 0.17 x (% improvement from baseline) <div>(Up to 6 point for 2.1g)</div>													
2.1h Building Systems Performance Encourage effective design of building systems other than space conditioning systems and lighting systems to reduce building's overall energy consumption (i) Receptacle Load Efficiency			 <													

Part 2 – Building Energy Performance		Green Mark Points											
(ii) Car Park Ventilation Energy	<table><tr><th colspan="2">Mode of ventilation</th><th>Points</th></tr><tr><td colspan="2">Natural Ventilation</td><td>1.5 points</td></tr><tr><td rowspan="2">Mechanical Ventilation</td><td>Without CO sensor/without Fume Extract</td><td>Point scored = 0.015 x % improvement from baseline (Up to 1 point)</td></tr><tr><td>With CO sensor / Fume Extract</td><td>+ 0.25 points</td></tr></table>		Mode of ventilation		Points	Natural Ventilation		1.5 points	Mechanical Ventilation	Without CO sensor/without Fume Extract	Point scored = 0.015 x % improvement from baseline (Up to 1 point)	With CO sensor / Fume Extract	+ 0.25 points
	Mode of ventilation		Points										
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With CO sensor / Fume Extract		+ 0.25 points											
(Up to 1.5 points)													
(iii) Energy Use Intensity	0.5 point for meeting 25 th percentile EUI as per prevailing BCA Building Energy Benchmarking Report (BEBR) (Up to 0.5 point)												
(iv) Energy Efficient Practices and Features	Points scored = 0.5 x (% improvement from baseline total building consumption) (Up to 2 points) (Up to 6 point for 2.1h)												
2.2 Renewable Energy													
2.2a Solar Energy Feasibility Study The evaluation of a building footprint’s potential in harnessing solar energy can raise awareness on viable solar opportunities in the development and assist building developers in their decision making to adopt photovoltaics.		0.5 point for provision of solar feasibility report (Up to 0.5 point) (Up to 0.5 point for 2.2a)											
2.2b Solar Ready Roof Designing roofs to be ready for photovoltaic installation facilitates ease of their deployment should building developers decide to do so at later stages of a project/ during building operation.		0.5 point each for achieving <ul style="list-style-type: none">• Structural readiness• Electrical readiness• Spatial readiness (Up to 1.5 points) (Up to 1.5 point for 2.2b)											
2.2c Adoption of Renewable Energy On-site generation of renewable energy can reduce the building development’s power consumption from the grid and carbon emissions.		<table><tr><th>Expected Energy Use Intensity (EUI) [kWh/m²/yr]</th><th>% Replacement of Building Electricity Consumption by Renewable Energy</th></tr><tr><td>≥ 220</td><td>1 point for every 0.5%</td></tr><tr><td>50 ≤ EUI < 220</td><td>1 point for every 1.25%</td></tr><tr><td>< 50</td><td>1 point for every 2.5%</td></tr></table> (Up to 6 point for 2.2c)		Expected Energy Use Intensity (EUI) [kWh/m²/yr]	% Replacement of Building Electricity Consumption by Renewable Energy	≥ 220	1 point for every 0.5%	50 ≤ EUI < 220	1 point for every 1.25%	< 50	1 point for every 2.5%		
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Part 3 – Resource Stewardship	Green Mark Points																														
<p>3.1c Alternative Water Sources The use of alternative water sources can reduce potable water consumption for general application and use.</p> <ul style="list-style-type: none"> AHU condensate collection where > 50% of total condensate is collected NEWater supply On-site recycled water Rainwater harvesting 	<p>1 point each (Up to 4 points)</p> <p>(Up to 4 points for 3.1b)</p>																														
<p>3.2 Materials</p> <p>3.2a Sustainable Construction To encourage the adoption of building designs, building structures and construction practices that are environmentally friendly and sustainable.</p> <p>(i) Conservation and Resource Recovery</p> <ul style="list-style-type: none"> The existing structures are conserved and not demolished. The existing structures are demolished with an enhanced demolition protocol, where a recovery rate of > 35% crushed concrete waste from the demolished building is sent to approved recyclers with proper facilities. <p>(ii) Resource Efficient Building Design</p> <ul style="list-style-type: none"> Concrete Usage Index (CUI) <ul style="list-style-type: none"> Adoption of sustainable building systems <p>List of Sustainable Building Systems</p> <ul style="list-style-type: none"> ➤ Pre-stressed Concrete Elements ➤ Hollow Core or Voids Concrete Elements ➤ Light Weight Concrete Elements ➤ High Strength Concrete Elements (Concrete grade >60MPa) ➤ Structural Steel Elements ➤ Composite Structural Elements ➤ Engineered Timber Elements ➤ Prefabricated Prefinished Volumetric Construction units ➤ Precast Concrete Elements ➤ Leave-in Formwork ➤ Others (to be accepted by BCA on case-by-case basis) <p>(iii) Low Carbon Concrete</p> <p>Clinker Content Use of concrete containing clinker $\leq 400 \text{ kg/m}^3$ for grades up to C50/60 for $\geq 80\%$ of the applicable superstructural concrete by volume</p> <p>Replacement of coarse and fine aggregates The usage should not fall below 1.5% x GFA for RCA and/ or 0.75% x GFA for WCS for points scoring.</p>	<p>1 point for either case (Up to 1 point)</p> <table border="1" data-bbox="824 953 1424 1140"> <thead> <tr> <th>Project's CUI (m^3/m^3)</th><th>Points</th></tr> </thead> <tbody> <tr> <td>≤ 0.60</td><td>0.5</td></tr> <tr> <td>≤ 0.50</td><td>1.0</td></tr> <tr> <td>≤ 0.45</td><td>1.5</td></tr> <tr> <td>≤ 0.40</td><td>2.0</td></tr> <tr> <td>≤ 0.35</td><td>2.5</td></tr> </tbody> </table> <p>(Up to 2.5 points)</p> <table border="1" data-bbox="824 1239 1424 1362"> <thead> <tr> <th>Total coverage area</th><th>Points</th></tr> </thead> <tbody> <tr> <td>$\geq 25\%$ of CFA</td><td>0.5</td></tr> <tr> <td>$\geq 50\%$ of CFA</td><td>1.0</td></tr> <tr> <td>$\geq 75\%$ of CFA</td><td>1.5</td></tr> </tbody> </table> <p>(Up to 1.5 points)</p> <table border="1" data-bbox="824 1593 1424 1749"> <thead> <tr> <th>Concrete Categories*</th><th>Points</th></tr> </thead> <tbody> <tr> <td>Uncertified concrete</td><td>0.5</td></tr> <tr> <td>SGBC-certified 1-Tick concrete</td><td>1.0</td></tr> <tr> <td>SGBC-certified 2-Tick concrete</td><td>1.5</td></tr> <tr> <td>SGBC-certified 3-Tick concrete</td><td>2.0</td></tr> </tbody> </table> <p>0.5 point for every 5% replacement by mass of coarse and fine aggregates with recycled concrete aggregates (RCA) and/ or washed copper slag (WCS) from approved sources for the superstructure concrete mix. (Up to 3 points for 3.2a(iii))</p> <p>(Up to 8 points for 3.2a)</p>	Project's CUI (m^3/m^3)	Points	≤ 0.60	0.5	≤ 0.50	1.0	≤ 0.45	1.5	≤ 0.40	2.0	≤ 0.35	2.5	Total coverage area	Points	$\geq 25\%$ of CFA	0.5	$\geq 50\%$ of CFA	1.0	$\geq 75\%$ of CFA	1.5	Concrete Categories*	Points	Uncertified concrete	0.5	SGBC-certified 1-Tick concrete	1.0	SGBC-certified 2-Tick concrete	1.5	SGBC-certified 3-Tick concrete	2.0
Project's CUI (m^3/m^3)	Points																														
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Part 3 – Resource Stewardship	Green Mark Points
3.3 Waste	
3.3a Environmental Construction Management Plan An effective and holistic management plan can facilitate better environmental performance of the construction process and promote waste minimisation.	1 point (Up to 1 point for 3.3a)
3.3b Operational Waste Management Appropriate collection and recycling provisions can facilitate the segregation of recyclable consumer waste at source. Provisions for the treatment of horticultural or wood waste for buildings with landscaping can promote their reuse and recycling as well. <ul style="list-style-type: none"> Facilities for the collection and storage of different recyclables such as paper, glass, metal and plastic in commingled or sorted form. Facilities or systems for food waste to be treated and recycled, for buildings generating large volumes of food waste. Facilities or systems for the placement of horticultural or wood waste for recycling. 	1 point each (Up to 3 point for 3.3b)

Part 4 – Smart and Healthy Building	Green Mark Points
P.8 Thermal Comfort The normal design dry-bulb temperature for comfort air-conditioning shall be within 23°C - 25°C, and resultant relative humidity ≤ 65% in accordance with SS 553 : 2016 - Code of Practice for Air-Conditioning and Mechanical Ventilation in Buildings.	Prerequisite
P.9 Minimum Ventilation Rate The building's air-conditioning and mechanical ventilation systems shall be designed to provide appropriate minimum quantum of outdoor air rates as stated in Table 1 and Table 5 of SS 553 : 2016.	Prerequisite
P.10 Filtration Media for Times of Pollution AHUs or dedicated outdoor air units in the building shall be designed to accommodate fine dust filters of least a rating of Minimum Efficiency Reporting Value (MERV) 14 (ASHRAE 52.2: 2012) or F8 (EN779: 2012), when the outdoor pollution level is in the unhealthy range in accordance with MOH's guidelines, as stipulated in SS 553 : 2016.	Prerequisite
P.11 Low Volatile Organic Compound (VOC) Paints Low VOC paints certified by an approved local certification body shall be used for at least 90% of the total painted internal wall areas.	Prerequisite
P.12 Refrigerants Air conditioning systems shall use refrigerants with ozone depleting potential (ODP) of 0 or global warming potential (GWP) of less than 100. A refrigerant leak detection system shall also be installed in critical areas of plant rooms containing chillers and/ or other equipment using refrigerants.	Prerequisite
P.13 Sound Level The relevant equipment as aforementioned shall be designed to comply with the recommended ambient sound levels in Table 4 of SS 553 : 2016.	Prerequisite

Part 4 – Smart and Healthy Building	Green Mark Points												
<p>P.14 Permanent Instrumentation for the Measurement and Verification of Chilled Water Air-Conditioning Systems Permanent instrumentation to monitor chilled water plant (water cooled and air-cooled system) efficiency shall also be provided. The installed instrumentation shall have the capability to calculate resultant efficiency (i.e. kW/RT) within 5% of its true value, in accordance with ASHRAE Guideline 22 and AHRI Standard 550/590. Each measurement system shall include the sensor, any signal conditioning, the data acquisition system and wiring connecting them.</p>	Prerequisite												
<p>P.15 Electrical Sub-Metering & Monitoring Subsystem measurement devices with remote capability shall be provided, linked to a monitoring system and measure and trend energy consumption data of:</p> <ul style="list-style-type: none"> Each of the following energy sub systems: <table border="1" data-bbox="201 674 799 951"> <tr> <th>Use (Sum of all loads)</th><th>Sub-systems thresholds</th></tr> <tr> <td>Lift & escalator</td><td>Sum of all feeders > 50 kVA</td></tr> <tr> <td>Heater, including heat pump</td><td>> 50 kWth</td></tr> <tr> <td>Process loads</td><td>Connected loads > 50 kVA Connected gas or district services load > 75 kW</td></tr> <tr> <td>Mechanical ventilation</td><td>The subsystem's load > 15kW</td></tr> <tr> <td>VRF systems (CUs, FCUs)</td><td>No threshold</td></tr> </table> <ul style="list-style-type: none"> Each tenancy or floor, as well as high energy load areas exceeding 50kVA such as car park, data centres, IT closets and process areas. 	Use (Sum of all loads)	Sub-systems thresholds	Lift & escalator	Sum of all feeders > 50 kVA	Heater, including heat pump	> 50 kWth	Process loads	Connected loads > 50 kVA Connected gas or district services load > 75 kW	Mechanical ventilation	The subsystem's load > 15kW	VRF systems (CUs, FCUs)	No threshold	Prerequisite
Use (Sum of all loads)	Sub-systems thresholds												
Lift & escalator	Sum of all feeders > 50 kVA												
Heater, including heat pump	> 50 kWth												
Process loads	Connected loads > 50 kVA Connected gas or district services load > 75 kW												
Mechanical ventilation	The subsystem's load > 15kW												
VRF systems (CUs, FCUs)	No threshold												
4.1 Indoor Air Quality													
<p>4.1a Occupant Comfort The testing and evaluation of indoor air quality parameters is crucial to ensure occupant comfort. Engaging building occupants completes the feedback loop, and is essential for the management and improvement of operational practices in high-performing green buildings.</p> <p>(i) Indoor Air Quality (IAQ) Surveillance Audit Committed to conduct an IAQ surveillance audit within one year after occupancy or after reasonable occupancy has been reached. The audit shall be conducted by an accredited laboratory under Singapore Accreditation Council with respect to the recommended IAQ parameters and acceptable limits stated in Table 1 of SS554: 2016, based on Indicative methods or reference methods.</p> <p>(ii) Post Occupancy Evaluation Committed to conduct Post Occupancy Evaluation (POE) questionnaire, with appropriate corrective actions if required, within a year after building occupancy or after reasonable occupancy has been reached.</p> <p>(iii) Indoor Air Quality Display Provision of display panels for temperature and relative humidity information at each floor/ tenancy, to raise awareness among building occupants on the internal conditions of the space.</p>	<p>0.5 point for indicative method 1 point for reference method</p> <p>0.5 point</p> <p>0.5 point</p> <p>(Up to 2 point for 4.1a)</p>												

Part 4 – Smart and Healthy Building	Green Mark Points														
<p>4.1b Outdoor Air Provision of adequate and proper ventilation in conditioned spaces to prevent build-up in the concentration of contaminants.</p> <p>(i) Ventilation Rates</p> <ul style="list-style-type: none"> Measurement and monitoring of outdoor airflow volume in accordance with desired ventilation rates. Use of demand control ventilation strategies such as carbon dioxide sensors or equivalent devices to regulate the quantity of fresh air and ventilation in accordance with the space requirements. <p>(ii) Enhanced Filtration Media Permanent provision of Minimum Efficiency Rating Value (MERV 14, ASHRAE 52.2 or F8/ EN779 class of filter or equivalent).</p> <p>(iii) Dedicated Outdoor Air System Provision of a dedicated outdoor air system, such as precool units, to encourage effective treatment of outdoor air for cooling and dehumidification.</p>	<p>0.5 point for precool units (e.g. PAHUs and PFCUs) 1 point for all AHUs and FCUs</p> <p>0.5 point</p> <p>0.5 point for all PAHUs 1 points for all PAHUs and AHUs</p> <p>0.5 point</p> <p>(Up to 3 point for 4.1b)</p>														
<p>4.1c Indoor Contaminants Indoor contaminant pollution control at source and air treatment strategies can safeguard the health of building occupants.</p> <p>(i) Local Exhaust and Air Purging System</p> <ul style="list-style-type: none"> Local isolation and exhaust systems to remove the source of pollutants Air purging system to replace contaminated indoor air with outdoor fresh air <p>(ii) Ultraviolet Germicidal Irradiation (UVGI) System Provision of UVGI system in AHUs and FCUs to control airborne infective microorganisms.</p> <p>(iii) More Stringent VOC Limits for Interior Fittings and Finishes Specification and use of products certified SGBP Very Good or above, of which the VOC emission rate standards meet more stringent VOC emission limits.</p> <p>(iv) Use of Persistent Bio-cumulative and Toxic (PBT) free lighting</p>	<p>1 point each (Up to 2 points)</p> <p>0.5 point</p> <table border="1" data-bbox="824 1465 1422 1858"> <thead> <tr> <th data-bbox="833 1476 1052 1581">Functional System</th><th data-bbox="1052 1476 1414 1581">Points (VOC content within a Functional System for ≥ 80% of applicable areas must be SGBP Very Good or above)</th></tr> </thead> <tbody> <tr> <td data-bbox="833 1581 1052 1619">External Wall</td><td data-bbox="1052 1581 1414 1619">1 pt</td></tr> <tr> <td data-bbox="833 1619 1052 1656">Internal Wall</td><td data-bbox="1052 1619 1414 1656">1 pt</td></tr> <tr> <td data-bbox="833 1656 1052 1694">Internal Flooring</td><td data-bbox="1052 1656 1414 1694">1 pt</td></tr> <tr> <td data-bbox="833 1694 1052 1732">Ceiling</td><td data-bbox="1052 1694 1414 1732">1 pt</td></tr> <tr> <td data-bbox="833 1732 1052 1770">Doors</td><td data-bbox="1052 1732 1414 1770">0.5 pt</td></tr> <tr> <td data-bbox="833 1770 1052 1858">Other Systems: Fixed furniture/ system furniture</td><td data-bbox="1052 1770 1414 1858">0.5 pt</td></tr> </tbody> </table> <p>(Up to 2 points)</p> <p>0.5 point for ≥ 90% of light fittings in the project.</p> <p>(Up to 5 point for 4.1c)</p>	Functional System	Points (VOC content within a Functional System for ≥ 80% of applicable areas must be SGBP Very Good or above)	External Wall	1 pt	Internal Wall	1 pt	Internal Flooring	1 pt	Ceiling	1 pt	Doors	0.5 pt	Other Systems: Fixed furniture/ system furniture	0.5 pt
Functional System	Points (VOC content within a Functional System for ≥ 80% of applicable areas must be SGBP Very Good or above)														
External Wall	1 pt														
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Ceiling	1 pt														
Doors	0.5 pt														
Other Systems: Fixed furniture/ system furniture	0.5 pt														

Part 4 – Smart and Healthy Building	Green Mark Points										
4.2 Spatial Quality											
<p>4.2a Lighting Natural lighting has been linked to the positive mental wellbeing of building occupants. It connects enclosed indoor environments with the external natural environment. In the tropics, special care must be taken to maximise effective daylight while minimising visual discomfort and maintaining the façade's thermal efficiency.</p> <p>(i) Effective daylighting for common areas Prorating the number of daylit transient common spaces with effective automatic lighting controls against the total number of applicable spaces. Note: Each toilet is counted as 0.5.</p> <p>(ii) Effective daylighting for occupied spaces Percentage of occupied spaces with access to effective daylighting Points are computed based on the percentage of total occupied areas* that can achieve the specific Daylight Autonomy (DA) requirement of DAN lx,50% (without overlighting), as outlined in the Green Mark NRB: 2015 Technical Guide and Requirements Annex B: Effective Daylighting Simulation and Pre-Simulated Daylight Availability Tables Methodology and Requirements. Effectively daylit areas shall be integrated with automated lighting controls. * Note: exclude special rooms that cannot have daylighting due to operation needs.</p> <p>Effective Mitigation of Overlit Areas Pre-Simulation Daylight Availability Tables: Adoption of suitable mitigation strategies for overlit spaces or Daylight Simulation: mitigation measures to effectively address overlighting are included into the simulation model in accordance with Annex B</p> <p>(iii) Quality of Artificial Lighting Low impact item</p> <ul style="list-style-type: none"> • Good light-output over life with a minimum lifespan rating of L70 ≥ 50,000 life hours • Lighting designed to avoid flicker and stroboscopic effects, by using high frequency ballasts for fluorescent luminaires and LED lighting with ≤ 30% flicker • Meeting the minimum colour rendering index (Ra or CRI) in Clause 5 of SS 531 – 1 : 2006 (2013) – Code of Practice for Lighting of Workplaces <p>High impact item</p> <ul style="list-style-type: none"> • LED Luminaires certified under SGBP scheme 	<p>Points scored = 1.5 x (% count with daylighting for toilets, staircases, corridors, lift lobbies and atriums) + 0.5 x (% areas of carpark with daylighting or having no carpark.) (Up to 2 points for 4.2ai)</p> <p>Pre-Simulation Daylight Availability Tables or Daylight Simulation</p> <table border="1"> <thead> <tr> <th>Percentage</th><th>Points</th></tr> </thead> <tbody> <tr> <td>15 to < 35 %</td><td>0.5</td></tr> <tr> <td>35 to < 55 %</td><td>1</td></tr> <tr> <td>55 to < 75 %</td><td>2</td></tr> <tr> <td>≥75%</td><td>3</td></tr> </tbody> </table> <p>(Up to 3 points)</p> <p>1 point</p> <p>(Up to 4 points for 4.2aii)</p> <p>0.5 point each for low impact item 1 point for high impact item</p> <p>(Up to 1 point for 4.2aiii)</p> <p>(Up to 6 points for 4.2a)</p>	Percentage	Points	15 to < 35 %	0.5	35 to < 55 %	1	55 to < 75 %	2	≥75%	3
Percentage	Points										
15 to < 35 %	0.5										
35 to < 55 %	1										
55 to < 75 %	2										
≥75%	3										
<p>4.2b Acoustics An improved acoustical performance for normally occupied spaces can enhance the aural comfort of its occupants, facilitating communication, reducing unwanted sound and aiding in speech privacy.</p>											

Part 4 – Smart and Healthy Building	Green Mark Points						
<p>(i) Sound Transmission Reduction Projects that demonstrate that the acoustic performance of the internal partitions between adjoining spaces will be constructed to achieve the following performance levels:</p> <table border="1" data-bbox="201 331 799 541"> <tr> <th>Description</th><th>Sound Transmission Class (STC)</th></tr> <tr> <td>Between general office spaces</td><td>40 - 50</td></tr> <tr> <td>Spaces where confidential speech are required/ Between mechanical and equipment spaces and occupied spaces:</td><td>50 – 60</td></tr> </table> <p>(ii) Acoustic Report 1.5 points can be scored for an acoustic design and verification report adhering to the requirements in the GM NRB: 2015 Technical Guide and Requirements.</p>	Description	Sound Transmission Class (STC)	Between general office spaces	40 - 50	Spaces where confidential speech are required/ Between mechanical and equipment spaces and occupied spaces:	50 – 60	<p>0.5 point</p> <p>1.5 point</p> <p>(Up to 2 points for 4.2b)</p>
Description	Sound Transmission Class (STC)						
Between general office spaces	40 - 50						
Spaces where confidential speech are required/ Between mechanical and equipment spaces and occupied spaces:	50 – 60						
<p>4.2c Wellbeing The state of being comfortable, healthy or happy. Nurturing, healing and inclusive spaces can enhance the building occupant and user's environment, and overall wellbeing.</p> <p>(i) Biophilic Design</p> <ul style="list-style-type: none"> • Provision of accessible sky gardens, sky terraces, internal courtyards and rooftop gardens as areas for respite. • Building design that adopt biomimicry designs. • The provision for at least 5% of the common areas or functional spaces to have fixed indoor planting. • Building design that takes after any natural shapes and forms/ creates ecological attachment to the place. • Provision of images of nature for 5% of common areas. <p>(ii) Universal Design (UD) Mark</p>	<p>1 point each</p> <p>0.5 point each</p> <p>0.25 point each</p> <p>Certified/Gold – 0.5 point Gold^{PLUS}/Platinum – 1 point</p> <p>(Up to 2 points for 4.2c)</p>						
4.3 Smart Building Operations							
<p>4.3a Energy Monitoring Tracking a building's energy use with the data presented in a relevant manner to engage its occupants can have an effect in helping to manage building energy consumption. Related to this ideal of sharing building data openly is the need to apply open standards to future-proof the building's management system and to facilitate data exchange between subsystems.</p>							

Part 4 – Smart and Healthy Building	Green Mark Points
<p>(i) Energy Portal and Dashboard</p> <ul style="list-style-type: none"> • Display metered data, trending of energy consumption (historical data) and relevant parameters • Display monthly energy consumption of 50th percentile line of the tenants/space within the buildings. The information could also include 25th and 75th percentile line. <p>(ii) BAS and Controllers with Open Protocol Use of BACnet, Modbus or any other non-proprietary protocol as the network backbone for the building management system, with the system being able to provide scheduled export of a set of any chosen data points to commonly used file formats.</p>	<p>1 point each (Up to 2 points)</p> <p>1 point</p> <p>(Up to 3 points for 4.3a)</p>
<p>4.3b Demand Control Using occupancy based controls to monitor the usage of spaces and vary temperature, ventilation and lighting demand while maintaining room temperature effectiveness, good indoor environmental quality and lighting quality, can significantly reduce building energy consumption. The energy savings from such controls can be taken into account under the Energy Performance Points Calculator under Part 2 Building Energy Performance.</p> <p>(i) ACMV Demand Control</p> <ul style="list-style-type: none"> • Binary sensing controls <ul style="list-style-type: none"> ➤ ≥ 80% of all transient areas ➤ ≥ 80% of all occupied areas • Occupancy-based sensing controls (for VAV systems) <ul style="list-style-type: none"> ➤ ≥ 80% of all transient areas ➤ ≥ 80% of all occupied areas <p>(ii) Lighting Demand Control Use of occupancy/ vacancy sensors to moderate brightness of the luminaries for :</p> <ul style="list-style-type: none"> ➤ ≥ 80% of all transient areas ➤ ≥ 80% of all occupied areas 	<p>0.5 point each (Up to 1 point)</p> <p>0.5 point each (Up to 1 point)</p> <p>0.5 point each (Up to 1 point)</p> <p>(Up to 3 points for 4.3b)</p>
<p>4.3c Integration and Analytics The innovative and integrative use of data can optimise workflow or attain persistence of high performance and energy efficiency in a building. Basic integration and use of sensor data can optimise and operate the building in an informed and effective manner. The use of advanced integration and analytics can provide enhanced efficacy in lowering energy use, increase asset reliability, and improve the user experience.</p>	

Part 4 – Smart and Healthy Building		Green Mark Points			
<table><tr><th>Basic Features</th><th>Advanced Features</th></tr><tr><td><ul style="list-style-type: none">• Use adaptive control algorithms• Exception handling by identifying systems that deviates from expected performance/setting• Detect equipment that run outside intended hours or settings• Monitor equipment condition for preventive maintenance• Basic fault detection and diagnostics (FDD) of sensors by finding failed or improperly operating sensors or actuators</td><td><ul style="list-style-type: none">• Whole system optimisation using a network of HVAC equipment• Integration of sub-systems to optimise resource use or improve user experience• Use of Building Information Modelling (BIM) or similar applications that provide location-based visualisation of multiple sensors• Participate in a Demand Response programme with electricity retailer</td></tr></table>	Basic Features	Advanced Features	<ul style="list-style-type: none">• Use adaptive control algorithms• Exception handling by identifying systems that deviates from expected performance/setting• Detect equipment that run outside intended hours or settings• Monitor equipment condition for preventive maintenance• Basic fault detection and diagnostics (FDD) of sensors by finding failed or improperly operating sensors or actuators	<ul style="list-style-type: none">• Whole system optimisation using a network of HVAC equipment• Integration of sub-systems to optimise resource use or improve user experience• Use of Building Information Modelling (BIM) or similar applications that provide location-based visualisation of multiple sensors• Participate in a Demand Response programme with electricity retailer	<p>0.5 point each for Basic Features and 1 point each for Advanced Features (Features displayed via BMS, BAS, website or mobile app)</p> <p>(Up to 3 points for 4.3c)</p>
Basic Features	Advanced Features				
<ul style="list-style-type: none">• Use adaptive control algorithms• Exception handling by identifying systems that deviates from expected performance/setting• Detect equipment that run outside intended hours or settings• Monitor equipment condition for preventive maintenance• Basic fault detection and diagnostics (FDD) of sensors by finding failed or improperly operating sensors or actuators	<ul style="list-style-type: none">• Whole system optimisation using a network of HVAC equipment• Integration of sub-systems to optimise resource use or improve user experience• Use of Building Information Modelling (BIM) or similar applications that provide location-based visualisation of multiple sensors• Participate in a Demand Response programme with electricity retailer				
<p>4.3d System Handover and Documentation</p> <p>Proper system verification and handover of higher-order functional and system level performance of buildings control systems, mechanical systems and electrical systems. The project shall demonstrate a commitment to comply to verification requirements and show evidence of relevant schedules and documentation.</p>		<p>1 point</p> <p>(Up to 1 point for 4.3d)</p>			

Part 5 – Advanced Green Efforts	Green Mark Points
5.1 Enhanced Performance	
<p>5.1 Enhanced Performance Credits Advanced Green Efforts indicators that are highlighted within the Green Mark NRB: 2015 criteria, or for other outcome beyond what is specified, based on high, medium and low impact items.</p> <p>Enhanced performance indicators within criteria</p>	
Advanced Green Efforts Under Part 1 Climatic Responsive Design	Green Mark Points
<p>1.1b Integrative Design Process <u>4D, 5D & 6D BIM</u></p> <ul style="list-style-type: none"> ➤ 4D (Time) BIM ➤ 5D (Cost) BIM ➤ 6D (Facilities Management) BIM 	1 point each (Up to 3 points)
<p>1.2a Sustainable Urbanism <u>Creation of possible new ecology and natural ecosystems</u></p>	1 point
<p>1.2b Integrated Landscape and Waterscape <u>GnPR ≥ 5</u></p>	1 point
<p>1.3a Tropical Façade Performance <u>Low heat gain façade</u></p> <ul style="list-style-type: none"> ➤ ETTV < 35W/m² 	1 point
<p><u>Vertical Greenery on the East and West Façade</u></p> <ul style="list-style-type: none"> ➤ For more than 30% of east and west façade areas ➤ For more than 15% of east and west façade areas 	1 point 0.5 point
<p><u>Thermal Bridging</u> Use of thermal break /insulating profiles certified by approved local certification bodies</p>	1 point
<p>1.3c Ventilation Performance <u>Wind Driven Rain Simulation</u></p>	1 point
Advanced Green Efforts under Part 2 Building Energy Performance	
<p>Option 1: Energy Performance Points Calculator 2.1e Building Energy <u>Further Improvement in Design Energy Consumption</u></p> <ul style="list-style-type: none"> ➤ Additional improvement of the design energy consumption against the notional reference above maximum credit scored under 2.1e Building Energy based on the same formula. 	<p><i>Points scored</i> $= \frac{\% \text{ improvement from baseline}}{3} - 11$ (Up to 2 points)</p>
<p>Option 2: Performance-Based Computation 2.1f Space Conditioning Performance <u>Efficient Space Conditioning Energy Design</u> Achieve highly efficient air-conditioning design</p> <ul style="list-style-type: none"> ➤ Achieving 0.70kW/ton TDSE ➤ Achieving 0.65kW/ton TDSE 	<p>0.5 point 1 point (Up to 1 point)</p>

Part 5 – Advanced Green Efforts	Green Mark Points								
<p>2.1g Lighting System Performance Efficient Lighting Design Achieve highly efficient air-conditioning design</p> <ul style="list-style-type: none"> ➤ 0.5 point for 40% improvement ➤ 1 point for 50% improvement <p>2.1h Building Systems Performance Additional Energy Efficient Practices and Features</p> <ul style="list-style-type: none"> ➤ Additional improvement from baseline total building consumption above maximum credit scored under 2.1h(iv) Energy Efficient Practices and Features based on the same formula. <p>2.2c Adoption of Renewable Energy Further Electricity Replacement by Renewables</p> <ul style="list-style-type: none"> ➤ Additional percentage electricity replacement by renewable energy above maximum credit scored under 2.2c Adoption of Renewable Energy based on the same formula. 	<p>0.5 point 1 point (Up to 1 point)</p> <p>Points scored $= \frac{\left(\frac{\% \text{ improvement from baseline}}{\text{total building consumption}} \right) - 4\%}{3}$ (Up to 2 points)</p> <table border="1" data-bbox="824 747 1305 1050"> <thead> <tr> <th>Expected Energy Use Intensity (EUI) [kWh/m²/yr]</th><th>% Replacement of Building Electricity Consumption by Renewable Energy</th></tr> </thead> <tbody> <tr> <td>≥ 220</td><td>1 point for every 0.5% (beyond 3%)</td></tr> <tr> <td>50 ≤ EUI < 220</td><td>1 point for every 1.25% (beyond 7.5%)</td></tr> <tr> <td>< 50</td><td>1 point for every 2.5% (beyond 15%)</td></tr> </tbody> </table> <p>(Up to 5 points)</p>	Expected Energy Use Intensity (EUI) [kWh/m ² /yr]	% Replacement of Building Electricity Consumption by Renewable Energy	≥ 220	1 point for every 0.5% (beyond 3%)	50 ≤ EUI < 220	1 point for every 1.25% (beyond 7.5%)	< 50	1 point for every 2.5% (beyond 15%)
Expected Energy Use Intensity (EUI) [kWh/m ² /yr]	% Replacement of Building Electricity Consumption by Renewable Energy								
≥ 220	1 point for every 0.5% (beyond 3%)								
50 ≤ EUI < 220	1 point for every 1.25% (beyond 7.5%)								
< 50	1 point for every 2.5% (beyond 15%)								
Advanced Green Efforts under Part 3 Resource Stewardship									
<p>3.1a Water Efficient Systems Better Water Efficient Fittings Demonstrate the use of better WELS rated water efficient fittings</p> <ul style="list-style-type: none"> ➤ Use of better WELS rated water efficient fittings for 100% of <u>basin taps & mixer and dual flush flushing cisterns</u> ➤ Use of better WELS rated water efficient fittings for <u>100% of applicable water fittings</u> as prescribed in P.07 whilst ensuring user requirements are not compromised. <p>3.2a(ii) Resource Efficient Building Design Use of BIM to calculate CUI</p> <ul style="list-style-type: none"> ➤ BIM is used to compute CUI <p>3.2a(iii) Low Carbon Concrete Use of Advanced Green Materials</p> <ul style="list-style-type: none"> ➤ Use of SGBC-certified 4-Tick concrete ➤ Use of SGBC-certified reinforcement bars for structural reinforced concrete elements, for more than 80% of the applicable superstructure elements by volume. 	<p>0.5 point</p> <p>1 point</p> <p>(up to 1 point)</p> <p>1 point</p> <p>0.5 point each (Up to 1 point)</p>								

Part 5 – Advanced Green Efforts	Green Mark Points								
<p>3.2b Embodied Carbon <u>Provide Own Emission Factors with Source Justification</u></p> <ul style="list-style-type: none"> ➤ Provision of own material emission factors <p><u>Compute the Carbon Footprint of the Entire Development</u></p> <ul style="list-style-type: none"> ➤ Computation of the carbon footprint of the entire development and a detailed carbon footprint report based on all the materials used within the development. <p>3.2c Sustainable Products <u>Sustainable Products with Higher Environmental Credentials</u></p> <ul style="list-style-type: none"> ➤ Use of products certified to higher tiers of environmental performance (per product). 	<p>0.25 pt per material (Up to 1 point)</p> <p>2 points</p> <table border="1" data-bbox="824 596 1305 779"> <thead> <tr> <th>Singapore Green Building Product Certification Rating</th><th>Points per product (≥ 80% of the applicable use)</th></tr> </thead> <tbody> <tr> <td>Very Good (2-ticks)</td><td>0.25</td></tr> <tr> <td>Excellent (3-ticks)</td><td>0.5</td></tr> <tr> <td>Leader (4-ticks)</td><td>1.0</td></tr> </tbody> </table> <p>(Up to 2 points)</p>	Singapore Green Building Product Certification Rating	Points per product (≥ 80% of the applicable use)	Very Good (2-ticks)	0.25	Excellent (3-ticks)	0.5	Leader (4-ticks)	1.0
Singapore Green Building Product Certification Rating	Points per product (≥ 80% of the applicable use)								
Very Good (2-ticks)	0.25								
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<p>Advanced Green Efforts under Part 4 Smart and Healthy Building</p>									
<p>4.1a Occupant Comfort <u>Indoor Air Quality Trending</u></p> <ul style="list-style-type: none"> ➤ Provision for monitoring and trend logging of temperature and relative humidity through a centralised system. ➤ Provision for monitoring and trend logging of common indoor air pollutants, such as formaldehyde, at each floor. <p>4.1c Indoor Contaminants <u>Zero ODP Refrigerants with Low Global Warming Potential</u></p> <ul style="list-style-type: none"> ➤ Zero ODP and GWP < 750 ➤ Zero ODP and GWP < 10 <p>4.3a Energy Monitoring <u>Permanent M&V for VRF Systems</u> Provision of permanent measuring instruments for monitoring of energy efficiency performance of Variable Refrigerant Flow (VRF) condensing units and air distribution subsystem.</p> <p><u>Permanent M&V for Hot Water Systems</u> Incorporation of Permanent Measurement and Verification for hot water systems, with performance requirement similar to P.14, for central hot water system.</p>	<p>0.5 point</p> <p>1.5 point (Up to 2 points)</p> <p>0.5 point 1 point (Up to 1 point)</p> <p>2 points</p> <p>1 point</p>								

Part 5 – Advanced Green Efforts	Green Mark Points
<p>4.3c Integration and Analytics <u>Additional Advanced Integration and Analytical Features</u> Additional advanced integration and analytical features above maximum credit scored under 4.3c(ii) Advanced Integration and Analytics</p> <p>4.3d System Handover and Documentation <u>Expanded Post Occupancy Performance Verification by a 3rd Party</u> Owner engages an independent competent professional to verify the operational performance and provide recommendations on system performance enhancement, conducted within one year from the building's TOP.</p> <p><u>Energy Performance Contracting</u> Engagement an Energy Performance Contracting (EPC) firm (accredited by SGBC) to implement and deliver energy efficiency, renewable energy and/or energy recovery projects with an energy performance contract wherein the EPC firm's remuneration is based on demonstrated energy savings. Operational system efficiency should be guaranteed over a minimum of 3 years.</p>	<p>1 point</p> <p>0.5 point can be scored per energy subsystem (Up to 2 points)</p> <p>1 point</p>
Other enhanced performance indicators	<p>2 points for high impact items 1 point for medium impact items 0.5 point for low impact items</p> <p>(Up to 15 point for 5.1)</p>
5.2 Complementary Certifications	
<p>5.2 Complementary Certifications Project demonstrates that it is certified through a local or international complementary certification or rating tool that assesses the project beyond the environmental indicators within Green Mark NRB: 2015.</p>	<p>1 point</p> <p>(Up to 1 point for 5.2)</p>
5.3 Demonstrating Cost Effective Design	
<p>5.3 Demonstrating Cost Effective Design Demonstration of cost effective or cost neutral design beyond the norm through a detailed quantity surveyor's report of the building.</p>	<p>1 point for cost effective design 2 points for cost neutral design</p> <p>(Up to 2 points for 5.3)</p>
5.4 Social Benefits	
<p>5.4 Social Benefits Projects that demonstrate their social benefits or how social sustainability has been incorporated into the project, beyond core functionality of the building. This can (but not limited to) include efforts that demonstrate enhanced considerations to further wellbeing, welfare, community integration as well as the purchase of clean energy (e.g. solar energy) through third party leasing contracts.</p>	<p>0.5 point for each distinct benefit</p> <p>(Up to 2 points for 5.4)</p>

0. Pre-requisites

The pre-requisites for Green Mark NRB:2015 sets the minimum environmental considerations that a project shall demonstrate based on industry norms. All pre-requisites listed as follows must be fulfilled in order to be eligible to score Green Mark points in the 5 Green Mark sections

Pre-requisites Directory for P.1 to P.15

P.1 to P.15 are parked under the criteria sections. They must be fulfilled by all projects targeting certification.

Section	Pre-Requisites
1. Climatic Responsive Design	P.1 – P.3
2. Building Energy Performance	P.4 – P.6
3. Resource Stewardship	P.7
4. Smart and Healthy Building	P.8 – P.15

Minimum Criteria Points Requirements

Indicator	Pre-Requisite Requirement	Minimum Points Requirement		
		Gold	Gold ^{PLUS}	Platinum
1.1b	Integrative Design Process	-	2 pts	
1.1e	User Engagement	Green Fit-out Guideline - 1 pt		
		-	-	Displaying Green Mark credential – 1 pt
1.2b	Integrated Landscape and Waterscape	-	Commercial, Healthcare – 2 pts Others – 1 pt	
1.3c	Ventilation Performance – Ventilation Simulation For Gold ^{PLUS} and Platinum projects with ≥ 2,000m ² of naturally ventilated occupied spaces, the following wind speeds must be met via ventilation simulation	-	4 pts • Gold ^{PLUS} – 0.4 m/s • Platinum – 0.6 m/s *Complementary methods to compliance are available as described in 1.3c	
2.3a	Solar Energy Feasibility Study	For buildings with a footprint ≥1,000m ² – 0.5 pt		
3.2a	Sustainable Construction	0.5 pt	2 pts	3.5 pts
3.2b	Embodied Energy	-	1 pts	
3.2c	Sustainable Products	2pts	3 pts	4 pts
4.1a(i)	Indoor Air Quality Audit	0.5 pt		
4.1a(ii)	Post Occupancy Evaluation	-	0.5 pt	
4.1b(ii)	Enhanced Filtration Media	-	0.5 pt	
4.1c(iii)	Use of PBT Free Lighting	-	Healthcare – 0.5 pt	
4.3d	System Handover and Documentation	-	1 pt	
Annex 2(d)	Local Energy Generation for Centralised Service Hot Water Heating	-	-	Healthcare – 1 pt
Annex 2(e)	Onsite Airside Energy Recovery	-	-	Healthcare – 1 pt
Annex 3(c)	Onsite Airside Energy Recovery	-	-	Laboratory – 1 pt
Annex 4(b)	Raising Awareness on Environmental Sustainability	-	Schools – 1pt	
Annex 4(c)	Communication of Efficiency Trends	-	Schools – 0.5pt	

* Laboratory denote Laboratory Buildings, Healthcare denote Healthcare Facilities

All projects will need to compute Energy Efficiency Index (EEI) and Energy Use Intensity (EUI) in kWh/m²/yr.

Energy Savings Requirements

Intent

The quantification and setting of minimum standards for energy savings of a green building can encourage an integrated approach to building design optimisation. By determining the building's energy usage based on different design options, developers can better understand their impact on total building performance and make cost effective design decisions that can maximise energy savings.

Scope

Applicable to all projects targeting Green Mark Gold^{PLUS} or Platinum rating.

Assessment

The minimum energy savings to be demonstrated for the following rating tiers are as follows:

Level of Green Mark Award	Minimum Energy Savings
Gold ^{PLUS}	25%
Platinum	30%

For a building with air-conditioned area $\geq 5,000\text{m}^2$, an energy model shall be used to demonstrate the building's designed energy savings compared to a prescribed reference model that reflects prevailing building standards and codes of practice. The simulation shall be conducted in accordance with the *Green Mark NRB: 2015 Technical Guide and Requirements - Annex C: Energy Modeling Methodology and Requirements*

For a building with air-conditioned areas $< 5,000\text{m}^2$, detailed calculations can be provided in place of energy modeling to justify the savings in energy consumption from a more efficient design.

For buildings served by existing DCS plants eligible for Path B as per the requirements outlined in the *Green Mark NRB: 2015 Technical Guide and Requirements*, the energy savings to be demonstrated (excluding the consumption of the DCS plant) are as follows:

Level of Green Mark Award	Cooling Load Savings	Energy Consumption Savings (excluding DCS plant)
Gold ^{PLUS}	10%	27%
Platinum	15%	33%

For projects targeting Green Mark Gold^{PLUS} or Platinum, the Energy Use Intensity should not exceed the 50th percentile value of similar building type, stated in the annual Building Energy Benchmarking Report (BEBR). In instances where the project exceeds the EUI stated, justification shall be provided and subjected to Green Mark assessment.

1. Climatic Responsive Design



Buildings serve as structures sheltering their occupants from the variable external climate. With this consideration, the built form should be considered to maximise its response to the local tropical climate, and establish a contemporary tropical vernacular. By appreciating the site context, building designers can capitalise on the physical environment and recognise opportunities for the urban built form to maximise responsive design. Consideration of the building's human centricity and whether it is in sync with its surrounding context should also be given due account. It is paramount for such climatically contextual design to be weaved into the early thinking of building design, and this is enabled through upstream effective leadership, supported by a collaborative process of design with the partnership of relevant stakeholders.

P.1 - P.3 + POINTS PREREQUISITES

30 POINTS

- 1.1 Leadership (10 pts)
- 1.2 Urban Harmony (10 pts)
- 1.3 Tropicality (10 pts)

Advanced Green Efforts (9 pts)

P.1 Envelope and Roof Thermal Transfer

Intent

Minimising thermal heat gain through the building envelope and roof can enhance indoor thermal comfort and reduce the energy needed to condition the indoor environment.

Scope

Applicable to building facades and roofs.

Assessment

Where the buildings' aggregate air-conditioned areas exceed 500 m², as determined in accordance with the formula set out in the *BCA Code on Envelope Thermal Performance for Buildings*, the Envelope Thermal Transfer Value (ETTV) shall not exceed the following limits:

Level of Award	Maximum ETTV
Gold	45 W/m ²
Gold^{PLUS}	40 W/m ²
Platinum	38 W/m ²

The average thermal transmittance (U-value) for the gross area of the building's roof shall not exceed the following limits:

		Buildings with aggregate air-conditioned area > 500m ² Maximum Thermal Transmittance for roof of air-conditioned building	Buildings with aggregate air-conditioned area ≤500m ² Maximum Thermal Transmittance for roof of non air-conditioned building
Roof Weight Group	Weight Range (kg/m ²)	Maximum U-value (W/m ² K)	
Light	< 50	0.5	0.8
Medium	50 to 230	0.8	1.1
Heavy	> 230	1.2	1.5

The limits stipulated do not apply to roofs with skylight for buildings with aggregate air-conditioned area > 500m². However, the Roof Thermal Transfer Value (RTTV) of such roofs, computed in accordance with the *Code on Envelope Thermal Performance for Buildings*, shall not exceed 50 W/m².

The roof limits stipulated do not apply to open sided sheds, linkways, covered walkways, store rooms, utility rooms, plant rooms and equipment rooms.

P.2 Air Tightness and Leakage

Intent

Minimising air infiltration through the building envelope can reduce the energy required for air-conditioning and enhance occupant thermal comfort.

Scope

Applicable to all windows and curtain walls on the building envelope.

Assessment

For windows and curtain wall systems, air leakage rates shall not exceed the limit specified in *SS 212: 2007 – Specification for Aluminium Alloy Windows* and *SS 381: 1996 (2007) – Materials and Performance Tests for Aluminium Curtain Walls* respectively.

P.3 Bicycle Parking

Intent

Providing the necessary infrastructure to encourage cycling as an alternative mode of transport can reduce the energy consumption from vehicular travel.

Scope

Applicable to all building developments outlined below.

Assessment

Meet the minimum quantity of bicycle parking lots required for the development, in line with URA circular URA/PB/2018/03-DCG (or prevailing circular) and LTA's Code of Practice - Street Work Proposal Relating to Development Works (or prevailing COP).



1.1 Leadership (10pts)

The long-term sustainability of the built environment, economy and society depends on the collective leadership of building owners in driving sustainable buildings in partnership with the end users of the building. Effective leadership is needed to influence and drive creative, organizational and technical improvements to the overall environmental credentials of projects, from the initial stages of the project through to building occupation and operation. Upstream leadership can push the boundary of projects' fundamental requirements and is the key towards shifting the needle towards climatic responsive design. This is supported by an integrated design process that resonates among the stakeholders, a strong design team and a shared vision of building a sustainable development and how the vision could be achieved.

- 1.1a Climatic & Contextually Responsive Brief (1 pt)
- 1.1b Integrative Design Process (4 pts)
- 1.1c Environmental Credentials of Project Team (2 pts)
- 1.1d User Engagement (3 pts)

1.1a Climatic & Contextually Responsive Brief

Intent

Considering the constraints and opportunities for environmental sustainability to set design goals approaches early at the onset of a building project can ensure a more holistic total building performance.

Scope

Applicable to all building developments.

Assessment

1 point can be scored for a climatic and culturally responsive brief detailed with:

- **Target Setting and Brief:** Setting of agreed achievable formal sustainability targets for the project. In addition to the project's targeted Green Mark rating, such targets should involve specific sustainable outcomes and indicators. The selection, deployment and responsibilities of the project team, builders and building operators should be detailed. This includes the identification of at least one member of the team to take the lead in coordinating sustainability efforts and tracking of the targets throughout the project phase. This could also include the client's sustainable aspirations for the project, and identification of its green potential benchmarked against similar projects.

1.1b Integrative Design Process

Intent

Addressing and negotiating between the various needs of all stakeholders involved in a building project to achieve common targets can result in a balanced and optimised sustainable design outcome. BIM can be used for coordination and design integration, enabling optimisation of resources and downstream building performance.

Scope

Applicable to all building developments.

Assessment

A maximum of 4 points can be scored for this section.

(i) Integrative team

2 points can be scored if the design team demonstrates an integrated design process. This encompasses the establishment of a collaborative framework for the project team during the briefing and design phases to encourage value-added contributions and constructive discussions. This process, which should be conducted in a consultative and non-hierarchical manner, includes the:

- Appointment of all relevant consultants early in the design phase
- Identification of responsible parties within the team to implement relevant sustainability goals and targets
- Detailing of sustainable design methodology action plans and progress
- Addressing of opportunities and challenges with integrative team strategies to achieve the targets
- Organising of design charrettes at key stages within the project design

(ii) Design for operation

1 point can be scored by involving Facility Manager (FM) in the design stage and incorporating his inputs into design.

(iii) Use of BIM.

1 point each can be scored for the following:

- **Collaborative BIM:** The use of a coordinated BIM modeling framework that harmonises the various disciplines' designs in a 3D environment, to co-ordinate spatial design and reduce clashes during construction.
- **Green BIM:** The use of integrative BIM models to form the base models for at least one environmental analysis and building performance simulations, the results of which can be used to further optimise the building design.

4D, 5D & 6D BIM (Advanced Green Efforts)

1 point each can be scored for the 3 levels of SMART BIM under *Advanced Green Efforts*:

4D (Time) BIM – This links time information to the BIM model for project scheduling and coordination. With real time construction activity on site linked to it, the 4D model can be used to review progress against the construction programme and identify methods to assess delays, make up time and evaluate extensions of time claims.

5D (Cost) BIM – This consists of elemental details, finishes, fixtures and equipment within the model linked to data on performance, manufacturers and specifications. The use of integrated scheduling tools can be incorporated to assist in the preparation of cost and quantity schedules and tracking of the project budget.

6D (Facilities Management) BIM – This involves the updated as built model of the building complete with the procured fixtures, finishes and equipment data.

1.1c Environmental Credentials of Project Team

Intent

A building project team with specialist green credentials can more competently and effectively coordinate the environmental design approach throughout the building design, construction and operation stages.

Scope

Applicable to all building developments.

Assessment

A maximum of 2 points can be scored for the project teams with the following credentials:

Green Individuals (Up to 0.5 point)

- Certified Green Mark Manager (GMM) or Green Mark Facilities Manager (GMFM) with valid Refresher course certificate (valid for 2 years) – 0.25 point
- Green Mark Professional (GMP) or Green Mark Facilities Professional (GMFP) – 0.5 point

Green and Gracious Builder (Up to 0.5 point)

- Main builder is a BCA certified Green and Gracious Builder – 0.25 point for *Certified* and *Merit* or 0.5 point for *Excellent* and *Star* rating

Green Companies (Up to 1.5 points)

- ISO 14001 certified: Architect, M&E engineer, C&S engineer, developer and main contractor - 0.25 point for each consultant type
- SGBC Green Services Certified firms – 0.25 point each

1.1d User Engagement

Intent

This refers to the provision of relevant information and guidance to building occupants/visitors to raise awareness on the building's green features, and on how they can contribute positively to reduce the building's environmental impact further.

Scope

Applicable to all building developments with occupants/visitors.

Assessment

A maximum of 3 points can be scored for the following:

- **Building user guide** – 0.5 point: To be disseminated to all eventual occupants in the building, the user guide should provide a detailed overview of the sustainable design strategies and green features employed in the building, on how they are operated and benefit the user.
- **Sustainability Education Corner** – 0.5 point: The Sustainability Education Corner should be dedicated to education and promotion of green building elements and environmental sustainability as well as the green

features specific to the development. It should be located at a prominent area, easily accessible and noticeable to all tenants, building occupants and/or visitors.

- **Sustainability Awareness & Education Programme** – 0.5 point: Awareness & educational programme could include regular scheduled events or tour to generate sustainability awareness
- **Green fit out guidelines** – 1 point: To be disseminated to the relevant tenant management/ personnel, the guidelines should detail recommended minimum environmental standards to assist them in making sustainable fit-out decisions.
- **Green lease** – up to 3 points: To be incorporated into the tenancy agreement, the green lease should establish agreed levels of environmental performance between the landlord and the tenant for $\geq 60\%$ of the net lettable area.
 - 3 points for $\geq 60\%$ of the net lettable area.
 - 1 point for $\geq 25\%$ of the net lettable area.
- **Displaying Green Mark credential** – 1 point: Can be awarded upfront when building owner commits to display the Green Mark Decal or Green Mark Plaque at prominent location (visible to public) when the project is completed. Photos evidence of installed GM credential to be submitted to BCA.



1.2 Urban Harmony (10 pts)

With buildings forming part of a larger urban environment, it is important to identify the impact of the physical form of a building, which prefixes its sustainable performance, with respect to its immediate locale and larger context. Designing for a building's human-centricity looks at how its presence can co-exist in harmony with its surrounding context and positively impact the movement and comfort of the people in its neighbourhood.

- 1.2a Sustainable Urbanism (5 pts)
- 1.2b Integrated Landscape and Waterscape (5 pts)

Photo courtesy of UOL Group Limited

1.2a Sustainable Urbanism

Intent

Through site analysis and mitigation measures, a sustainable accessible and contextual response can be developed to ensure that the development enhances the urban realm as well as minimises its environmental impact and dis-amenity to the surrounding buildings.

Scope

Applicable to all building developments.

Assessment

A maximum of 5 points can be scored under the following sub-criteria:

(i) Environmental Analysis

Up to 2 points can be scored for either the following conducted prior to the commencement of activities on site to identify the anticipated effects on climate change, flora and fauna, soil, air and water that the development may have. It should identify and implement measures to mitigate any adverse impacts, protect valuable site ecology and/ or to improve the site to its original condition.

- Environmental study – 1 point
- Comprehensive Environmental Impact Assessment (EIA) by 3rd party – 2 points

Creation of possible new ecology and natural ecosystems (Advanced Green Efforts)



1 point can be scored if the project can detail strategies in the EIA on how the completed project 'heals the land'. Beyond mitigation measures, it should have a net positive impact by enhancing the site ecology beyond its current state. The regenerative features should be quantified in terms of an overall net improvement versus the building not being constructed and the site remaining in the current context.

(ii) Response to Site Context

A site analysis identifies the relationships between the human and physical geography of the site. It should consider how the urban context, site topography and hydrology, site micro climate, site access and connectivity can inform the design of the urban form and site layout to respond accordingly. Up to 3 points can be scored for either:

- Level 1 site analysis and design that demonstrates sensitivity to the site condition – 1 point
- Level 2 site analysis optimised design with at least 2 types of iterative simulations – 3 points

(iii) Urban Heat Island (UHI) Mitigation

Demonstrate measures to mitigate the urban heat island effect and through the material selection of the hardscape (eg. materials with high Solar Reflectance Index), softscape (eg. greenery) and building surfaces (eg. coatings such as cool paints). Areas for renewable energy generation such as photovoltaic panels are deemed to comply. Up to 1 point can be scored for:

- $\geq 50\%$ site coverage (at plan view) with mitigation measures – 0.5 point
- $\geq 80\%$ site coverage (at plan view) with mitigation measures – 1 point

(iv) Green Transport

0.5 point each can be scored for the provision of the following:

- Electrical vehicle charging and parking infrastructure: There shall be at least 1 lot per 100 lots (Up to 5 lots)
- Meet the prevailing lower bound requirement by of 'Range Based Car Parking Standard (RCPS)' based on development type and parking zone published by LTA.
- Provision of bicycle lots over and above requirements stated in URA circular [URA/PB/2018/03-DCG](#) (or prevailing circular) and [LTA's Code of Practice - Street Work Proposal Relating to Development Works](#) (or prevailing COP) with at least 1 bicycle parking lot per 1,500m² of GFA (Up to 30 lots)
- Additional features to promote bicycle usage. Examples of features (at least 2 of the features should be implemented in order to score) include:

<ul style="list-style-type: none"> ➤ Adequate shower and toilet provision above NEA requirements ➤ Adequate provision of lockers ➤ Bicycle maintenance facility ➤ Comprehensive wayfinding signage 	<ul style="list-style-type: none"> ➤ Dedicated circulation routes within development for cyclists to access bicycle parking and end-of-trip facilities safely ➤ Ground level sheltered parking ➤ Innovative bicycle parking designs ➤ Security surveillance for bicycle parking
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1.2b Integrated Landscape and Waterscape

Intent

Projects are encouraged to integrate a verdant landscape and waterscape into their building design, to enhance the biodiversity around the development and provide visual relief to building occupants and neighbours.

Scope

Applicable to all building developments.

Assessment

A maximum of 5 points can be scored under the following sub-criteria:

The provision of greenery for the development can be quantified via the Green Plot Ratio (GnPR). Points can be scored as follows:

GnPR	Points Allocation
0.5 to <1.0	0.5
1.0 to <2.0	1.0
2.0 to <3.0	2.0
3.0 to <4.0	2.5
≥ 4.0	3.0

*To meet and exceed the landscape replacement and GPR requirement stated in URA circular [URA/PB/2017/06-DCG](#) (or prevailing circular)

GnPR ≥ 5 (Advanced Green Efforts)



1 more point can be scored under *Advanced Green Efforts* if the project has a GnPR ≥ 5.

(i) Tree Conservation

0.5 point each can be scored for the following:

- Preservation of existing trees on-site to prevent disturbance to established habitats.
- Replanting of an equivalent number of similar or native species of equivalent LAI for felled trees.

(ii) Sustainable Landscape Management

1.5 points can be scored for projects certified under NParks Landscape Excellence Assessment Framework (LEAF) certification. For projects not certified under LEAF, 0.5 point each can be scored for the following:

- The adoption of native species of greenery > 50% of the flora selected wherever possible to maintain the local ecosystem
- Projects that scored full points under 1.02a (i) for EIA
- A landscape management plan established that covers:
 - The use of organic composts from horticultural wastes
 - The potential for onsite composting
 - General landscape maintenance and management plan during building occupation

(iii) Sustainable Stormwater Management

Points can be scored for either of the following:

- Projects that have obtained PUB Active, Beautiful and Clean Waters (ABC Waters) certification – 1 point
- Treatment of stormwater run-off from total area through the provision of infiltration or design features before discharge to the public drains, to reduce storm surges and to treat the water
 - ≥ 10% of run-off: 0.5 point
 - ≥ 35% of run-off: 1 point



1.3 Tropicality (10 pts)

Shaping building passive design in consideration of the climatic context, including its orientation, facades as well as interior layout can reduce the building's heat load and energy usage and enhance effective thermal comfort for its occupants. From a performance point of view, buildings should be highly permeable in areas of natural ventilation and at the same time be shielded against heat ingress.

- 1.3a Tropical Façade Performance (3 pts)
- 1.3b Internal Spatial Organisation (3 pts)
- 1.3c Ventilation Performance (4 pts)

1.3a Tropical Façade Performance

Intent

The holistic consideration of façade performance can reduce direct sunlight into the building and minimise thermal heat gain, enhancing indoor comfort and lowering the energy for conditioning the indoor environment.

Scope

Applicable to facades and roofs bounding conditioned or non-conditioned spaces.

Assessment

A maximum of 3 points can be scored for the façade performance, based on weighted average area, assessed through either:

Simulation method: Through building physics software simulation, 1 point can be scored for meeting the notional façade detailed as follows, and for every 5% heat load reduction of the envelope and solar insolation reduction of the fenestrations against the notional façade.

Overall Weighted Values	Industrial Buildings	Other building types
Window U-Value	5.4 W/m ² K	2.8 W/m ² K
Wall U-Value	1.5 W/m ² K	0.7 W/m ² K
Overall Envelope U-value	2.4 W/m ² K	1.6 W/m ² K
Window-to-Wall Ratio (Each façade)	0.2	0.4
Total Effective Glass Shading Coefficient (SC ₁ x SC ₂)	0.6	0.4
Roof U-Value	1.1 W/m ² K	0.8 W/m ² K
Sky light/ Roof window U-Value	4.3 W/m ² K	2.2 W/m ² K
RTTV (where there are sky lights for AC areas)	50 W/m ² K	50 W/m ² K

Checklist method: Eligible for industrial buildings with a WWR \leq 0.25, and other building types with a WWR \leq 0.5. Points can be scored as follows:

Non Simulation Checklist for Industrial Buildings:

Overall Weighted Values	Baseline	Points for Improvement	Point cap
Envelope U-Value	2.4 W/m ² K	0.5 points for every 0.4 W/m ² K reduction from baseline	2 pts
WWR (Excludes Façade openings/ voids)	0.2	0.5 pt for meeting baseline 0.5 pt for every 0.05 reduction from baseline	2 pts
Glass Shading Coefficient (SC ₁)	0.5	1 pt for meeting baseline 0.5 pt for every 0.05 reduction from baseline	2 pts
Effective Sun Shading	-	\geq 10% effectiveness (North and South) - 1pt \geq 30% effectiveness (East and West) - 1 pt	2 pts
Roof U-Value	1.0 W/m ² K	0.5 pt for every 0.1 W/m ² K reduction from baseline	2 pts
Sky light/ Roof window U-Value	4.0 W/m ² K	0.5 pt for meeting baseline 1 pt for U-Value of 2 W/m ² K	1 pt

Non Simulation Checklist for Other Building Types:

Overall Weighted Values	Baseline	Points for Improvement	Point cap
Envelope U-Value	1.6 W/m ² K	0.5 pt for meeting baseline 0.5 pt for every 0.2 W/m ² K reduction from baseline	2 pts
WWR (Excludes façade openings/ voids)	0.4 (East, West facades not to exceed 0.3)	1 pt for meeting WWR of 0.4 0.5 pt for every 0.05 reduction from baseline	2 pts
Glass Shading Coefficient (SC ₁)	0.4	0.5 pt for meeting baseline 0.5 pt for every 0.05 reduction from baseline	2 pts
Effective Sun Shading	-	≥ 10% effectiveness (North and South) - 1 pt ≥ 30% effectiveness (East and West) - 1 pt	2 pts
Roof U-Value	0.8 W/m ² K	1 pt for meeting 0.8 W/m ² K	1 pt
Sky light/ Roof window U-Value	2.2 W/m ² K	0.5 pt for meeting U-Value	0.5 pt

Low heat gain façade (Advanced Green Efforts)

1 point can be scored for achieving ETTV < 35W/m².



Vertical Greenery on the East and West Façade (Advanced Green Efforts)

- 1 point for more than 30% of east and west façade areas
- 0.5 point for more than 15% of east and west façade areas

Thermal Bridging (Advanced Green Efforts)

1 point can be scored for the use of thermal break /insulating profiles certified by approved local certification bodies, namely the Singapore Green Building Council and the Singapore Environment Council, and with a frame U-values, U_{fr} , of < 6.0 W/m²K for ≥ 80% of external facades adjoining air-conditioned interiors.

1.3b Internal Spatial Organisation

Intent

Adopting passive design strategies in the internal spatial organisation of a building provides opportunities to enhance building performance.

Scope

Applicable to all building developments.

Assessment

Up to 3 points can be scored for the following:

- 1 point can be scored for locating non-air-conditioned spaces, e.g. lift cores, staircases, toilets, electrical plantrooms etc that covers 2/3 of the east and west facing walls to reduce thermal heat gain into occupied spaces. 0.5 point can be scored for 1/3 of the east and west façades covered by these non-air-conditioned spaces.
- Prorating the number of transient common spaces, e.g. toilets, staircases, corridors, lift lobbies and atriums by the mode of ventilation against the total number of applicable spaces – Up to 2 points

$$\text{Points scored} = \frac{\text{Number of NV spaces} \times 2 + \text{Number of MV spaces} \times 0.5 + \text{Number of AC spaces} \times 0}{\text{Total number of spaces}}$$

Note: Handicap toilets are excluded from count. Each toilet is counted as 0.5 each.

1.3c Ventilation Performance

Intent

Naturally ventilated functional areas should be effectively designed to be thermally comfortable and healthy for the building occupants.

Scope

Applicable for naturally ventilated occupied spaces and gathering spaces such as building atria.

Assessment

A maximum 4 points can be scored for this sub-indicator based on the following options:

Ventilation Performance Checklist

Parameter	Description	Points
Openings towards prevailing wind directions	0.1 point for every 10% of units or rooms with openings facing towards the prevailing winds (North & South)	1
Depth of room vs opening <i>W: Limiting depth for effective ventilation</i> <i>H: Floor-to-ceiling height</i>	<ul style="list-style-type: none"> Single sided ventilation: $W \leq 2H$ Cross Ventilation: $W \leq 5H$ <p>A factor of 1.5 can be applied to the W-H ratio for atria.</p>	<p>$\geq 50\%$ of applicable spaces meet - 1 pt or</p> <p>$\geq 70\%$ of applicable spaces meet - 2 pts</p>

Full Ventilation Simulation

Up to 4 points can be scored for ventilation simulations or wind tunnel testing conducted based on *Green Mark NRB: 2015 Technical Guide and Requirements Annex A: Computational Fluid Dynamics Simulation Methodology and Requirements*. The simulation results and recommendations derived are to be implemented to ensure optimised natural ventilation. More than 70% of applicable naturally ventilated spaces to meet the minimum weighted average wind velocity to score. Where the wind speed result cannot be met, thermal comfort or air quality modeling should be performed and the relevant criteria stated in *Annex A* met for all naturally ventilated spaces:

Points	Minimum weighted Average Wind Velocity	Thermal Comfort	Air Quality
3	Moderate (0.2m/s)	-	-
4	Good (0.4m/s)	$-1.0 < PMV < +1.0$	Air Change Rate ≥ 4 Air Exchange Efficiency ≥ 1
	Very Good (0.6m/s)	$-0.8 < PMV < +0.8$	Air Change Rate ≥ 10 Air Exchange Efficiency ≥ 1.2

Wind Driven Rain Simulation (Advanced Green Efforts)



Up to 1 point can be scored for wind driven rain simulation in compliance with *Annex A* to identify the most effective building design and layout that minimises the impact of wind-driven rain into naturally-ventilated occupied spaces.

2. Building Energy Performance



The built environment is an important contributor towards reducing global carbon emissions and fossil fuel consumption. This section builds on *Section 1 – Climatic Responsive Design*, and focuses on how building projects can demonstrate the optimisation of building energy systems through energy efficiency, effectiveness and replacement strategies to reduce their environmental impact.

The energy performance of a building is measured through the efficiency of its active mechanical and electrical systems. In the urban tropics, this is mainly attributed to air conditioning systems, artificial lighting and hot water production in some building types. In addition, to consider the energy effectiveness of a building holistically, the extent of use of energy systems in terms of their absolute energy consumption should also be taken into account. Further tapping unto opportunities to utilise renewables in place of fossil energy sources, the energy performance of building projects can be improved significantly.

An Energy Performance Points Calculator in Excel format has been formulated to aid the design team to understand the buildings' total energy performance, while providing options to reduce energy consumption. This calculator can be used to compute this section's points.

P.4 - P.6 + POINTSPREREQUISITES

30 POINTS

2.1 Energy Efficiency (22 pts)

Option 1: Energy Performance Points Calculator

Option 2: Performance-Based Computation

2.2 Renewable Energy (8 pts)

Advanced Green Efforts (7 to 9 pts)

P.4 Air Conditioning Total System and Component Efficiency

Intent

Energy efficient air-conditioning systems with better optimised total system performance require less energy to produce and distribute conditioned air into building spaces.

Scope

Applicable to air-conditioning systems serving the building comfort cooling needs.

Assessment

Where the cooling capacity of any air-conditioning system exceeds 30 kW, the equipment (excluding air distribution) shall comply with the relevant provisions of *SS 530: 2014 - Code of Practice for Energy Efficiency Standard for Building Services and Equipment*.

Where the building's aggregate air-conditioned areas exceed 500 m², the Design Total System Efficiency (DSE) and the efficiency of the cooling and air distribution components shall not exceed the limits in the tables below. For buildings with different systems, the tables will apply for the system with a larger aggregate capacity. The DSE is based on the expected part-load condition over the simulated average annual total cooling load profile for chilled-water systems, and total weighted system efficiency for unitary systems.

a) Air Cooled Chilled-Water System/ Unitary Air-Conditioning System

Relevant equipment: *Air-cooled chillers, chilled-water pumps, variable refrigerant flow (VRF) systems, single-split units, multi-split units, air distribution system (e.g. AHUs, PAHUs, FCUs)*

Green Mark Rating	Peak Building Cooling Load (RT)		Remarks
	<500 RT	≥500RT	(η_c , η_a) shall meet their respective thresholds.
	Minimum DSE η_t (kW/RT)		η_c : System kW/ton excluding the air distribution equipment η_a : Air distribution equipment kW/ton
Gold	NA (0.9, N.A.)	NA (to be assessed on case by case basis)	$\eta_t = \eta_c + \eta_a$
Gold ^{PLUS}	1.10 (0.85, 0.25)		
Platinum	1.03 (0.78, 0.25)		

b) Water Cooled Chilled Water System

Relevant equipment: *Water-cooled chillers, chilled-water pumps, condenser water pumps, cooling towers, air distribution system*

Green Mark Rating	Peak Building Cooling Load (RT)		Remarks
	<500 RT	≥500RT	
	Minimum DSE η_t (kW/RT)		
Gold	NA (0.75, N.A.)	NA (0.68, NA)	(η_c, η_a) shall meet their respective thresholds. η_c : System kW/ton excluding the air distribution equipment η_a : Air distribution equipment kW/ton $\eta_t= \eta_c+\eta_a$
Gold ^{PLUS}	0.95 (0.7, 0.25)	0.9 (0.65, 0.25)	
Platinum	0.93 (0.68, 0.25)		

c) District Cooling System (DCS) – Within or outside gazetted zones, operated by supplier of district cooling services registered under the Energy Conservation Act

Relevant equipment: *DCS plant (e.g. chillers, chilled-water pumps, condenser water pumps, cooling towers, network pumps, thermal storage, heat exchangers, renewable energy or energy recovery systems within the plant vicinity), building air-distribution system*

Green Mark Rating	Minimum DSE η_t^* (kW/RT)	Remarks
Gold	0.9 (0.65, N.A.)	(η_c, η_a) shall meet their respective thresholds.
Gold ^{PLUS}		η_c : DCS system kW/ton
Platinum	0.9 (0.65, 0.25)	η_a : Building's air distribution equipment and chilled-water pumps.
		$\eta_t = \eta_c + \eta_a$

*For DCS plants serving the building that were commissioned before October 2016, the supplier can meet the requirements under alternative Path B stipulated in the *GM NRB: 2015 Technical Guide and Requirements* instead.

P.5 Lighting Efficiency and Controls

Intent

Energy efficient lighting with adequate control strategies require less energy to illuminate a space.

Scope

Applicable to artificial lighting provisions for the type of usage specified in Clause 7 of *SS 530: 2014 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment*.

Assessment

The maximum lighting power budget for artificial lighting and lighting controls shall comply with Clause 7 of *SS 530: 2014*. In hotel buildings, a control device shall be installed in every guestroom to automatically switch off the lighting when unoccupied.

P.6 Vertical Transportation Efficiency

Intent

Energy efficient vertical transportation systems require less energy to transport passengers in buildings.

Scope

Applicable to all lifts and escalators, except typologies where such technology is not available.

Assessment

Lifts and escalators shall be equipped with AC variable voltage and variable frequency (VVVF) motor drive and sleep mode features.



2.1 Energy Efficiency (22 pts)

Air-conditioning, lighting and receptacle loads are typically the highest energy consuming building mechanical systems. Additionally, given the relatively large area of carparks in many developments, carparks also constitute a significant energy use. Using more efficient systems can reduce their contribution to the building total energy consumption.

Option 1: Energy Performance Points Calculator

- 2.1a Air Conditioning Total System Efficiency (5 pts)
- 2.1b Lighting System Efficiency (3 pts)
- 2.1c Carpark System Efficiency (2 pts)
- 2.1d Receptacle Load Efficiency (1 pt)
- 2.1e Building Energy (11 pts)

Option 2: Performance-Based Computation

- 2.1f Space Conditioning Energy (10 pts)
- 2.1g Lighting Energy (6 pts)
- 2.1h Building Energy (6 pts)

Option 1: Energy Performance Points Calculator (22 points)

2.1a Air Conditioning Total System Efficiency

Intent

The use of energy efficient air-conditioning systems can optimise their total system performance, and reduce the energy needed to produce and distribute conditioned air into building spaces.

Scope

Applicable to all the air-conditioning systems serving the building comfort cooling needs, including the air distribution equipment.

100% non – air-conditioned building projects will score full points under this indicator.

Assessment

The Energy Performance Points Calculator shall be used to calculate the percentage improvement of the weighted total design system efficiency of all the various air conditioning systems used in the project, against the code baseline. The figure should be based on the operational design load determined by the simulated average annual total cooling load profile. A maximum of 5 points can be scored as follows:

Baseline	Peak Building Cooling Load (RT)	
	<500 RT	≥500RT
	Total Design System Efficiency (kW/RT)	
	1.08	0.98
Points scored = 0.2 x (% improvement from baseline)		

For district cooling plants under Path B scenario, where the plant is excluded from the computation, the baseline reference for the building air distribution equipment can be taken as 0.28 kW/ton for the purposes of points computation here.

2.1b Lighting System Efficiency

Intent

The use of energy efficient lighting can reduce the energy needed to illuminate a space.

Scope

Applicable to building interior lighting and landscape lighting, including tenant lighting provision. Carpark and emergency lighting shall be excluded from the calculation.

Assessment

The Energy Performance Points Calculator shall be used to calculate the percentage improvement of the building's weighted lighting power budget against the code baseline in *SS 530: 2014 - Code of Practice for Energy Efficiency Standard for Building Services and Equipment*. A maximum of 3 points can be scored as follows:

- Points scored = 0.1 x (% improvement from baseline)

The lighting should be designed to the recommended lux levels in *SS 531 – 1: 2006 (2013)– Code of Practice for Lighting of Workplaces*.

2.1c Carpark System Efficiency

Intent

The use of energy efficient carpark ventilation and lighting systems can reduce the energy needed for carpark operations.

Scope

Applicable to buildings with carparks. For building projects with no and open carpark, full points can be scored here.

Assessment

The Energy Performance Points Calculator shall be used to generate the savings of the carpark lighting and ventilation systems against code. A maximum of 2 points can be scored as follows:

- Points scored = $0.05 \times (\% \text{ improvement from baseline})$

2.1d Receptacle Load Efficiency

Intent

The use of energy efficient receptacle equipment can reduce their energy consumption.

Scope

Applicable to non-speculative buildings.

Assessment

Where the procurement of energy efficient receptacle plug loads and process equipment can be committed and quantified at the design stage, their aggregate savings against BCA's reference receptacle power budget can be generated using the Energy Performance Points Calculator. A maximum of 1 point can be scored as follows:

- Points scored = $0.025 \times (\% \text{ improvement from baseline}) \times (\% \text{ of functional areas})$

2.1e Building Energy

Intent

Encourage effective design of building systems to reduce building's overall energy consumption.

Scope

Applicable to all buildings.

Assessment

The Energy Performance Points Calculator* shall be used to generate the percentage improvement of the design energy consumption of the base building against the notional reference. The consumption should exclude carpark and receptacle loads. A maximum of 11 points can be scored as follows:

- **Points scored** = $\frac{\% \text{ improvement from baseline}}{3}$

**Note: In addition to the Energy Performance Points Calculator, energy modeling (for buildings with air-conditioned areas $\geq 5000\text{m}^2$) or detailed calculations (for buildings with air-conditioned area $< 5000\text{m}^2$) shall be performed to demonstrate that minimum energy savings for Gold^{PLUS} and Platinum ratings are met, as per 0. Pre-requisite Requirements.*

Further Improvement in Design Energy Consumption (Advanced Green Efforts)



Beyond the points cap, further points can be scored for improvement of the design energy consumption against the notional reference based on the above formula, up to a maximum of 2 points.

Option 2: Performance-Based Computation (22 points)

2.1f Space Conditioning Performance

Intent

Efficient use of energy to maintain a thermally acceptable indoor environment, by effective design of natural ventilation, energy efficient mechanical ventilation and air-conditioning systems.

Scope

Applicable to all air-conditioning and ventilation systems design to maintain thermal comfort, including the air distribution equipment and mechanical ventilation systems.

Assessment

Up to 10 points can be scored based on the systems to achieve the intended thermal comfort of the spaces, prorated by functional areas (excluding circulation, plant rooms and transit areas). Improvement is calculated based on system efficiency of conditioning systems used in the project, against the code baseline. Project can use single mode of ventilation for scoring if more than 90% of the functional space uses one mode of ventilation.

Up to 10 points based on proration of functional spaces

Mode of ventilation	Scoring methodology																	
Natural Ventilation	6 points for design for natural ventilation Up to 4 points based on scoring in section 1.3c																	
Mechanical Ventilation	<div>Efficient mechanical ventilation design</div> <div>Point scored = 0.15 x % improvement from baseline stated in SS553.</div> <table><tr><td>Systems</td><td colspan="2">Constant Volume & Variable Volume</td></tr><tr><td>Fan systems with nameplate motor power</td><td>≥ 4kW</td><td>< 4kW</td></tr><tr><td>Option 1: Fan system motor nameplate</td><td>0.35</td><td>No baseline</td></tr><tr><td>Option 2: Fan system input</td><td></td><td></td></tr><tr><td>*Applicable pressure drop adjustments can be considered based on SS553 in accordance to GM NRB: 2015 Technical Guide and Requirements, subjected to BCA's evaluation</td><td>0.3</td><td>0.17</td></tr></table>			Systems	Constant Volume & Variable Volume		Fan systems with nameplate motor power	≥ 4kW	< 4kW	Option 1: Fan system motor nameplate	0.35	No baseline	Option 2: Fan system input			*Applicable pressure drop adjustments can be considered based on SS553 in accordance to GM NRB: 2015 Technical Guide and Requirements, subjected to BCA's evaluation	0.3	0.17
Systems	Constant Volume & Variable Volume																	
Fan systems with nameplate motor power	≥ 4kW	< 4kW																
Option 1: Fan system motor nameplate	0.35	No baseline																
Option 2: Fan system input																		
*Applicable pressure drop adjustments can be considered based on SS553 in accordance to GM NRB: 2015 Technical Guide and Requirements, subjected to BCA's evaluation	0.3	0.17																
Air-Conditioning	<div>Up to 9 points for efficient air-conditioning system</div> <table><tr><td rowspan="4">Baseline</td><td colspan="2">Peak Building Cooling Load (RT)</td></tr><tr><td><500 RT</td><td>≥500RT</td></tr><tr><td colspan="2">Total Design System Efficiency (kW/RT)</td></tr><tr><td>1.08</td><td>0.98</td></tr></table> <div>Points scored = 0.4 x (% improvement from baseline)</div> <div>*TDSE refers to combined efficiency of the cooling and air distribution components</div> <div>*For district cooling plants under Path B scenario, where the plant is excluded from the computation, the baseline reference for the building air distribution equipment can be taken as 0.28 kW/ton for the purposes of points computation here.</div>			Baseline	Peak Building Cooling Load (RT)		<500 RT	≥500RT	Total Design System Efficiency (kW/RT)		1.08	0.98						
Baseline	Peak Building Cooling Load (RT)																	
	<500 RT	≥500RT																
	Total Design System Efficiency (kW/RT)																	
	1.08	0.98																

Efficient Space Conditioning Energy Design (Advanced Green Efforts)



- Up to 1 point for achieving highly efficient air-conditioning design
 - 1 point for achieving 0.65kW/ton TDSE
 - 0.5 point for achieving 0.70kW/ton TDSE

* For buildings tapping on district cooling plants under Path A scenario, it will include district cooling system efficiency as well as air and water distribution efficiency of the building.

* Not applicable to buildings tapping on district cooling plants under Path B scenario.

2.1g Lighting Performance

Intent

The use of energy efficient lighting can reduce the energy needed to illuminate a space.

Scope

Applicable to building interior lighting and landscape lighting, including tenant lighting provision and carpark lighting. Emergency lighting shall be excluded from the calculation.

Assessment

Up to 6 points can be scored for energy efficient lighting design (including carpark lighting) based on percentage improvement of the building's weighted lighting power budget against the code baseline in *SS 530 : 2014 - Code of Practice for Energy Efficiency Standard for Building Services and Equipment*.

- Points scored = $0.17 \times (\% \text{ improvement from baseline})$

The lighting should be designed to the recommended lux levels in *SS 531 – 1: 2006 (2013) – Code of Practice for Lighting of Workplaces*.

Efficient Lighting Design (Advanced Green Efforts)



- Up to 1 point for achieving highly efficient lighting design
 - 1 point for 50% improvement
 - 0.5 point for 40% improvement

2.1h Building Systems Performance

Intent

Encourage effective design of building systems other than space conditioning systems and lighting systems to reduce building's overall energy consumption.

Scope

Applicable to all buildings.

Assessment

Up to 6 points can be scored for achieving lower building energy through lower receptacle load, more efficient carpark ventilation and energy efficient practices and features.

(i) Receptacle Load Efficiency

Where the procurement of energy efficient receptacle plug loads and process equipment can be committed and quantified at the design stage, their aggregate savings against BCA's reference receptacle power budget, as specified under can be computed against baseline receptacle load value. A maximum of 2 point can be scored as follows:

Receptacle loads	Nominal Values
Computer Intensive Office	22W/m ²
General office areas	16W/m ²
Large conference areas	11W/m ²
Schools (Tertiary/IHLs)	8W/m ²
Schools (Primary/Secondary)	5W/m ²
Server/Computer rooms	540W/m ²

- Points scored = $0.05 \times (\% \text{ improvement from baseline}) \times (\% \text{ of functional areas})$

(ii) Car Park Ventilation Energy

Up to 1.5 point can be scored by prorating mode of ventilation for carpark and achieving least energy consumption for carpark's ventilation systems against code.

Ventilation Mode	Mechanical Ventilation (Up to 1.25 points)		Natural Ventilation (1.5 points)
	Without CO sensor/without Fume Extract	With CO sensor / Fume Extract	
Points	Point scored = $0.015 \times \% \text{ improvement from baseline}$ (Up to 1 point)	+ 0.25 points	1.5 points

Note: For building with no carpark, full point can be scored if building occupants is more than 10 pax.

(iii) Energy Use Intensity

0.5 point can be scored for meeting 25th percentile EUI as per prevailing BCA Building Energy Benchmarking Report (BEBR). Note that all projects will need to compute Energy Efficiency Index (EEI) and Energy Use Intensity (EUI) in kWh/m²/yr as prerequisite requirement.

(iv) Energy Efficient Practices and Features

Up to 2 points can be scored for achieving lower energy consumption with more energy efficient practices and features.

Points scored = $0.5 \times (\% \text{ improvement from baseline total building consumption})$

*Note: Hot water saving is computed based on Hot Water System Ratio (with or without heat recovery), which will consider heating energy, pumping energy and thermal losses of system.

Additional Energy Efficient Practices and Features (Advanced Green Efforts)

- Up to 2 points can be scored for further improvements.
 - 1 point for every 3% improvement above 4% improvement from baseline total building consumption
-



2.2 Renewable Energy (8 pts)

After considering energy efficiency and effectiveness, replacement of fossil energy use with renewables should also be looked into. This indicator focuses on driving the creation of opportunities for generation and utilisation of renewable energy. It aims to spur and acknowledge efforts by buildings to work towards the vision of zero energy or net positive energy low-rise buildings and low energy high-rise buildings.

Note: Renewable energy and solar energy are used synonymously here as the context of Singapore's tropical climate, coupled with limited natural resources, warrants solar energy as the most viable renewable energy option.

- 2.2a Solar Energy Feasibility Study (0.5 pt)
- 2.2b Solar Ready Roof (1.5 pts)
- 2.2c Adoption of Renewable Energy (6 pts)

2.2a Solar Energy Feasibility Study

Intent

The evaluation of a building footprint's potential in harnessing solar energy can raise awareness on viable solar opportunities in the development and assist building developers in their decision making to adopt photovoltaics.

Scope

Applicable to all building developments.

Assessment

0.5 point can be scored for a solar feasibility report detailing the following aspects:

- Roof characteristics and shading considerations
- Technical solar energy generation potential
- Economics of solar installation
- Roof access and safety requirements
- Roof spatial optimisation recommendations

2.2b Solar Ready Roof

Intent

Designing roofs to be ready for photovoltaic installation facilitates ease of their deployment should building developers decide to do so at later stages of a project/ during building operation.

Scope

Applicable to projects that scored under *2.03a Solar Energy Feasibility Study*. Where solar panels are installed under *2.03c Adoption of Renewable Energy*, the area coverage of the feasible roof area by the panels can be counted towards compliance under this indicator.

Assessment

The project shall demonstrate its roof design for solar readiness for at least 50% of feasible roof area determined through *2.3a*. 0.5 points each can be scored for the following:

- **Structural readiness:** Roof designed to accommodate optimised easy structural installation of solar panels on rooftop spaces, and included proof that the building and roof can support any additional static and wind load imposed by future PV systems
- **Electrical readiness:** Provisions to accommodate optimised easy electrical installation of solar panels on rooftop spaces
- **Spatial readiness:** Roof designed to optimise the available non-shaded rooftop area for solar panels - adoption of roof spatial optimisation recommendations outlined in *2.03a Solar Energy Feasibility Study*

2.2c Adoption of Renewable Energy

Intent

On-site generation of renewable energy can reduce the building development's power consumption from the grid and carbon emissions.

Scope

Applicable to building developments with on-site generation of renewable energy.

Assessment

The Energy Performance Points Calculator or manual calculation can be used to calculate savings from replacement of the building electricity consumption through the use of renewable energy.

Points can be scored up to a maximum of 6 points based on the following:

This will also include the use of solar hot water systems and renewable energy sources such as solar panels.

Expected Energy Use Intensity (EUI) [kWh/m ² /yr]	% Replacement of Building Electricity Consumption by Renewable Energy
≥ 220	1 point for every 0.5%
50 ≤ EUI < 220	1 point for every 1.25%
< 50	1 point for every 2.5%

Further Electricity Replacement by Renewables (Advanced Green Efforts)



Up to 5 more points can be scored for further percentage electricity replacement by renewable energy.

3.Resource Stewardship



With global use of resources increasing in the backdrop of the limited carrying capacity of the Earth, it is imperative that we work towards conserving the Earth's resources for future generations. "Resource Stewardship" in the built environment refers to the responsible use and protection of the environment through conservation and sustainable practices. This section rewards projects for the responsible use and conservation of resources from the stages of construction through to building operations and occupancy. Resources covered include water, construction materials, construction and operational waste.

P.07 + POINTSPREREQUISITES

30 POINTS

- 2.1 Water (8 pts)
- 2.2 Materials (18 pts)
- 2.3 Waste (4 pts)

Advanced Green Efforts (8 pts)

P.7 Water Efficient Fittings

Intent

The use of water efficient fittings can reduce the building's potable water consumption.

Scope

Applicable to all building developments with water fittings installed.

Assessment

The project shall demonstrate the use of water efficient fittings that meet minimum requirements as detailed in the following table:

Type of Water Fittings	Prescribed Minimum WELS rating	Applicable Areas
Basin Taps & Mixers	3 Ticks WELS rating	Public/ staff/ school toilets
	2 Ticks WELS rating	Other areas
Sink Taps & Mixers	2 Ticks WELS rating	All areas
Shower Taps, Mixers or Showerheads	2 Ticks WELS rating	Public/ staff/ school shower facilities
Dual Flush Flushing Cisterns	2 Ticks WELS rating	All areas

Exemptions can be granted on a case-by-case basis, where there are special functional needs. As for all other water fittings such as flush valves, bib taps that are not listed in the above table shall comply with the mandatory standards stipulated in the *Singapore Standard CP 48 : 2005 – Code of Practice for Water Services*.



3.1 Water (8 pts)

With increasing occurrences of droughts and dry spells attributed to varying weather phenomenon and global warming, bouts of water shortage globally are an ever imminent threat. As Singapore has limited water catchment resources, it is crucial to implement good water management in order to ensure the long term sustainability of Singapore's water system. Considering water efficient, monitoring and potable water replacement strategies in the building design can reduce potable water consumption and raise awareness on responsible use of water during building operation.

- **3.1a Water Efficient Systems (3 pts)**
- **3.1b Water Monitoring and Leak Detection (2 pts)**
- **3.1c Alternative Water Sources (3 pts)**

3.1a Water Efficient Systems

Intent

The design of water efficient mechanical systems and strategies can minimise potable water consumption in building operations.

Scope

Applicable to all buildings with landscape irrigation, cooling towers or water fittings.

Assessment

(i) Landscape Irrigation

0.5 point each can be scored for the following, maximum of 1 point:

- Every 25% of the landscape areas that are served by water efficient irrigation systems with features such as automatic sub-soil drip irrigation system with moisture or rain sensor control.
- Every 20% of the landscape areas that comprises drought tolerant plants.

(ii) Water Consumption of Cooling Towers

1 point each can be scored for the following:

- Provision of cooling tower water treatment system along with effective filtration system that can help increase solubility of water and facilitate 7 or more cycles of concentration (CoC) at acceptable water quality.
- Provision of devices that recovers waste heat from the condensers and helps reduce the water requirement needed to remove heat through the cooling towers.

Better Water Efficient Fittings (Advanced Green Effort)



- Up to 1 point can be scored should the project demonstrate the use of better WELS rated water efficient fittings
 - 0.5 points for use of better WELS rated water efficient fittings for 100% of basin taps & mixer and dual flush flushing cisterns
 - 1 point for the use of better WELS rated water efficient fittings for 100% of applicable water fittings as prescribed in P.07 whilst ensuring user requirements are not compromised.

3.1b Water Monitoring

Intent

Better control and monitoring can facilitate setting of consumption reduction targets. Making the monitored information accessible to end users can facilitate user engagement programmes and promote behavioural changes with regard to water management and use.

Scope

Applicable to all buildings with potable water usage.

Assessment

2 points can be scored under this section.

(i) Water monitoring and leak detection

0.5 point each can be scored for the following:

- Provision of private meters for all major water uses in the development
- Provision of smart remote metering system with alert features for leak detection

(ii) Water Usage Portal and Dashboard

Up to 1 point can be scored. This requires the provision of water management portal, dashboard or other equivalent forms in the form of digital displays or web-based/ mobile application. 0.5 point each can be scored for the provision of following functions in the water usage portal and dashboard:

- Display metered data, trending of water consumption (historical data) and relevant parameters which facilitate better management of water consumption during building operation.
- Enable individual tenants/space to monitor their own water usages and consumption. Information will include monthly consumption of 50th percentile line of the tenants/space, based on operating hours, within the buildings. The information could also include 25th and 75th percentile line to facilitate understanding of consumption range.

3.1c Alternative Water Sources

Intent

The use of alternative water sources can reduce potable water consumption for general application and use.

Scope

Applicable to all buildings with potable water usage.

Assessment

Where alternative water sources are used for general application, for example landscape irrigation, toilet flushing, cooling tower make-up water or washing of external areas/ carpark areas, up to a maximum of 3 points can be scored based on the types of water recycling systems used as well as the extent of reduction in potable water usage:

- AHU condensate collection where > 50% of total condensate is collected – 1 point
- NEWater supply – 1 point
- On-site recycled water – 1 point
- Rainwater harvesting – 1 point



3.2 Materials (18 pts)

Buildings are resource intensive in their construction and fit-out, and incur a significant carbon footprint. Adopting sustainable construction design and practices, considering embodied energy from a life cycle approach as well as giving priority to sustainable fit-out systems can reduce the environmental impact of the building.

- 3.2a Sustainable Construction (8 pts)
- 3.2b Embodied Carbon (2 pts)
- 3.2c Sustainable Products (8 pts)

3.2a Sustainable Construction

Intent

To encourage the adoption of building designs, building structures and construction practices that are environmentally friendly and sustainable.

Scope

Applicable to all structural and non-structural components constituting the building superstructure.

Assessment

(i) Conservation and Resource Recovery

For projects built on sites with existing building structures, 1 point can be scored where either:

- The existing structures are conserved and not demolished.
- The existing structures are demolished with an enhanced demolition protocol, where a recovery rate of > 35% crushed concrete waste from the demolished building is sent to approved recyclers with proper facilities.

(ii) Resource Efficient Building Design

Up to 4 points can be scored here:

Concrete Usage Index (CUI): Points scored are as follows:

Project's CUI (m ³ /m ³)	Points
≤ 0.60	0.5
≤ 0.50	1
≤ 0.45	1.5
≤ 0.40	2
≤ 0.35	2.5

Adoption of sustainable building systems: Points can also be scored based upon the extent of use of sustainable building systems as a percentage of the constructed floor area (CFA) as follows:

Sustainable Building Systems	Points awarded		
	0.5 points	1.0 point	1.5 points
Pre-stressed Concrete Elements	Total coverage area ≥ 25% of CFA	Total coverage area ≥ 50% of CFA	Total coverage area ≥ 75% of CFA
Hollow Core or Voids Concrete Elements			
Light Weight Concrete Elements			
High Strength Concrete Elements (Concrete grade >60MPa)			
Structural Steel Elements			
Composite Structural Elements			
Engineered Timber Elements			
Prefabricated Prefinished Volumetric Construction units			
Precast Concrete Elements			
Leave-in Formwork			
Others (to be accepted by BCA on case-by-case basis)			

Use of BIM to calculate CUI (Advanced Green Effort)



1 point can be scored where BIM is used to compute CUI.

(iii) Low Carbon Concrete

A maximum of 3 points can be scored here.

Clinker content – Points can be scored for the use of concrete containing clinker $\leq 400 \text{ kg/m}^3$ for grades up to C50/60 for $\geq 80\%$ of the applicable superstructural concrete by volume as follows.

Concrete Categories*	Points
Uncertified concrete	0.5
SGBC-certified 1-Tick concrete	1.0
SGBC-certified 2-Tick concrete	1.5
SGBC-certified 3-Tick concrete	2.0

*Note: SGBC-certified concrete is deemed to have fulfilled the requirement of clinker content $\leq 400 \text{ kg/m}^3$

Replacement of coarse and fine aggregates – 0.5 point can be scored for every 5% replacement by mass of coarse and fine aggregates with recycled concrete aggregates (RCA) and/ or washed copper slag (WCS) from approved sources for the superstructure concrete mix. The usage should not fall below $1.5\% \times \text{GFA}$ for RCA and/ or $0.75\% \times \text{GFA}$ for WCS for points scoring.

Use of Advanced Green Materials (Advanced Green Effort)



- 0.5 point can be scored for use of SGBC-certified 4-Tick concrete, as per above.
- 0.5 point can be scored for use of SGBC-certified reinforcement bars for structural reinforced concrete elements, for more than 80% of the applicable superstructure elements by volume.

3.2b Embodied Carbon

Intent

BCA's Carbon Calculator is a tool to help developments identify their carbon debt and quantify their environmental impact and embodied energy, as well as allow benchmarking of projects over time.

Assessment

A maximum of 2 points can be scored for the use of BCA Carbon Calculator to compute the embodied carbon footprint of the development:

- Declaration of Concrete, Glass and Steel – 1 point
- Declaration of additional materials – Up to 1 point (0.25 pt per material)

Provide Own Emission Factors with Source Justification (Advanced Green Efforts)

Up to 1 point can be scored for the provision of own material emission factors (0.25 pt per material).

Compute the Carbon Footprint of the Entire Development (Advanced Green Efforts)

2 points can be scored for computation of the carbon footprint of the entire development and a detailed carbon footprint report based on all the materials used within the development.

3.2c Sustainable Products

Intent

The environmental performance of materials covered here includes their recycled content and environmental impact during production and resource extraction. The intent is to encourage the specification of resource efficient and environmentally friendly products for use in the fit-out of a building, taking a functional system approach to focus on greening major fit-out materials whilst allowing for flexibility in design as well as recognising designs with optimal/ minimal material use.

Scope

Applicable to non-structural building components. Structural components are excluded.

Assessment

A maximum of 8 points can be scored for (i) and (ii).

(i) Functional Systems

Points can be awarded for the specification and use of green products certified by approved local certification bodies, namely the Singapore Green Building Council and the Singapore Environment Council, within the 6 main functional system categories of the building as follows:

Non-Speculative Buildings/ Speculative Buildings with Tenanted Areas Included

Functional System Category	External Wall	Internal Wall	Flooring	Doors	Ceiling	Roofing
Base Group (Coverage: $\geq 60\%$)	1 pt	1 pt	1 pt	1 pt	0.5 pt	0.5 pt
Finishes Group (Coverage: $\geq 60\%$)	2 pt	2 pt	2 pt	0.5 pt	0.5 pt	0.5 pt

Speculative Buildings with Tenanted Areas Excluded

Functional System Category	External Wall	Internal Wall	Flooring	Doors	Ceiling	Roofing
Base Group (Coverage: $\geq 80\%$)	1 pt	0.5 pt	0.5 pt	0.5 pt	0.25 pt	0.5 pt
Finishes Group (Coverage: $\geq 80\%$)	2 pt	1 pt	1 pt	0.25 pt	0.25 pt	0.5 pt

All products (only if used) within a Group for the stipulated coverage must be green certified to score for that Group. Additionally, in order to score for a Finishes Group, projects must score for the respective Base Group first. Detailed examples may be found in the *GM NRB: 2015 Technical Guide and Requirements*.

(ii) Singular Sustainable Products outside of Functional Systems

Where sustainable hardscape, building services and M&E products certified by an approved local certification body are used, 0.25 point can be scored per product for $\geq 80\%$ of the applicable use, maximum of 2 points.

Sustainable Products with Higher Environmental Credentials (Advanced Green Effort)



Up to 2 points can be scored for the use of products certified to higher tiers of environmental performance (per product).

Singapore Green Building Product Certification Rating	Points per product ($\geq 80\%$ of the applicable use)
Very Good (2-ticks)	0.25
Excellent (3-ticks)	0.5
Leader (4-ticks)	1.0



3.3 Waste (4 pts)

It is estimated that 2.2 billion tonnes of waste will be generated globally in 2025 (*Source: World Bank*). Singapore's output of solid waste has increased significantly over the years, from 1,260 tonnes per day in 1970, to a high of 8,402 tonnes per day in 2015 (*Source: NEA*). Waste is an indicator of excess as it means we are using more than we need and depleting precious raw materials which could be by our future generations. To minimise waste generation it is crucial to use resources (other than building materials) consumed during the construction process efficiently, as well as provide adequate facilities and systems to manage waste during building operation.

- 3.3a Environmental Construction Management Plan (1 pt)
- 3.3b Operational Waste Management (3 pts)

3.3a Environmental Construction Management Plan

Intent

An effective and holistic management plan can facilitate better environmental performance of the construction process and promote waste minimisation.

Scope

Applicable to all buildings.

Assessment

1 point can be scored for effective implementation of an environmental construction management plan on construction sites through specific target setting, monitoring of energy and water use and construction waste minimisation measures.

3.3b Operational Waste Management

Intent

Appropriate collection and recycling provisions can facilitate the segregation of recyclable consumer waste at source. Provisions for the treatment of horticultural or wood waste for buildings with landscaping can promote their reuse and recycling as well.

Scope

Applicable to all buildings.

Assessment

1 point each can be scored for the provision of the following:

- Facilities for the collection and storage of different recyclables such as paper, glass, metal and plastic in commingled or sorted form.
- Facilities or systems for food waste to be treated and recycled, for buildings generating large volumes of food waste.
- Facilities or systems for the placement of horticultural or wood waste for recycling.

The recycling facilities or systems provided should be applicable to the building type and occupancy base and located at the convenience of use for building users.

4. Smart and Healthy Building



Most of us spend a substantial proportion of our time within buildings, where we are psychologically, physiologically and emotionally affected by our surrounding environment. Aspects of a healthy indoor environment include better air quality, effective daylighting, quality artificial lighting, pleasant acoustics, inclusivity as well as biophilic design features that evokes the experience of nature. Designing for healthy buildings can be a sound economic investment that reaps healthy economic returns, with measures to improve the indoor environment leading to manifold monetary savings from improved health and well-being. A healing, positive environment nurtures healthier and happier occupants. In spaces where people work and study, this can result in increased work quality and productivity output. For social, recreational and commercial spaces, this can translate to an enhanced consumer/ visitor experience and encourage more frequent patronage and human traffic.

At the same time, managing a building's indoor environmental quality well necessitates operating the building smartly. Smart controls, direct access to building data and early fault detection allow the facility management team to gain a good understanding of the building's health. This enables necessary intervention and optimisation measures to suit the occupants' health and well-being.

P.8 - P.15 + POINTSPREREQUISITES 30 POINTS

2.4 Indoor Air Quality (10 pts)

2.5 Spatial Quality (10 pts)

2.6 Smart Operations (10 pts)

Advanced Green Efforts (10 pts)

P.8 Thermal Comfort

Intent

The air-conditioning system should be designed to serve its intended purpose of providing a thermally comfortable space for occupants.

Scope

Generally applicable to all air conditioning systems serving occupied spaces of building developments.

Assessment

The normal design dry-bulb temperature for comfort air-conditioning shall be within 23°C - 25°C, and resultant relative humidity $\leq 65\%$ in accordance with SS 553 : 2016 - *Code of Practice for Air-Conditioning and Mechanical Ventilation in Buildings*.

P.9 Minimum Ventilation Rate

Intent

The provision of adequate ventilation in a building is of fundamental importance to ensure the health of the occupants. Insufficient ventilation can cause a build-up in the concentration of carbon dioxide and other contaminants emitted indoors.

Scope

Applicable to air-conditioning or mechanical ventilation systems in regularly occupied spaces of all building developments.

Assessment

The building's air-conditioning and mechanical ventilation systems shall be designed to provide appropriate minimum quantum of outdoor air rates as stated in Table 1 and Table 5 of SS 553 : 2016.

P.10 Filtration Media for Times of Pollution

Intent

The effective removal of harmful pollutants in outdoor air from the building ventilation system through high efficiency filters can enhance indoor air quality and the health and well-being of the occupants.

Scope

Applicable to air handling units (AHUs) or systems for dedicated treatment of outdoor air in air-conditioned building developments.

Assessment

AHUs or dedicated outdoor air units in the building shall be designed to accommodate fine dust filters of least a rating of Minimum Efficiency Reporting Value (MERV) 14 (ASHRAE 52.2: 2012) or F8 (EN779: 2012), when the outdoor pollution level is in the unhealthy range in accordance with MOH's guidelines, as stipulated in SS 553 : 2016.

P.11 Low Volatile Organic Compound (VOC) Paints

Intent

Limiting the use of high-emitting building and furnishing materials can improve the indoor environmental quality for the health and well-being of occupants.

Scope

Applicable to all indoor paints including primers, sealers, base coats and top coats.

Assessment

Low VOC paints certified by an approved local certification body shall be used for at least 90% of the total painted internal wall areas.

P.12 Refrigerants

Intent

Controlling the use and release of ozone depleting substances and greenhouse gases can reduce their potential damage to the ozone layer and curb global warming.

Scope

Applicable to all air conditioning systems within building developments.

Assessment

Air conditioning systems shall use refrigerants with ozone depleting potential (ODP) of 0 or global warming potential (GWP) of less than 100.

A refrigerant leak detection system shall also be installed in critical areas of plant rooms containing chillers and/ or other equipment using refrigerants.

P.13 Sound Level

Intent

Minimising noise and vibration from mechanical and electrical equipment can ensure a basic level of acoustic comfort for occupant health and wellbeing.

Scope

Applicable to mechanical and electrical equipment serving occupied spaces of building developments.

Assessment

The relevant equipment as aforementioned shall be designed to comply with the recommended ambient sound levels in Table 4 of *SS 553 : 2016*.

P.14 Permanent Instrumentation for the Measurement and Verification of Chilled Water Air-Conditioning Systems

Intent

Better energy management and monitoring of chilled water air-conditioning systems can ensure their operational efficiency can be optimised and maintained throughout the equipment lifespan.

Scope

Applicable to chilled-water air-conditioning systems serving the building with aggregate cooling capacity exceeding 30 kW. This applies also to district cooling systems (DCS) operated by suppliers of district cooling services registered under the Energy Conservation Act.

Assessment

Permanent measuring instruments for monitoring of chilled-water system (water cooled and air-cooled system) operating efficiency shall be provided. The installed instrumentation shall have the capability to calculate the resultant operating system efficiency (i.e. kW/RT) within 5% of its true value and in accordance with SS591. Each measurement system shall include the sensor(s), any signal conditioning, the data acquisition system and wiring connecting these components. The permanent instrumentation shall comply with the following:

- Location and installation of the measuring devices to meet the manufacturer's recommendation; location of temperature sensors should be within reach to facilitate site verification
- All data logging with capability to trend at 1-minute sampling time interval, and recorded to the 3rd decimal digit
- Computation and display of air-side efficiency, water-side efficiency and total system efficiency.
- Magnetic in-line flow meter, with 1% uncertainty and capable of electronic in-situ verification to within $\pm 2\%$ of its original factory calibration. If installation of magnetic in-line meters is not possible, ultrasonic flow meters or other flow meters that can meet the indicated performance may be used.

- Temperature sensors are to be provided for chilled water and condenser water loop and shall have an end-to-end measurement uncertainty not exceeding $\pm 0.05^{\circ}\text{C}$ over the entire measurement range. Provisions shall be made for test-plugs or additional thermowells to be installed before and after each temperature sensor along the chilled water and condenser water lines for verification of measurement accuracy. All thermo-wells are recommended to be installed in a manner that ensures the sensors can be in direct contact with the fluid flow. There shall be valid justification if direct immersion of the temperature sensor(s) is/are not possible. Such projects will be assessed on a case-by-case basis.
- Dedicated power meters (of IEC Class 1 or better) and metering current transformers, where applicable, of Class 1 or better, are to be provided for each of the following groups of equipment where applicable: chillers, chilled water pumps, condenser water pumps, cooling towers, air distribution sub-system (i.e. AHUs, PAHUs, FCUs)
- A heat balance substantiating test for the water-cooled chilled-water system is to be computed in accordance to SS 591 for verification of the accuracy of the M&V instrumentation. The heat balance shall be computed over the entire normal operating hours with more than 80% of the computed heat balance within $\pm 5\%$ over a 1-week period. Heat balance readings should generate automatically from BMS/BAS.

P.15 Electrical Sub-Metering & Monitoring

Intent

Monitoring major energy uses in the building can enable audit and continuous improvement to optimise use and avoid energy wastage.

Scope

Applicable to all building developments with GFA of 5,000m² or more.

Assessment

Subsystem measurement devices with remote capability shall be provided, linked to a monitoring system and measure and trend energy consumption data of:

- Each of the following energy sub systems:

Use (Sum of all loads)	Sub-systems thresholds
Lift & escalator	Sum of all feeders > 50 kVA
Heater, including heat pump	> 50 kWth
Process loads	Connected loads > 50 kVA Connected gas or district services load > 75 kW
Mechanical ventilation	The subsystem's load > 15kW
VRF systems (CUs, FCUs)	No threshold

- Each tenancy or floor, as well as high energy load areas exceeding 50kVA such as car park, data centres, IT closets and process areas.



4.1 Indoor Air Quality (10 pts)

Contemporary research has shown that poor air quality is an attributing factor to sick building syndrome symptoms and respiratory illnesses, which can have detrimental effects on business productivity and performance as well as the wellbeing of the occupants. As people spend longer hours in buildings, research has also indicated that the cost of poor indoor environmental quality could well be even higher than most other costs. It is important to ensure good air quality to reduce the risk of illnesses within building occupied spaces where occupants are expected to work or remain in for an extended period of time.

- 4.1a Occupant Comfort (2 pts)
- 4.1b Outdoor Air (3 pts)
- 4.1c Indoor Contaminants (5 pts)

4.1a Occupant Comfort

Intent

The testing and evaluation of indoor air quality parameters is crucial to ensure occupant comfort. Engaging building occupants completes the feedback loop, and is essential for the management and improvement of operational practices in high-performing green buildings.

Scope

Applicable for normally occupied spaces air-conditioned for comfort purposes.

Assessment

(i) Indoor Air Quality (IAQ) Surveillance Audit

0.5 point can be scored for an IAQ surveillance audit conducted by an accredited laboratory under Singapore Accreditation Council with respect to the recommended IAQ parameters and acceptable limits stated in Table 1 of SS554: 2016 Code of Practice for Indoor Air Quality for Air-Conditioned Buildings, and committed to be conducted for the building within one year after occupancy or after reasonable occupancy has been reached.

1 point can be scored if the above IAQ surveillance audit is conducted based on the reference methods stated in Table 1 of SS554: 2016.

The spreadsheet of the standardised IAQ report template is available at:

- https://www.bca.gov.sg/GreenMark/others/IAQ_report_template.xlsx

(ii) Post Occupancy Evaluation

0.5 point can be scored if a Post Occupancy Evaluation (POE) questionnaire is committed to be conducted within a year after building occupancy or after reasonable occupancy has been reached to assess occupant wellbeing and interactions with their indoor environment. Appropriate corrective actions should also be committed to be taken to improve the quality of the indoor environmental conditions if required.

The spreadsheets of the standardised POE survey questionnaire and results are available at:

- https://www.bca.gov.sg/GreenMark/others/POE_survey_template.xlsx
- https://www.bca.gov.sg/GreenMark/others/POE_results_template.xlsx

(iii) Indoor Air Quality Display

0.5 point can be scored for the provision of display panels for temperature and relative humidity information at each floor/ tenancy, to raise awareness among building occupants on the internal conditions of the space.

Indoor Air Quality Trending (Advanced Green Effort)



Up to 2 points can be scored for the provision of monitoring and trend logging for the following:

- Provision for monitoring and trend logging of temperature and relative humidity through a centralised system – 0.5 point
- Provision for monitoring and trend logging of common indoor air pollutants, such as formaldehyde, at each floor - 1.5 point

4.1b Outdoor Air

Intent

Provision of adequate and proper ventilation in conditioned spaces to prevent build-up in the concentration of contaminants.

Scope

Applicable to all building developments with air conditioning systems supplying outdoor air to occupied spaces. Full points can be scored here for buildings with no air-conditioned spaces.

Assessment

(i) Ventilation Rates

A maximum of 1.5 points can be scored for the:

- Measurement and monitoring of outdoor airflow volume in accordance with desired ventilation rates at precool units (e.g. PAHUs and PFCUs) or all AHUs and FCUs - 0.5 point or 1 point respectively
- Use of demand control ventilation strategies such as carbon dioxide sensors or equivalent devices to regulate the quantity of fresh air and ventilation in accordance with the space requirements – 0.5 point

(ii) Enhanced Filtration Media

0.5 point or 1 point can be scored for the permanent provision of Minimum Efficiency Rating Value (MERV 14, ASHRAE 52.2 or F8/ EN779 class of filter or equivalent) to all PAHUs or to all PAHUs and AHUs respectively.

(iii) Dedicated Outdoor Air System

0.5 point can be scored for the provision of a dedicated outdoor air system, such as precool units, to encourage effective treatment of outdoor air for cooling and dehumidification.

4.1c Indoor Contaminants

Intent

Indoor contaminant pollution control at source and air treatment strategies can safeguard the health of building occupants.

Scope

Applicable to buildings with relevant ventilations systems.

Assessment

(i) Local Exhaust and Air Purging System

1 point each can be scored for the provision of:

- Local isolation and exhaust systems to remove the source of pollutants
- Air purging system to replace contaminated indoor air with outdoor fresh air

(ii) Ultraviolet Germicidal Irradiation (UVGI) System

0.5 point can be scored for the provision of UVGI system in AHUs and FCUs to control airborne infective microorganisms.

(iii) More Stringent VOC Limits for Interior Fittings and Finishes

A maximum of 2 points can be scored through the specification and use of products certified SGBP Very Good or above, which meet more stringent VOC emission limits. All products used in the respective Functional System with coverage of $\geq 80\%$ of applicable areas must be SGBP Very Good or above to qualify for GM points for respective system.

- On interior fittings such as system furniture, cabinetry etc
- On wall or floor finishes as part of the functional system

Functional System					Other Systems
External Wall	Internal Wall	Internal Flooring	Ceiling	Doors	Fixed furniture/ system furniture
1 pt	1 pt	1 pt	1 pt	0.5 pt	0.5 pt

Note: For finishes, the combination of components that make out the finishes level of the functional system shall meet the criteria. Where bare finishes were to be used as part of the design for the operation of the building, this will apply to the final coat of treatment on the bare finish, be it protective coating or sealer or paint. If absolute no finishes are used, this criterion is not applicable unless the base finish is ascertained to meet the higher stringent standard on VOC contaminant.

(iv) Use of Persistent Bio-cumulative and Toxic (PBT) free lighting

0.5 point can be scored for the use of PBT-reduced or free luminaries for $\geq 90\%$ of light fittings in the project.

Zero ODP Refrigerants with Low Global Warming Potential (Advanced Green Effort)



Points can be scored for the use of refrigerants with Ozone Depleting Potential (ODP) of 0 as well as low global warming potential (GWP) as follows:

- GWP < 750 - 0.5 point or
- GWP < 10 - 1 point



4.2 Spatial Quality (10 pts)

The spatial quality of a building is assessed through the experiential value of both the physical and social qualities of the spaces within the development. Although many spatial quality indicators are qualitative, there are a number of commonly agreed upon indicators that act as a reliable proxy to determine the projects spatial quality which can enhance the indoor environment and wellbeing of the occupants and visitors to the building. These include creating access to quality daylight and artificial lighting, ensuring spaces are acoustically comfortable and inclusive as well as incorporating design features that evoke a connection to nature.

- 4.2a Lighting (6 pts)
- 4.2b Acoustics (2 pts)
- 4.2c Wellbeing (2 pts)

4.2a Lighting

Intent

Natural lighting has been linked to the positive mental wellbeing of building occupants. It connects enclosed indoor environments with the external natural environment. In the tropics, special care must be taken to maximise effective daylight while minimising visual discomfort and maintaining the façade's thermal efficiency. This is made possible by incorporating effective daylight design strategies at the beginning of the design process. Where daylight is not possible, adherence to minimum quality standards for artificial lighting provisions ensures well-lit and comfortable spaces for occupants.

Scope

Applicable to common spaces and occupied spaces of building developments.

Assessment

Up to 6 points can be scored for the following:

(i) Effective daylighting for common areas

Effective daylighting for common areas – 2 points

Up to 2 points can be scored by prorating the number of daylit transient common spaces with effective automatic lighting controls against the total number of applicable spaces.

Note: Each toilet is counted as 0.5.

1.5 points for % count with daylighting for toilets, staircases, corridors, lift lobbies and atriums-

0.5 point for % areas of carpark with daylighting or having no carpark.

(ii) Effective daylighting for occupied spaces

Effective daylighting for occupied spaces – 4 points

Method	Percentage of occupied spaces with access to effective daylighting (3 points)	Effective Mitigation of Overlit Areas (1 point)										
Pre-Simulated Daylight Availability Tables: Simplified method for standard designs to guide concept stage design in identifying design strategies for optimised daylight design.	Points can be scored as follows based on the percentage of total occupied areas* that can achieve the specific Daylight Autonomy (DA) requirement of $DA_{N\ 1x,50\%}$ (without overlighting), as outlined in the <i>Green Mark NRB: 2015 Technical Guide and Requirements Annex B: Effective Daylighting Simulation and Pre-Simulated Daylight Availability Tables Methodology and Requirements</i> . Effectively daylit areas shall be integrated with automated lighting controls.	1 point can be scored for the adoption of suitable mitigation strategies for overlit spaces, such as blinds which are controlled with daylight sensors, variable opacity glazing (electrochromic glass, thermochromic glass), bi-level glazing (glazing with higher VLT for higher level glazing and glazing with lower VLT for lower level glazing) and fitted glazing.										
Daylight Simulation: Performance-based method for non-standard/ complex designs.	<table><tr><th>Percentage</th><th>Points</th></tr><tr><td>15 to < 35 %</td><td>0.5</td></tr><tr><td>35 to < 55 %</td><td>1</td></tr><tr><td>55 to < 75 %</td><td>2</td></tr><tr><td>≥75%</td><td>3</td></tr></table> <p>* Note: exclude special rooms that cannot have daylighting due to operation needs.</p>	Percentage	Points	15 to < 35 %	0.5	35 to < 55 %	1	55 to < 75 %	2	≥75%	3	1 point can be scored where mitigation measures to effectively address overlighting are included into the simulation model in accordance with <i>Annex B</i> .
Percentage	Points											
15 to < 35 %	0.5											
35 to < 55 %	1											
55 to < 75 %	2											
≥75%	3											

(iii) Quality of Artificial Lighting

Points can be scored for the following attributes of lighting used in occupied spaces, maximum of 1 point (90% of the applicable functional areas should be served by the relevant luminaires to score):

- Good light-output over life with a minimum lifespan rating of $L70 \geq 50,000$ life hours - 0.5 point
- Lighting designed to avoid flicker and stroboscopic effects, by using high frequency ballasts for fluorescent luminaires and LED lighting with $\leq 30\%$ flicker - 0.5 point
- Meeting the minimum colour rendering index (Ra or CRI) in Clause 5 of *SS 531 – 1 : 2006 (2013) – Code of Practice for Lighting of Workplaces* - 0.5 point
- LED Luminaires certified under SGBP scheme - 1 point

4.2b Acoustics

Intent

An improved acoustical performance for normally occupied spaces can enhance the aural comfort of its occupants, facilitating communication, reducing unwanted sound and aiding in speech privacy.

Scope

Applicable to occupied spaces of building developments.

Assessment

(i) Sound Transmission Reduction

0.5 point can be scored for projects that demonstrate that the acoustic performance of the internal partitions between adjoining spaces will be constructed to achieve the following performance levels:

Description	Sound Transmission Class (STC)
Between general office spaces	40 - 50
Spaces where confidential speech are required/ Between mechanical and equipment spaces and occupied spaces:	50 – 60

Equivalent sound transmission metrics may also be used to qualify the range.

(ii) Acoustic Report

1.5 points can be scored for an acoustic design and verification report adhering to the requirements in the *GM NRB: 2015 Technical Guide and Requirements*.

4.2c Wellbeing

Intent

Wellbeing refers to the state of being comfortable, healthy or happy. Providing nurturing, healing and inclusive spaces can enhance the building occupant and user's environment, and overall wellbeing. This includes integrating within buildings places of respite, nature access, architecture that invoke a connection to nature as well as accessible and inclusive spaces.

Scope

Applicable to all building developments.

Assessment

A maximum of 2 points can be scored for the following:

(i) Biophilic Design

Points can be scored for architecture that reinforces the attributes and experience of nature to nurture the human-nature relationship:

- The provision of accessible sky gardens, sky terraces, internal courtyards and rooftop gardens as areas for respite – 1 point
- The provision for at least 5% of the common areas or functional spaces to have fixed indoor planting – 0.5 point
- Building design that adopt biomimicry designs – 1 point
- Building design that takes after any natural shapes and forms/ creates ecological attachment to the place – 0.25 point
- Provision of images of nature for 5% of common areas – 0.25 point

(ii) Universal Design (UD) Mark

The BCA UD Mark accords recognition to developments that adopt a user-centric philosophy in their design, operations and maintenance. Points can be scored for projects being awarded either:

- UD Mark Certified/ Gold Award – 0.5 point
- UD Mark Gold^{PLUS}/ Platinum Award – 1 point



4.3 Smart Building Operations (10 pts)

The use of automation, data and behavioural science can enable building professionals to optimise equipment and related processes in order to maintain equipment efficiency and building comfort requirements. A three-level taxonomy is defined to classify the maturity of smartness as a framework, namely basic monitoring of data, using feedback from data to control demand, and finally advanced integration and analytics of data. Additionally, a proper handover to the facilities and operations team is of fundamental importance to ensure that the systems work as per their intended function and that sustainable design is translated into actual operational performance.

- 4.3a Energy Monitoring (3 pts)
- 4.3b Demand Control (3 pts)
- 4.3c Integration and Analytics (3 pts)
- 4.3d System Handover and Documentation (1 pt)

4.3a Energy Monitoring

Intent

Tracking a building's energy use with the data presented in a relevant manner to engage its occupants can have an effect in helping to manage building energy consumption. Related to this ideal of sharing building data openly is the need to apply open standards to future-proof the building's management system and to facilitate data exchange between subsystems.

Scope

Applicable to all buildings.

Assessment

(i) Energy Portal and Dashboard

Up to 2 points can be scored. This requires the provision of energy management portal, dashboard or other equivalent forms in the form of digital displays or web-based/ mobile application. 1 point each can be scored for the provision of following functions in the energy portal and dashboard:

- Display metered data, trending of energy consumption (historical data) and relevant parameters which facilitate better management of energy consumption during building operation.
- Enable individual tenants/space to monitor their own energy usages and consumption. Information will include monthly consumption of 50th percentile line of the tenants/space, based on operating hours, within the buildings. The information could also include 25th and 75th percentile line to facilitate understanding of consumption range.

(ii) BAS and Controllers with Open Protocol

1 point can be scored for using BACnet, Modbus or any other non-proprietary protocol as the network backbone for the building management system, with the system being able to provide scheduled export of a set of any chosen data points to commonly used file formats.

Permanent M&V for VRF Systems (Advanced Green Effort)



An additional 2 points can be awarded for provision of permanent measuring instruments for monitoring of energy efficiency performance of Variable Refrigerant Flow (VRF) condensing units and air distribution subsystem. The installed instrumentation shall have the capability to calculate resultant system efficiency (i.e. kW/RT or COP) within 10% uncertainty. Each measurement system shall include the sensor, any signal conditioning, the data acquisition system and wiring connecting them. All data are to be logged at 5 minute sampling time interval, and recorded to at least 1 decimal place, and data shall be available for extraction for verification purposes.

Permanent M&V for Hot Water Systems (Advanced Green Effort)

1 point for incorporation of Permanent Measurement and Verification, with performance requirement similar to P.14, for central hot water system.

4.3b Demand Control

Intent

Using occupancy based controls to monitor the usage of spaces and vary temperature, ventilation and lighting demand while maintaining room temperature effectiveness, good indoor environmental quality and lighting quality, can significantly reduce building energy consumption. The energy savings from such controls can be taken into account under the Energy Performance Points Calculator under *Part 2 Building Energy Performance*.

Scope

Applicable to buildings.

Assessment

(i) ACMV Demand Control

A maximum of 2 points can be scored for the use of the following controls to regulate the temperature and/ or airflow of spaces served by air-conditioning and/ or mechanical ventilation systems:

- Binary sensing controls
 - 0.5 point for $\geq 80\%$ of all transient areas
 - 0.5 point for $\geq 80\%$ of all occupied areas
- Occupancy-based sensing controls (for VAV systems)
 - 1 point for $\geq 80\%$ of all transient areas
 - 1 point for $\geq 80\%$ of all occupied areas

(ii) Lighting Demand Control

0.5 point each can be scored for the use of occupancy/ vacancy sensors to moderate brightness of the luminaries for $\geq 80\%$ of transient and occupied areas respectively.

4.3c Integration and Analytics

Intent

The innovative and integrative use of data can optimise workflow or attain persistence of high performance and energy efficiency in a building. Basic integration and use of sensor data can optimise and operate the building in an informed and effective manner. The use of advanced integration and analytics can provide enhanced efficacy in lowering energy use, increase asset reliability, and improve the user experience.

Scope

Applicable to all buildings.

Assessment

A maximum of 3 points can be scored for the following:

(i) Basic Integration and Analytics

Assessment

0.5 point each can be scored for basic integration and analytics features such as (but not limited to):

Basic Features (Features displayed via BMS, BAS, website or mobile app)	Examples
Use <u>adaptive</u> control algorithms	<ul style="list-style-type: none"> Adjust cooling tower approach based on wet bulb temperature
Exception handling by identifying <u>systems</u> that deviates from expected performance/setting	<ul style="list-style-type: none"> When efficiency of chiller plant system (in kW/RT) deviates >10% When a space setpoint is set below a typical value When a space operates significantly below its setpoint
Detect equipment that run <u>outside intended hours or settings</u>	<ul style="list-style-type: none"> AHUs/FCUs that run past regular office hours
Monitor equipment condition for <u>preventive</u> maintenance	<ul style="list-style-type: none"> Use embedded sensors to predict mechanical wear and failure Priorities equipment maintenance using machine condition monitoring
Basic fault detection and diagnostics (FDD) of sensors by finding failed or improperly operating <u>sensors or actuators</u>	<ul style="list-style-type: none"> Compare set points to actual to find leaking valves or stuck dampers Set algorithms to counter-check between sensors

(ii) Advanced Integration and Analytics

1 point each can be scored for advanced integration and analytics features such as (but not limited to):

Advanced Features (Features displayed via BMS, BAS, website or mobile app)	Examples
Whole system optimisation using a <u>network of HVAC equipment</u>	<ul style="list-style-type: none"> Drive pumps minimally to satisfy the most demanding valve.
<u>Integration</u> of sub-systems to optimise resource use or improve user experience	<ul style="list-style-type: none"> Integration of ID card access system to a hot-desk scheme
Use of <u>Building Information Modelling (BIM)</u> or similar applications that provide location-based visualisation of multiple sensors	<ul style="list-style-type: none"> BIM for facilities and asset management such as energy and water use or temperature and relative humidity monitoring.
Participate in a <u>Demand Response</u> programme with electricity retailer	<ul style="list-style-type: none"> Reduce energy consumption of specific electrical items for short periods <p>Pls refer to *Demand Response Programme by EMA.</p>

*Link: https://www.ema.gov.sg/Demand_Response_Program.aspx

Additional Advanced Integration and Analytical Features (Advanced Green Effort)



An additional 1 point can be scored for additional advanced integration and analytical features beyond the points cap.

4.3d System Handover and Documentation

Intent

Design and delivery integration is essential to delivering an operationally energy efficient building. Control systems should be properly tested and verified and to ensure operational continuity from construction to building maintenance and operation. These criteria indicate the presence of a quality assurance plan to maintain the desired energy efficiency and indoor comfort.

Assessment

1 point can be scored for a proper system verification and handover of higher-order functional and system level performance of buildings control systems, mechanical systems and electrical systems. The project shall demonstrate a commitment to comply to verification requirements and show evidence of relevant schedules and documentation.

Expanded Post Occupancy Performance Verification by a 3rd Party (Advanced Green Effort)



0.5 point can be scored per energy subsystem (e.g. lighting controls, mechanical ventilation, hot water system, heat recovery system, renewable energy system) up to 2 points, where the owner engages an independent competent professional (either a BCA registered Energy Auditor or a Professional Engineer (PE) (Mech/Elect)) to verify the operational performance and provide recommendations on system performance enhancement. This should be conducted within one year from the building's TOP.

Energy Performance Contracting (Advanced Green Effort)

1 point can be scored for engaging an Energy Performance Contracting (EPC) firm (accredited by SGBC) to implement and deliver energy efficiency, renewable energy and/or energy recovery projects with an energy performance contract wherein the EPC firm's remuneration is based on demonstrated energy savings. Operational system efficiency should be guaranteed over a minimum of 3 years.

5. Advanced Green Efforts



The Green Mark NRB: 2015 Advanced Green Efforts section recognises the implementation of industry leading performance or innovative strategies, designs or processes that demonstrate exceptional levels of sustainability. The 20 points in this section are bonus points that can be added to the base Green Mark score to help projects demonstrate their holistic environmental performance and achieve higher levels of Green Mark award.

The enhanced performance criteria have indicators placed within the 4 main sections of Climatic Responsive Design, Building Energy Performance, Resource Stewardship and Smart and Healthy Building that we have identified as practices that are pioneering initiatives in sustainable design.

The remaining criteria within this section recognise projects that undertake sustainability with the view of market transformation, such as demonstrating cost neutrality. Other criteria recognise broader aspects of sustainability including socio-economic indicators or global sustainability benchmarking that address issues outside of green building rating tools.

20 POINTS

- 5.1 Enhanced Performance (15 pts)
- 5.2 Demonstrating Cost Effective Design (2 pts)
- 5.3 Complementary Certifications (1 pt)
- 5.4 Social Benefits (2 pts)

5.1 Enhanced Performance

Intent

Points can be awarded based on the Advanced Green Efforts indicators that are highlighted within the Green Mark NRB: 2015 criteria. Alternatively, where projects can demonstrate substantial performance to a specific sustainability indicator or outcome addressed within Green Mark beyond what is specified in the criteria, points can be awarded on a case by case basis.

Assessment

A maximum of 15 points for enhanced performance indicators can be scored for each project. Submission requirements for assessment shall follow the guidance for each enhanced performance indicator within the main Green Mark sections, or for other outcome beyond what is specified, based on 2 points for high impact items, 1 points for medium impact items and 0.5 point for low impact items.

5.2 Complementary Certifications



Intent

Green Mark is an assessment tool that assesses the environmental sustainability of a building. However, the consideration of sustainability indicators beyond those relevant to the built environment is also important.

Assessment

1 point can be scored where the project demonstrates that it is certified through a local or international complementary certification or rating tool that assesses the project beyond the environmental indicators within Green Mark NRB: 2015.

5.3 Demonstrating Cost Effective Design



Intent

Projects that can demonstrate that they have achieved high levels of environmental performance without an increased capital expenditure are of great interest to promote market transformation and encourage the mass market to drive towards higher levels of environmental sustainability.

Assessment

1 or 2 points respectively can be scored for demonstration of cost effective or cost neutral design beyond the norm through a detailed quantity surveyor's report of the building.



5.4 Social Benefits

Intent

While Green Mark focuses on environmental sustainability, this criterion rewards projects that are able to demonstrate that their project contributes to social sustainability.

Assessment

A maximum of 2 points can be scored for projects that demonstrate their social benefits or how social sustainability has been incorporated into the project, beyond core functionality of the building. This can (but not limited to) include efforts that demonstrate enhanced considerations to further wellbeing, welfare, community integration as well as the purchase of clean energy (e.g. solar energy) through third party leasing contracts. 0.5 point for each distinct benefit.



Annexes

Energy Efficiency & Other Green Features for Specialised Building (up to 15 pts)

The Green Mark NRB: 2015 recognises the need for context specific criteria to enhance the sustainability value to the project. Annexes for specialised building list the additional sustainability features relevant to specific building types. The points scored under the respective Annex are bonus points that can be added to the base Green Mark score (140).

- Annex 1: Hawker Centres (15 pts)
- Annex 2: Healthcare Facilities (10 pts)
- Annex 3: Laboratory Buildings (10 pts)
- Annex 4: Schools (10 pts)

Quick References Table

Certain criteria in GM NRB:2015 may not be applicable to specialised buildings types such as Healthcare, Laboratories, School and hawker centers. Hence, additional criteria are added to the scoring for these specialised buildings types. Additional points for different building typologies can be prorated based on size of functional spaces.

The below quick references table, highlights the various scorable, possibly scorable and unlikely-scorable credits for the different annexes

✓ : Scorable credits

○ : possibly scorable credits

✧ : unlikely-scorable credits

Elective Requirements	Office/Retail /Commercial	Annex 1 Hawker Centres	Annex 2 Healthcare	Annex 3 Laboratories	Annex 4 School
Part 1 – Climatic Responsive Design					
P.1 Envelope and Roof Thermal Transfer		✧	✓	✓	✓
P.2 Air Tightness and Leakage		✧	✓	✓	✓
P.3 Bicycle Parking		✓	✓	✓	✓
1.1 Leadership					
1.1a Climatic & Contextually Responsive Brief		✓	✓	✓	✓
1.1b Integrative Design Process		✓	✓	✓	✓
1.1c Environmental Credentials of Project Team		✓	✓	✓	✓
1.1d Building Information Modeling 4D, 5D & 6D BIM (Advanced Green Efforts)		○	✓	✓	✓
1.1e User Engagement		✓	✓	✓	✓
1.2 Urban Harmony					
1.2a Sustainable Urbanism					
Environmental Analysis Creation of possible new ecology and natural ecosystems (Advanced Green Efforts)		✓	✓	✓	✓
Response to Site Context		✓	✓	✓	✓
Urban Heat Island (UHI) Mitigation		✓	✓	✓	✓
Green Transport		✓	✓	✓	✓
1.2b Integrated Landscape and Waterscape					
Green Plot Ratio (GnPR) GnPR ≥ 5.0 (Advanced Green Efforts)		✓	✓	✓	✓
Tree Conservation		✓	✓	✓	✓
Sustainable Landscape Management		✓	✓	○	✓
Sustainable Storm Water Management		✓	✓	○	✓
1.3 Tropicality					
1.3a Tropical Façade Performance – Low Heat Gain Façade (Advanced Green Efforts) Greenery on East and West Façade (Advanced Green Efforts) Thermal Bridging (Advanced Green Efforts)		✓	✓	✓	✓
1.3b Internal Spatial Organisation		✓	✓	✓	✓
1.3c Ventilation Performance Wind Driven Rain Simulation (Advanced Green Efforts)		✓	✓	✧	✓
Part 2 – Building Energy Performance					
P.4 Air Conditioning Total System and Component Efficiency		✓	✓	✓	✓
P.5 Lighting Efficiency and Controls		✓	✓	✓	✓
P.6 Vertical Transportation Efficiency		✓	✓	✓	✓
2.1 Energy Efficiency					
Option 1: Energy Performance Points Calculator					
2.1a Air Conditioning Total System Efficiency		✓	✓	✓	✓
2.1b Lighting System Efficiency		✓	✓	✓	✓
2.1c Carpark System Energy		✓	✓	✓	✓
2.1d Receptacle Energy		✧	✧	✧	✓
2.1e Building Energy Further Improvement in Design Energy Consumption (Advanced Green Efforts)		✓	✓	✓	✓

Option 2: Performance-Based Computation					
2.1f Space Conditioning Performance (10 pts) <i>Efficient Space Conditioning Energy Design (Advanced Green Efforts)</i>		✓	✓	✓	✓
2.1g Lighting System Performance (6 pts) <i>Efficient Lighting Design (Advanced Green Efforts)</i>		✓	✓	✓	✓
2.1h Building System Performance (6 pts) <i>Additional Energy Efficient Practices and Features (Advanced Green Efforts)</i>		✓	✓	✓	✓
2.3 Renewable Energy					
2.3a Solar Energy Feasibility Study 2.03b Solar Ready Roof		✓	✓	✓	✓
2.3c Adoption of Renewable Energy		✓	✓	✓	✓
2.3a Solar Energy Feasibility Study 2.03b Solar Ready Roof <i>Further Electricity Replacement by Renewables (Advanced Green Efforts)</i>		✓	✓	✓	✓
Part 3 – Resource Stewardship					
P.9 Water Efficient Fittings		✓	✓	✓	✓
3.1 Water					
3.1a Water Efficient Systems					
Landscape irrigation		✓	✓	○	✓
Water Consumption of Cooling Towers <i>Better Water Efficient Fittings (Advanced Green Efforts)</i>		✧	✓	✓	○
3.1b Water Monitoring					
Water Monitoring and Leak Detection		✓	✓	✓	✓
Water Usage Portal and Dashboard		✓	✓	✓	✓
3.1c Alternative Water Sources		✓	✓	✓	✓
3.2 Materials					
3.2a Sustainable Construction					
Conservation and Resource Recovery		✓	✓	✓	✓
Resource Efficient Building Design <i>Use of BIM to calculate CUI (Advanced Green Efforts)</i>		✓	✓	✓	✓
Low Carbon Concrete <i>Enhanced Low Carbon Concrete (Advanced Green Efforts)</i>		✓	✓	✓	✓
3.2b Embodied Carbon <i>Provide Own Emission Factors with Source Justification (Advanced Green Efforts)</i> <i>Compute the Carbon Footprint of the Entire Development (Advanced Green Efforts)</i>		✓	✓	✓	✓
3.2c Sustainable Products					
Functional Systems		✓	✓	✓	✓
Singular Sustainable Products outside of Functional Systems <i>Sustainable Products with Higher Environmental Credentials (Advanced Green Efforts)</i>		✓	✓	✓	✓
3.3 Waste					
3.3a Environmental Construction Management Plan		✓	✓	✓	✓
3.3b Operational Waste Management		✓	✓	✓	✓
Part 4 – Smart & Healthy Building					
P.10 Thermal Comfort		✧	✓	✓	✓
P.11 Minimum Ventilation Rate		✧	✓	✓	✓
P.12 Filtration Media for Times of Pollution		✧	✓	✓	✓
P.13 Low Volatile Organic Compound (VOC) Paints		✓	✓	✓	✓
P.14 Refrigerants		✧	✓	✓	○
P.15 Sound Level		✓	✓	✓	✓
P.16 Permanent Instrumentation for the Measurement and Verification of Chilled Water Air-Conditioning Systems		✧	✓	✓	○
P.17 Electrical Sub-Metering & Monitoring		✓	✓	✓	✓
4.1 Indoor Air Quality					
4.1a Occupant Comfort					
Indoor Air Quality (IAQ) Surveillance Audit		✧	✓	✓	✓
Post Occupancy Evaluation		✓	✓	✓	✓
Indoor Air Quality Display <i>Indoor Air Quality Trending (Advanced Green Efforts)</i>		✧	✓	✓	✓
4.1b Outdoor Air					
Ventilation Rates		✧	✧	✓	✓
Enhanced Filtration Media		✧	✓	✓	✓
Dedicated Outdoor Air System		✧	✓	✓	✓
4.1c Indoor Contaminants					
Local Exhaust and Air Purging System		✧	✓	✓	○
Ultraviolet Germicidal Irradiation (UVGI) System		✓	✓	✓	○
More Stringent VOC Limits for Interior Fittings and Finishes		✓	✓	✓	✓
<i>Use of Persistent Bio-cumulative and Toxic (PBT) free lighting</i>		✓	✓	✓	✓

Zero ODP Refrigerants with Low Global Warming Potential (Advanced Green Efforts)					
4.2 Spatial Quality					
4.2a Lighting					
Effective daylighting for common areas		✓	✓	○	✓
Effective daylighting for occupied spaces		✓	✓	○	✓
Quality of Artificial Lighting		✓	✓	✓	✓
4.2b Acoustics					
Sound Transmission Reduction		✧	✓	✓	✓
Acoustic Report		✧	✓	✓	✓
4.2c Wellbeing					
Biophilic Design		✓	✓	○	✓
Universal Design (UD) Mark		✓	✓	✓	✓
4.3 Smart Building Operations					
4.3a Energy Monitoring					
Energy Portal and Dashboard		✓	✓	✓	○
BAS and Controllers with Open Protocol		✓	✓	✓	○
<i>Permanent M&V for VRF Systems (Advanced Green Effort)</i>					
<i>Permanent M&V for Hot Water Systems (Advanced Green Effort)</i>					
4.3b Demand Control					
ACMV Demand Control		✧	✓	✓	○
Lighting Demand Control		✓	✓	✓	✓
4.3c Integration and Analytics					
Basic Integration and Analytics		✧	✓	✓	○
Advanced Integration and Analytics		✧	✓	✓	○
<i>Additional Advanced Integration and Analytical Features (Advanced Green Effort)</i>					
4.3d System Handover and Documentation					
<i>Expanded Post Occupancy Performance Verification by a 3rd Party (Advanced Green Effort)</i>		✓	✓	✓	✓
<i>Energy Performance Contracting (Advanced Green Effort)</i>					
Part 5 – Advanced Green Efforts					
5.1 Enhanced Performance		✓	✓	✓	✓
5.2 Demonstrating Cost Effective Design		✓	✓	✓	✓
5.3 Complementary Certifications		✓	✓	✓	✓
5.4 Social Benefits		✓	✓	✓	✓

Annex 1: Energy Efficiency & Other Green Features [Hawker Centres]

Intent

Encourage use of innovative energy efficient equipment, system or design feature.

Scope

Applicable to naturally ventilated hawker centre building.

Assessment

A maximum of 15 points can be scored for the following:

- a. Implementation of Environmental- friendly procurement & purchase policy – 0.5 point
- b. All kitchen exhaust to be connected to centralised exhaust system with filter to remove odour or particulates – 2 points
- c. Provision of design to facilitate outflow of heated air to provide thermal comfort at seating area. – 2 points
- a. Provision of relevant information and guidance to facility management to main Indoor Air Quality performance in respect to cleaning, prevent migration of odors at cooking, dining & toilets etc – 3 points
- b. Provision of commitment to achieve “Happy Toilet” by Restroom Association Singapore (RAS) – 1 point
- c. Provision of commitment to undertake POE every 6 months – 0.5 point
- d. Provision of innovative and sustainable facilities management solutions to optimise management of Hawker Centres’ operations such as of Internet of Things(IoT), cloud computing, cashless payment – 1 point.
- e. Points achieved under the following credits carries double weightage;
 - 1.2a(iii) Urban Heat Island (UHI) Mitigation – 1 point
 - 3.3b Operational Waste management – 3 points
 - 4.2a Lighting – 6 points
 - 4.2c Wellbeing – 2 points
 - 4.3b(ii) Lighting Demand Control – 1 point

Annex 2: Energy Efficiency & Other Green Features [Healthcare Facilities]

Intent

Encourage use of innovative energy efficient equipment, system or design feature.

Scope

Applicable to healthcare facilities including hospitals, medical centres etc

Assessment

A maximum of 10 points can be scored for the following:

- a. Use of energy efficient Uninterruptible Power Supply (UPS) systems – 1 point
- b. Use of Low-loss service transformer – 1 point
- c. Computation of Service Hot Water Demand – for patients' wards, kitchen and restaurant/ café and additional service hot water demand for clinical & surgery, supply and sterilisation – 1 or 2 points respectively.
- d. Provision of solar thermal hot water system or heat pumps or combines heat & power (CHP) system or Photovoltaic Thermal (PV/T) or other low and zero carbon technology hot water system to meet service hot water heating demand. The performance of service hot water system shall meet the efficiencies as described below – 1 point. Thereafter, additional point for every 10% improvement from minimum efficiency stated for each category (max 5)
 - Solar Thermal Hot water system – Solar Factor (SF) of 0.5 or Solar Energy Factor (SEF) of 2
 - Hot Water System Ratio (HWSR) of 1.60 or Heat Pump – COP of 3.5
 - Combustion turbine – based CHP – Effective electrical efficiency of 0.5
 - Reciprocating engine based CHP – effective electrical efficiency of 0.7
- e. Promote airside energy recovery to all healthcare ventilation system through provision of energy – recovered device with no-recirculation (i.e. 100% of the room air to be exhausted). The energy transfers efficiency of energy – recovered device shall meet the below prescribed requirement – 1 point
 - Run Around coil – min 45% energy transfer efficiency
 - Plate heat exchanger – min 50% energy transfer efficiency
 - Thermal Wheel - 60% energy transfer efficiency
 - Other types – min 50% energy transfer efficiency
- f. Provision of process water management - 1 point
- g. Prevent air-borne contaminate releases and NOx emission from Fuel burning process – 1 point
- h. Thermal comfort & control for clinical area or/and operating theatre – 0.5 or 1 point respectively
- i. Control of indoor thermal environment by re-heating the air by provision of site – recovered energy (including condenser heat) or site solar energy – 1 point

Annex 3: Energy Efficiency & Other Green Features [Laboratories Buildings]

Intent

Encourage use of innovative energy efficient equipment, system or design feature.

Scope

Applicable to buildings with laboratories.

Assessment

A maximum of 10 points can be scored for the following:

- a. Use of energy efficient Uninterruptible Power Supply (UPS) systems – 1 point
- b. Design for variable ventilation and ventilation optimisation – 0.5 or 1 point per feature (up to 3 points)
- c. Promote airside energy recovery to all laboratory ventilation system through provision of energy – recovered device with no-recirculation (i.e. 100% of the room air to be exhausted). The energy transfers efficiency of energy – recovered device shall meet the below prescribed requirement – 1 point
 - Run Around coil – min 45% energy transfer efficiency
 - Plate heat exchanger – min 50% energy transfer efficiency
 - Thermal Wheel - 60% energy transfer efficiency
 - Other types – min 50% energy transfer efficiency
- d. Receptacle load benchmarking with existing lab to optimise cooling load design – 1 point
- e. Include lab specific energy-efficient items under Green Lease – 0.5 point

such as:

 - Auto Sash Closure for Fume Hood
 - Programmable timers for receptacles
 - Use of energy efficient equipment
- f. Green guideline to tenants/building users include monitoring of Air Change Rate or Air Changes per hour (ACH) – 1 point
- g. CFD study for exhaust air to prevent pollutants without sufficient dilution from entering neighboring buildings without – 4 points
- h. (Option 1) Points achieved under 4.03 b(i) ACMV Demand Control credit carries double weightage
(Option 2) Setback control for Non-Occupancy Operation – 2 points
 - ACH for non-occupancy hours to be <60% of maximum operating ACH (for Biological/Chemical Laboratories)
 - Reduced ventilation/lighting operation during non-occupancy hours (for Physical Laboratories)

Annex 4: Energy Efficiency & Other Green Features [Schools]

Intent

Encourage integration of environmental sustainability awareness into curriculum and enrichment education in schools. To allow exposure and communication of environmental sustainability to the public in early ages.

Scope

Applicable to primary, secondary educational buildings.

Assessment

A maximum of 10 points can be scored for the following:

- a. Provision, communication and dissemination of environmental policy that covers energy, waste and water management plan and green procurement – 0.5 point
- b. Raising Awareness on Environmental Sustainability through creation of Sustainability Education – 2 points (0.5 point each)
 - Develop framework for Environmental Sustainability Education, such as incorporating bespoke curriculum to be taught to students of different levels,
 - Setting up of environmental club
 - Spread awareness on environmental sustainability amongst staff and students through posters, courses, competitions programmes or green corner.
 - Implement student-led programmes or activities related to environmental sustainability.
- c. Communication of Energy and Water Efficiency Trends – 0.5 point
Regular sharing of energy and water usage (minimally on monthly basis) through platforms such as newsletter, assembly and etc, with analysis on the reasons for the consumption trend.
- d. Percentage of non-air-conditioned functional areas of total functional areas, scored according to the table below – Up to 2 points

% Non-air-conditioned	Points
60% to ≤ 70%	1
70% to ≤ 80%	1.5
≥ 80%	2

- e. Minimising energy used to provide unnecessary or over-cooling – 2 points
 - Setting room temperature of air-conditioned computer and LAN rooms to 24 degrees or above – 1 point
 - Setting temperature of water in the water cooler to 15 degrees or above – 1 point
- f. Points achieved under the following credits carries double weightage;
 - 1.2a(iii) Urban Heat Island (UHI) Mitigation – 1 point
 - 3.1b(ii) Water Usage Portal and Dashboard – 1 point
 - 4.2a(ii) Quality of Artificial Lighting – 1 point
 - 4.2c Biophilic Design – 2 points
 - 4.3a (i) Energy Portal and Dashboard – 1 point

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