



# GM RB: 2016

BCA GREEN MARK FOR RESIDENTIAL BUILDINGS

## Assessment Criteria and Requirements

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### Green Mark RB: 2016 Revision Log

Revision	Description	Date Effective
R0	Launch for Pilot	06/09/2016
R1	Revised Version for Implementation	22/09/2017
R2	Reformatting, minor wording and examples amendments	15/02/2020

## What is BCA Green Mark?

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

## Introducing Green Mark for Residential Buildings GM RB: 2016

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Green Mark for Residential Buildings GM RB: 2016 is the fifth edition of the Green Mark scheme for new residential buildings. Developed with extensive industry collaboration, this version delivers:

- A streamlined criteria that **addresses sustainability in a more balanced and holistic manner**
- **Greater Emphasis** – climatically contextual design, energy effectiveness, greater focus on health and wellbeing of building occupants, smart buildings, and a systematic approach to addressing embodied energy and resource use.
- Recognises the design process and encourages due processes to respond to site context which facilitates **sustainability to be considered at the early project stages** where there is the greatest opportunity for low cost, high reward options to be implemented.
- Green Mark itself becomes a **design guide and accessible to professionals, students and the population at large**
- A **collaborative framework** – with extensive external industry members involved in its setting of metrics, assessment methods and performance levels.

The Green Mark RB: 2016 Criteria should be read in conjunction with Green Mark RB: 2016 Technical Guide and Requirements.

## Why Green Mark RB: 2016?

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Green Mark provides a consistent method to assess and verify buildings for their overall environmental performance which assists project teams to deliver a more sustainable built environment and encourages best practice and market transformation. At the same time, it is a design guide that can be referenced to understand the attributes of what makes buildings truly sustainable. GM RB: 2016 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 RB: 2016

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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

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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 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.

## Green Mark RB: 2016 Ratings

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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<sup>PLUS</sup> or Platinum. The design of the building development shall also meet all the relevant mandatory requirements regulated under the Building Control Regulations.

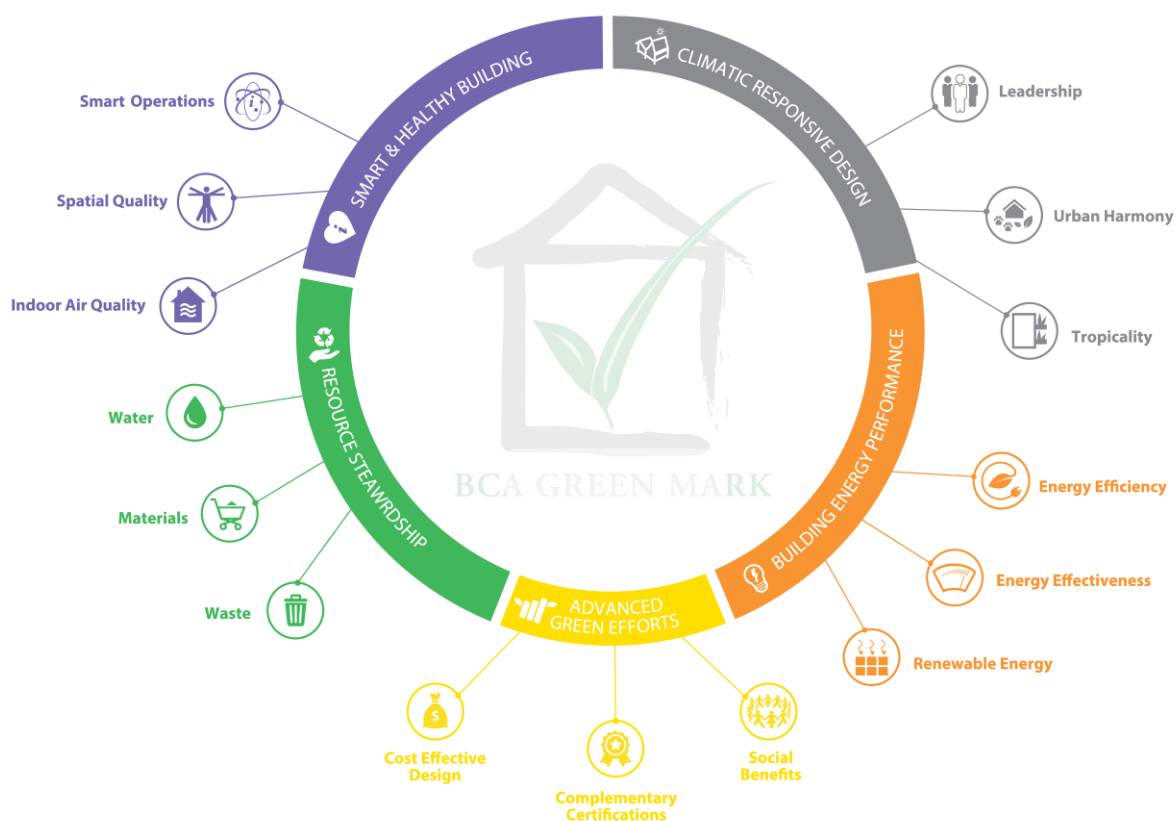
The Green Mark Score of the building design is the total of all the numerical scores (i.e. Green Mark points) assigned based on the degree of compliance with the applicable criteria. The following table states the corresponding Green Mark Score to attain the respective Green Mark rating namely BCA Green Mark Gold, Gold<sup>PLUS</sup> and Platinum. Buildings must also fulfil their respective pre-requisite requirements to attain the respective Green Mark rating. The total points scored include the bonus points scored under Advanced Green Efforts.

## BCA Green Mark Award Rating Scores

Green Mark Rating	Green Mark Score
Green Mark Platinum	70 and above
Green Mark Gold <sup>PLUS</sup>	60 to <70
Green Mark Gold	>50 to <60

## Criteria Overview

To dovetail the criteria with the sustainable outcomes of Green Mark RB: 2016, the criteria has been re-structured into 5 sections, with 16 criteria and 48 sustainability indicators. The total points is 140 points, inclusive of 20 points from Section 5: Advanced Green Efforts



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 RB: 2016 Points Summary

S/N	Item	Points
<b>1. Climatic Responsive Design</b>		<b>35</b>
1.1	Leadership	8
1.1a	Climatic and Contextually Responsive Brief	1
1.1b	Integrative Design Process	2
1.1c	Environmental Credentials of Project Team	2
1.1d	Building Information Modelling	2
1.1e	User Engagement	1
1.2	Urban Harmony	10
1.2a	Sustainable Urbanism	5
1.2b	Integrated Landscape and Waterscape	5
1.3	Tropicality	17
1.3a	Tropical Façade Performance	5
1.3b	Internal Organisation	2
1.3c	Ventilation Performance	10
<b>2. Building Energy Performance</b>		<b>25</b>
2.1	Energy Efficiency	12
2.1a	Air Conditioning System Efficiency	6
2.1b	Lighting Efficiency	4
2.1c	Car Park Energy	2
2.2	Energy Effectiveness	5
2.2a	Energy Efficient Practices, Design and Features	5
2.3	Renewable Energy	8
2.3a	Feasibility Study	0.5
2.3b	Solar Ready Roof	1.5
2.3c	Replacement Energy	6
<b>3. Resource Stewardship</b>		<b>35</b>
3.1	Water	13
3.1a	Water Efficiency Measures	9
3.1b	Water Usage Monitoring	1
3.1c	Alternative Water Sources	3
3.2	Materials	18
3.2a	Sustainable Construction	8
3.2b	Embodied Energy	2
3.2c	Sustainable Products	8
3.3	Waste	4
3.3a	Environmental Construction Management Plan	1
3.3b	Operational Waste Management	3
<b>4. Smart and Healthy Building</b>		<b>25</b>
4.1	Indoor Air Quality	8
4.1a	Occupant Comfort	2
4.1b	Contaminants	6
4.2	Spatial Quality	9
4.2a	Lighting	5
4.2b	Acoustics	2
4.2c	Wellbeing	2
4.3	Smart Building Operations	8
4.3a	Energy Monitoring	2
4.3b	Demand Control	2
4.3c	Integration and Analytics	2
4.3d	System Handover and Documentation	2
<b>5. Advanced Green Efforts</b>		<b>20</b>
5.1	Enhanced Performance	15
5.2	Demonstrating Cost Effective Design	2
5.3	Complementary Certifications	1
5.4	Social Benefits	2

## Green Mark RB: 2016 Prerequisites

### Prerequisite Requirements

#### Climatic Responsive Design

**P.1** To enhance biodiversity through the integration of lush greenery provision, preservation of existing trees and sustainable landscape management. In addition, to reduce storm surges and improve quality of water entering the public drains through introduction of waterscape within the development. Projects are given two options to comply with:

**Option 1: Minimum Green Plot Ratio (GnPR)**

- Gold<sup>PLUS</sup>:  $\geq 4.0$
- Platinum:  $\geq 4.0$  *OR*

**Option 2: Minimum points scored under Part 1.2b Integrated Landscape and Waterscape**

- Gold<sup>PLUS</sup>: 2.5 points
- Platinum: 2.5 points

**P.2** The residential envelope thermal transmittance value (RETV) of the building, as determined in accordance with the formula set out in the “Code on Envelope Thermal Performance for Buildings” issued by the Commissioner of Building Control, shall not exceed the following:

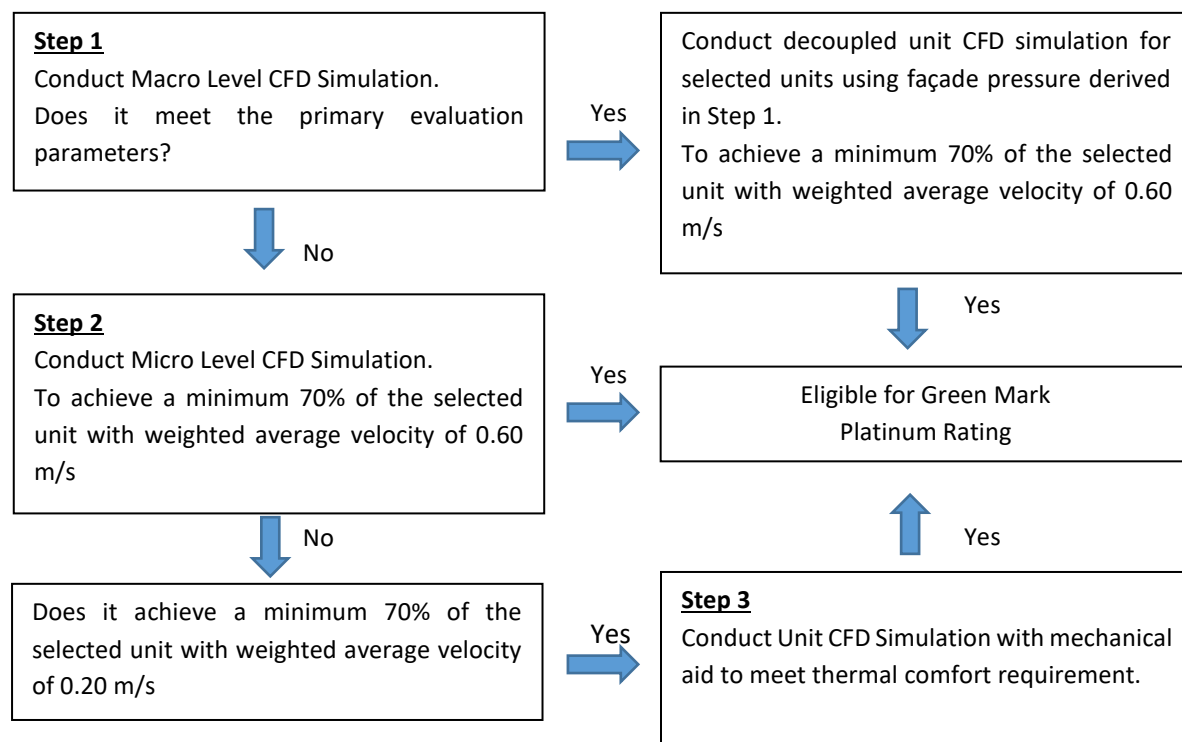
Level of Award	RETV
Gold	25W/m <sup>2</sup> or lower
Gold <sup>PLUS</sup>	22W/m <sup>2</sup> or lower
Platinum	20W/m <sup>2</sup> or lower

The RETV of west, south-west and north-west facades of all buildings within development should not exceed maximum RETV of 25W/m<sup>2</sup>.

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

Roof Weight Group	Weight Range (kg/m <sup>2</sup> )	Maximum U-value (W/m <sup>2</sup> K)
Light	< 50	0.8
Medium	50 to 230	1.1
Heavy	> 230	1.5

**P.3** To be eligible for Green Mark Platinum rating, it is a requirement to use ventilation simulation modelling and analysis or wind tunnel testing to identify the most effective building design and layout. The simulation results and the recommendations derived are to be implemented to ensure good natural ventilation. Projects are given the following pathway to comply with the requirement:



Other than dwelling units, common areas like staircases and lobbies (excluding those that are located in basement areas) should also be designed to be naturally ventilated (i.e. to provide openable windows or other openings with aggregate area of not less than 5% of the space required to be ventilated).

**P.4** For windows and curtain wall systems, air leakage rates shall not exceed the limit specified in SS212 and SS381 respectively

### Building Energy Performance

**P.5** To adopt energy efficient vertical transportation systems to reduce their energy consumption.

All lifts shall be equipped with Variable Voltage Variable Frequency (VVVF) drives and sleep mode features except for building typologies where such technology is not available.

**P.6** Prescribed energy performance standard of air-conditioning system for all dwelling units to be as follows:

Level of Award	Air Conditioners with
Gold	$COP_{100\%} \geq 3.78$ and weighted COP $\geq 4.29$
Gold <sup>PLUS</sup>	$COP_{100\%} \geq 4.86$ and weighted COP $\geq 5.50$
Platinum	

**P.7** At least 10% improvement in lighting power budget over baseline (excluding external lighting).

Baseline = Maximum lighting power budget stated in SS530

**P.8** To evaluate building footprint's potential in harnessing solar energy, so as to raise awareness of viable solar opportunities within the development and encourage building developers to adopt photovoltaics.

Minimum scores under 2.3a Renewable Energy Feasibility Study  
(for buildings with footprint area<sup>1</sup> ≥ 1,000 m<sup>2</sup>)

Green Mark Gold: 0.5 points

Green Mark Gold<sup>PLUS</sup>: 0.5 points

Green Mark Platinum: 0.5 points

### Resource Stewardship

**P.9** To provide water efficient fittings for common facilities that meet minimum requirements as detailed in the following table

Type of Water Fittings	Prescribed Rating based on Water Efficiency Labelling Scheme (WELS)
Basin Taps & Mixers	✓✓✓
Sink Taps & Mixers	✓✓
Shower Taps, Mixers or Showerheads	✓✓
Dual Flush Flushing Cisterns	✓✓

**P.10** Minimum scores under 3.2a Sustainable Construction

Green Mark Gold ≥ 0.5 points

Green Mark Gold<sup>PLUS</sup> ≥ 2 points

Green Mark Platinum ≥ 3.5 points

**P.11** Minimum scores under 3.2b Embodied Energy

Green Mark Gold<sup>PLUS</sup> ≥ 1 point

Green Mark Platinum ≥ 1 point

**P.12** Minimum score under 3.2c Sustainable Products

Green Mark Gold ≥ 2 points

Green Mark Gold<sup>PLUS</sup> ≥ 3 points

Green Mark Platinum ≥ 4 points

<sup>1</sup> A building's footprint refers to the area on a project site used by the building structure, defined by the perimeter of the building plan. Open car park spaces, landscape, underground construction and non-building facilities (such as covered walkways) are not included in the building footprint.

**Smart and Healthy Building**

**P.13** To limit the use of high VOC emitting building and furnishing materials to improve indoor air quality for the health and well-being of occupants.

The internal paints shall be certified by an approved local certification body and test methods shall comply with ISO 17895 or ISO 11890. All coats of paint shall be considered, including primers, sealers, base coats and top coats.

## Green Mark RB: 2016 Criteria

Part 1 - Climatic Responsive Design	Green Mark Points
<b>1.1 Leadership</b>	
<p><b><u>1.1a Climatic &amp; Contextually Responsive Brief</u></b></p> <p>Conceptualization of clear environmental sustainability targets and design approaches early at the onset of the project. The brief should include;</p> <ul style="list-style-type: none"> <li>(a) Preliminary definition of the client’s sustainable aspirations for the project and identification of its green potential benchmarked against similar projects.</li> <li>(b) Setting of agreed achievable sustainability targets for the project. In addition to the project’s targeted Green Mark rating, such targets should involve specific sustainable outcomes and indicators.</li> </ul>	<p style="text-align: center;"><b>Cap at 1 point</b></p> <p style="text-align: center;">1 point</p>
<p><b><u>1.1b Integrative Design Process</u></b></p> <p>Develop collaborative framework for the project team during the briefing, concept design and technical design phase to address the various needs of all stakeholders to achieve the common targets resulting in a more balanced and optimized design outcome.</p>	<p style="text-align: center;"><b>Cap at 2 points</b></p> <p style="text-align: center;">2 points</p>
<p><b><u>1.1c Environmental Credentials of Project Team</u></b></p> <p>This pertains to the appointment of environmental specialists at building design, construction and operations stages.</p> <p><b>Green Individuals:</b></p> <ul style="list-style-type: none"> <li>• Green Mark Accredited Professional (GM AP) or Green Mark Accredited Facilities Professional (GM AP (FM)) and Green Mark Advanced Accredited Professional (GM AAP) or Green Mark Advanced Accredited Facilities Professional (GM AAP (FM)).</li> </ul> <p><b>Green and Gracious Builder:</b></p> <p>The main builder is a BCA certified Green and Gracious Builder.</p> <p><b>Green Companies:</b></p> <ul style="list-style-type: none"> <li>• at least 3 of the following companies are ISO 14001 certified: Architect, M&amp;E Engineer, C&amp;S Engineer, Developer and Main Contractor.</li> <li>• SGBC Green Services Certified firm.</li> </ul>	<p style="text-align: center;"><b>Cap at 2 points</b></p> <p style="text-align: center;">0.25 point for GM AP or GM AP(FM) 0.5 point for GM AAP or GM AAP(FM) (Up to 0.5 point for Green Individuals)</p> <p style="text-align: center;">0.25 point for Certified and Merit; or 0.5 point for Excellent and Star rating (Up to 0.5 point for Green &amp; Gracious Builder)</p> <p style="text-align: center;">0.5 point</p> <p style="text-align: center;">0.5 point (Up to 1.5 points for Green Companies)</p>

<p><b><u>1.1d Building Information Modelling</u></b></p> <p>(a) Use of BIM between various parties (Architect, the MEP Engineers and the Structural Engineer) in the construction value chain for clash detection purposes.</p> <p>(b) Use of BIM for environmental analysis and building performance simulation.</p>	<p><b>Cap at 2 points</b></p> <p>1 point</p> <p>1 point</p>
<p><b><u>1.1e User Engagement</u></b></p> <p>This refers to the provision of relevant information and guidance to building occupants as to how they can contribute positively to the reduction of the building's environmental impact.</p> <p>(a) Building User Guide with Green Fit-out Guidelines</p>	<p><b>Cap at 1 points</b></p> <p>1 point</p>
<p><b>1.2 Urban Harmony – Part A</b></p>	
<p><b><u>1.2a Sustainable Urbanism</u></b></p> <p>Minimise environmental impact to the surroundings through site analysis.</p> <p><b><u>(i) Environmental Impact Statement</u></b></p> <p>A study/ assessment to be 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.</p> <ul style="list-style-type: none"> <li>• Environmental Study</li> <li>• Comprehensive Environmental Impact Assessment (EIA)</li> </ul> <p><b><u>(ii) Response to Site Context</u></b></p> <p>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.</p> <ul style="list-style-type: none"> <li>• Level 1 site analysis and design that demonstrates sensitivity to the site condition</li> <li>• Level 2 analysis optimised design via iterative simulations</li> </ul>	<p><b>Cap at 5 points</b></p> <p>1 point</p> <p>2 points</p> <p>(Up to 2 points)</p> <p>1 point</p> <p>3 points</p> <p>(Up to 3 points)</p>

<p><u>(iii) Urban Heat Island (UHI)</u></p> <p>Measures to mitigate the urban heat island effect through the material selection of the hardscape, softscape and building surfaces.</p> <ul style="list-style-type: none"> <li>• ≥50% of site coverage (at plan view) with mitigation measures</li> <li>• ≥80% of site coverage (at plan view) with mitigation measures</li> </ul> <p><u>(iv) Green Transport</u></p> <p>To reduce the emissions from vehicular transport through promotion of electric vehicles and bicycle lots.</p> <ul style="list-style-type: none"> <li>• Provision of electrical vehicle charging and parking infrastructure ((at least 1 lot per 100 lots, cap at 5 lots)</li> <li>• Provision of <u>sheltered</u> bicycle lots, in-line with LTA’s quantity requirement</li> </ul>	<p>0.5 point</p> <p>1 point (Up to 1 point)</p> <p>0.5 point</p> <p>1 point (Up to 1 point)</p>												
<p><b>1.2 Urban Harmony – Part B</b></p>													
<p><b><u>1.2b Integrated Landscape and Waterscape</u></b></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><u>(i) Green Plot Ratio (GnPR)</u></p> <p>The provision of greenery for the development can be quantified via the Green Plot Ratio (GnPR).</p> <p><u>(ii) Tree Conservation</u></p> <p>Encourage preservation of existing trees on-site to prevent disturbance to established habitats</p> <ul style="list-style-type: none"> <li>• preservation of existing trees</li> <li>• replant an equivalent number of similar species of equivalent Leaf Area Index (LAI)</li> </ul>	<p style="text-align: center;"><b>Cap at 5 points</b></p> <table border="1" data-bbox="999 1234 1465 1554" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>GnPR Value</th> <th>Points</th> </tr> </thead> <tbody> <tr> <td>2.5 to &lt; 3.0</td> <td>1.0</td> </tr> <tr> <td>3.0 to &lt; 3.5</td> <td>1.5</td> </tr> <tr> <td>3.5 to &lt; 4.0</td> <td>2.0</td> </tr> <tr> <td>4.0 to &lt; 4.5</td> <td>2.5</td> </tr> <tr> <td>≥ 4.5</td> <td>3.0</td> </tr> </tbody> </table> <p style="text-align: center;">(Up to 3 points)</p> <p>0.5 point</p> <p>0.5 point (Up to 1 point)</p>	GnPR Value	Points	2.5 to < 3.0	1.0	3.0 to < 3.5	1.5	3.5 to < 4.0	2.0	4.0 to < 4.5	2.5	≥ 4.5	3.0
GnPR Value	Points												
2.5 to < 3.0	1.0												
3.0 to < 3.5	1.5												
3.5 to < 4.0	2.0												
4.0 to < 4.5	2.5												
≥ 4.5	3.0												



<p><u>(iii) Sustainable Landscape Management</u></p> <p>Enhance biodiversity through sustainable landscape management.</p> <ul style="list-style-type: none"> <li>• projects certified under NParks Landscape Excellence Assessment Framework (LEAF) certification</li> <li>• Adoption of native plant species of greenery &gt;50% of the flora selected</li> <li>• Provision of landscape management plan</li> </ul> <p><u>(iv) Sustainable Storm Water Management</u></p> <p>To reduce storm surges and improve quality of water entering the public drains through infiltration or design features.</p> <ul style="list-style-type: none"> <li>• projects certified under PUB Active, Beautiful and Clean Waters (ABC Waters) certification</li> <li>OR</li> <li>• Treatment of storm water run-off through the provision of infiltration or design features before discharge to the public drains <ul style="list-style-type: none"> <li>• treatment of <math>\geq 10\%</math> of runoff from total site area</li> </ul> </li> </ul>	<p>1 point</p> <p>0.5 point</p> <p>0.5 point</p> <p>(Up to 1 point)</p> <p>1 point</p> <p>0.5 point</p> <p>(Up to 1 point)</p>
<p><b>1.3 Tropicality</b></p>	
<p><u>1.3a Tropical Façade Performance</u></p> <p>Enhance the overall thermal performance of building envelope to minimise heat gain thus reducing the overall cooling load when required.</p> <p><u>Baseline</u> : Maximum Permissible RETV = 25 W/m<sup>2</sup></p>	<p><b>Cap at 5 points</b></p> <p>1 points for every reduction of 1 W/m<sup>2</sup> in RETV from the baseline</p> <p>Points awarded = 25- (RETV)</p> <p>where RETV <math>\leq</math> 25 W/m<sup>2</sup></p>
<p><u>1.3b Internal Organisation</u></p> <p>Design for natural ventilation in following common areas:</p> <p>(a) Lift lobbies and corridors</p> <p>(b) Staircases</p>	<p><b>Cap at 2 points</b></p> <p>Extent of Coverage: 80% of applicable areas</p> <p>1 point</p> <p>1 point</p>
<p><u>1.3c Ventilation Performance</u></p> <p>Enhance dwelling unit indoor comfort through the provision of good natural ventilation design.</p> <p>(i) Use of ventilation simulation modelling and analysis to identify the most effective building design and layout to achieve good natural ventilation for all selected typical unit types.</p>	<p><b>Cap at 10 points</b></p>

Step 1

Use of ventilation simulation modelling and analysis to identify the most effective building design and layout to achieve good natural ventilation provided the following primary evaluation parameters can be achieved:

- A minimum 60% of Dwelling Units with window openings facing the prevailing north or north-east and south or south-east directions AND a minimum 2.7 Pa of Global Pressure Differential of Dwelling Units located at building mid height level

OR

- If less than 60% of Dwelling Units with window openings facing the prevailing north or north-east and south or south-east directions, a minimum 4.3 Pa of Global Pressure Differential of Dwelling Units located at building mid height level.

**OR**

Step 2

Use of ventilation simulation modelling and analysis or wind tunnel testing to identify the most effective building design and layout to achieve good natural ventilation.

**Note:**

*Development scoring for 1.3c (i) Step 2- Ventilation Simulation Modelling is not eligible to score under 1.3c (ii)*

**OR**

Step 3

Thermal comfort modelling shall be performed based on the following PMV equation and comply with the stated PMV range

$$PMV = -11.7853 + 0.4232T - 0.57889V$$

PMV Range	PPD
-0.5 < PMV < +0.5*	<10*

where PMV is Predicted Mean Vote

PPD is Predicted Percentage Dissatisfied

T is indoor air temperature (°C). Baseline of T is 29.5°C

V is indoor wind speed (m/s)

3 points if the development has good natural ventilation – i.e. a minimum 70% of the selected units with minimum weighted average wind velocity of 0.60 m/s

Points scored = (% of selected typical units with good natural ventilation)/7  
(up to 10 points)

1 point if the development complies with the thermal comfort criteria

<p>(ii) Effective building layout design and unit design reduce the need for using air-conditioning.</p> <p>Design for air flow within dwelling units</p> <ul style="list-style-type: none"> <li>• <u>Building layout design</u>: Proper design of building layout that utilizes prevailing wind conditions to achieve adequate cross ventilation.</li> <li>• <u>Dwelling unit design</u>: Good ventilation in indoor units through sufficient openings.</li> </ul> <p><b>Note:</b> <i>Development scoring for <u>1.3c (i) Ventilation Simulation Step 2</u> is not eligible to score under 1.3c (ii)</i></p>	<p>0.5 point for every 10% of units with window openings facing north <b>AND</b> south directions</p> <p>0.5 point for every 10% of living rooms and bedrooms designed with true cross ventilation</p> <p>(Up to 7 points)</p>
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Part 2 – Building Energy Performance	Green Mark Points						
<b>2.1 Energy Efficiency</b>							
<p><b>2.1a Air Conditioning System Efficiency</b></p> <p>Use energy efficient air-conditioners.</p> <p>The project team shall demonstrate through ventilation simulation modelling and analysis e.g. computer fluid computation (CFD) to ensure that hot air can be effectively discharged and the declared efficiency of the air-conditioning system can achieve. Details for the housing of the condenser units such as clearance spaces and screens shall be considered.</p> <p><b>Note:</b></p> <p>For developments where air-conditioners are not provided, points will be scored and prorated under <b>1.3c i) for Ventilation Performance</b></p>	<p><b>Cap at 6 points</b></p> <p>Air-conditioners with the following energy performance:</p> <table border="1" data-bbox="911 443 1390 645"> <thead> <tr> <th>Air Conditioners with</th> <th>Points</th> </tr> </thead> <tbody> <tr> <td>COP<sub>100%</sub> ≥ 4.29 and weighted COP ≥ 4.86</td> <td>3</td> </tr> <tr> <td>COP<sub>100%</sub> ≥ 4.86 and weighted COP ≥ 5.50</td> <td>5</td> </tr> </tbody> </table> <p>Extent of coverage: At least 80% of dwelling units</p> <p>1 point for using CFD to ensure effectiveness</p> <p>OR</p> <p>0.5 point for design with adequate clearance distance for condenser units and screens for condenser units shall be more than or equal to 70% of free area</p>	Air Conditioners with	Points	COP <sub>100%</sub> ≥ 4.29 and weighted COP ≥ 4.86	3	COP <sub>100%</sub> ≥ 4.86 and weighted COP ≥ 5.50	5
Air Conditioners with	Points						
COP <sub>100%</sub> ≥ 4.29 and weighted COP ≥ 4.86	3						
COP <sub>100%</sub> ≥ 4.86 and weighted COP ≥ 5.50	5						
<p><b>2.1b Lighting Efficiency</b></p> <p>Encourage the use of energy efficient lighting in common areas to minimise energy consumption from lighting usage while maintaining proper lighting level.</p> <p><u>Baseline</u> = Maximum lighting power budget stated in SS530</p>	<p><b>Cap at 4 points</b></p> <p>0.12 point for every percentage improvement in the lighting power budget <b>above 10% improvement over baseline</b></p> <p>Points scored = 0.12 x (% improvement-10%)</p>						
<p><b>2.2c Car Park Energy</b></p> <p>Encourage the use of energy efficient design and control of ventilation systems in car parks</p> <p>a) Car parks are designed with natural ventilation</p> <p>b) Mechanical ventilated car parks with CO sensors installed to regulate the ventilation required.</p> <p><b>Note:</b></p> <p>Where there is a combination of different ventilation mode adopted for car park design, the points obtained will be prorated accordingly</p>	<p><b>Cap at 2 points</b></p> <p>Naturally ventilated car parks – 2 points</p> <p>Mode of mechanical ventilation provided</p> <p>Fume extract – 1.5 points</p> <p>Mechanical ventilated with or without supply (air) – 1 point</p>						

<b>2.2 Energy Effectiveness</b>	
<p><b><u>2.2a Energy Efficient Practices, Design and Features</u></b></p> <p>Encourage the use of energy efficient features which are innovative and have positive environmental impact.</p> <p>Use of the following energy efficient features such as:</p> <ul style="list-style-type: none"> <li>(i) Gas water heater or energy efficient heat pump water heater</li> <li>(ii) Heat recovery system</li> <li>(iii) Re-generative lift</li> <li>(iv) Energy labelled appliances such as 4 ticks refrigerator, 5 ticks clothes dryer and 5 ticks TV</li> <li>(v) Calculation of Energy Efficiency Index (EEI)</li> <li>(vi) Others</li> </ul>	<p style="text-align: center;"><b>Cap at 5 points</b></p> <p style="text-align: center;">1 point for high impact item <math>\geq</math> 80%</p> <p style="text-align: center;">0.5 point for low impact item <math>\geq</math> 50%</p>
<b>2.3 Renewable Energy</b>	
<p><b><u>2.3a Feasibility Study</u></b></p> <p>To conduct a feasibility study on harnessing solar energy, covering the intent, scope and assessment of the proposed project, the technical and financial aspects and also include roof spatial optimisation.</p>	<p style="text-align: center;"><b>Cap at 0.5 point</b></p> <p style="text-align: center;">0.5 point</p>
<p><b><u>2.3b Solar Ready Roof</u></b></p> <p>Solar ready roof includes the structural readiness, roof layout and electrical readiness provision as follows:</p> <ul style="list-style-type: none"> <li>• <b>Structural readiness:</b> Roof to be designed to accommodate an optimised easy structural installation of solar panels on rooftop spaces</li> <li>• <b>Electrical readiness:</b> Provisions to be put in place to accommodate an optimised easy electrical installation of solar panels on rooftop spaces</li> <li>• <b>Spatial readiness:</b> Roof to be designed to optimise the available non-shaded rooftop area for photovoltaic adoption of roof spatial optimization.</li> </ul>	<p style="text-align: center;"><b>Cap at 1.5 points</b></p> <p style="text-align: center;">0.5 point each</p>
<p><b><u>2.3c Replacement Energy</u></b></p> <p>To encourage annual replacement of electricity (based on building electricity consumption) by renewable energy.</p>	<p style="text-align: center;"><b>Cap at 6 points</b></p> <p style="text-align: center;">1 point for every 1% replacement of electricity replacement (exclude household's usage) by renewable energy</p>

Part 3 – Resource Stewardship	Green Mark Points												
<b>3.1 Water</b>													
<p><b>3.1a Water Efficiency Measures</b></p> <p>Reduce potable water consumption through the use of water efficient fittings/products and systems</p> <p>(i) Dwelling units – Provision of products that are certified under WELS</p> <ul style="list-style-type: none"> <li>• Basin taps and mixers</li> <li>• Sink taps and mixers</li> <li>• Shower taps and mixers or Showerheads</li> <li>• Dual Flush flushing cisterns</li> <li>• Clothes washing machines</li> </ul> <p>(ii) Provision of water efficient automated irrigation system and/or drought tolerant plants.</p> <ul style="list-style-type: none"> <li>• Automated irrigation system with sensor control</li> <li>• Drought tolerant plant</li> </ul>	<p style="text-align: center;"><b>Cap at 9 points</b></p> <table border="1" data-bbox="852 461 1466 748"> <tr> <td colspan="2" style="text-align: center;">Rating based on Water Efficiency Labelling Scheme (WELS)</td> <td rowspan="4" style="text-align: center; vertical-align: middle;">Points scored based on the number, water efficiency rating of the products used</td> </tr> <tr> <td style="text-align: center;">Very Good</td> <td style="text-align: center;">Excellent</td> </tr> <tr> <td colspan="2" style="text-align: center;">Weightage</td> </tr> <tr> <td style="text-align: center;">6</td> <td style="text-align: center;">7</td> </tr> <tr> <td colspan="3" style="text-align: center;">Up to 7 points</td> </tr> </table> <p style="text-align: center;">0.5 point for every 25% of landscape area served 0.5 point for every 20% of landscape area (Up to 2 points)</p>	Rating based on Water Efficiency Labelling Scheme (WELS)		Points scored based on the number, water efficiency rating of the products used	Very Good	Excellent	Weightage		6	7	Up to 7 points		
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<p><b>3.1b Water Usage Monitoring</b></p> <p>Facilitate setting of water consumption reduction targets and continual monitoring through the provision of water meters for major water uses.</p> <p>(i) Private meters</p> <p>(ii) Smart remote metering system</p>	<p style="text-align: center;"><b>Cap at 1 point</b></p> <p style="text-align: center;">0.5 point</p> <p style="text-align: center;">1 point</p>												
<p><b>3.1c Alternative Water Sources</b></p> <p>Encourage the use of alternative water sources to reduce potable water consumption for general application and use</p> <p>(i) NEWater supply</p> <p>(ii) On-site recycled water</p> <p>(iii) Rainwater harvested</p>	<p style="text-align: center;"><b>Cap at 3 points</b></p> <p style="text-align: center;">1 point</p> <p style="text-align: center;">1 point</p> <p style="text-align: center;">1 point</p>												
<b>3.2 Materials</b>													
<p><b>3.2a Sustainable Construction</b></p> <p><b>(i) Conservation and Resource Recovery</b></p> <p>To reward conservation of existing building structures and recovery of demolished building materials for reuse or recycling.</p> <p>Where existing building structures on site are demolished, 1 point can be awarded for enhanced demolition protocol, where a recovery rate of &gt;35%</p>	<p style="text-align: center;"><b>Cap at 8 points</b></p> <p style="text-align: center;">1 point</p>												

<p>crushed concrete waste from the demolished building is sent to approve recyclers with proper facilities.</p>																										
<p><b>ii) Resource Optimisation</b></p> <p><b>Part 1. Concrete Usage Index (CUI)</b></p> <p>To optimise concrete use through the calculation of the project's Concrete Usage Index (CUI) and encourage adoption of sustainable building systems.</p> <p><u>Adoption of sustainable building systems</u></p> <p>Examples of sustainable building systems:</p> <ul style="list-style-type: none"> <li>• Pre-stressed Concrete Elements</li> <li>• Hollow Core or Voided Concrete Elements</li> <li>• Light Weight Concrete Elements</li> <li>• *High Strength Concrete Elements</li> <li>• Structural Steel Elements</li> <li>• Composite Structural Elements</li> <li>• Engineered Timber Elements</li> <li>• Prefabricated Prefinished Volumetric Construction (PPVC)</li> <li>• Precast Concrete Elements</li> <li>• Leave-in Formwork</li> <li>• Others (to be accepted by BCA on a case-by-case basis)</li> </ul> <p>*Refers to concrete grade &gt;60MPa</p>	<table border="1" data-bbox="852 331 1447 521"> <thead> <tr> <th>Criteria</th> <th>Points</th> </tr> </thead> <tbody> <tr> <td>CUI</td> <td rowspan="2"><b>Cap at 4 points</b></td> </tr> <tr> <td>Adoption of Sustainable Building Systems</td> </tr> </tbody> </table> <p><u>CUI:</u></p> <p>Points shall be scored for CUI are based on the following table:</p> <p><i>Table 3.2a-1 CUI scoring Matrix:</i></p> <table border="1" data-bbox="852 763 1426 1079"> <thead> <tr> <th>Project's CUI</th> <th>Points</th> </tr> </thead> <tbody> <tr> <td>≤ 0.60</td> <td>0.5</td> </tr> <tr> <td>≤ 0.50</td> <td>1</td> </tr> <tr> <td>≤ 0.45</td> <td>1.5</td> </tr> <tr> <td>≤ 0.40</td> <td>2</td> </tr> <tr> <td>≤ 0.35</td> <td>2.5</td> </tr> </tbody> </table> <p><u>Adoption of sustainable building systems</u></p> <p>Points shall be scored for the adoption of key/distinctive sustainable building systems (refer to Table below) based upon the extent of their use as a percentage of the constructed floor area (CFA).</p> <table border="1" data-bbox="852 1346 1426 1671"> <thead> <tr> <th>Extent of use</th> <th>Points</th> </tr> </thead> <tbody> <tr> <td>Total coverage area &lt;50% of CFA</td> <td>0.5</td> </tr> <tr> <td>Total coverage area ≥50% and &lt; 75% of CFA</td> <td>1</td> </tr> <tr> <td>Total coverage area ≥ 75% of CFA</td> <td>1.5</td> </tr> </tbody> </table> <p>(Up to 1.5 pts for adoption of sustainable building system)</p>	Criteria	Points	CUI	<b>Cap at 4 points</b>	Adoption of Sustainable Building Systems	Project's CUI	Points	≤ 0.60	0.5	≤ 0.50	1	≤ 0.45	1.5	≤ 0.40	2	≤ 0.35	2.5	Extent of use	Points	Total coverage area <50% of CFA	0.5	Total coverage area ≥50% and < 75% of CFA	1	Total coverage area ≥ 75% of CFA	1.5
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<p><b>Part 2. Low-Carbon Concrete</b></p> <p>To replace the use of concrete within a project with green cements and recycled aggregates</p> <p>Applicable for superstructure works only.</p>	<p style="text-align: center;"><b>Cap at 3 points</b></p> <p><u>Use of recycled/ engineered aggregates e.g. RCA and WCS</u></p> <p>0.5 points can be scored for every 5% replacement by mass of coarse and/or fine aggregates with recycled/ engineered aggregates from approved sources for the superstructure concrete.</p> <p>However, the use of coarse and fine recycled/ engineered aggregates in structural applications shall be limited to 10% replacement by mass unless approval is obtained from the relevant authorities.</p> <p>Usage should not fall below 1.5% x GFA for coarse recycled/ engineered aggregates and 0.75% x GFA for fine recycled/engineered fine aggregates.</p> <p style="text-align: center;">(Up to 1 point)</p> <p><u>Clinker Content:</u></p> <p>Up to 2 points can be scored for the use of concrete containing clinker <math>\leq 400 \text{ kg/m}^3</math> for grades up to C50/60 for <math>\geq 80\%</math> of the applicable super-structural concrete by volume, according to the performance requirements in the specifications. Tiered points will also be awarded for using concrete certified by SGBC based on the extent of environmental friendliness.</p> <table border="1" data-bbox="852 1055 1437 1384"> <thead> <tr> <th>*Concrete Categories</th> <th>Points (or points tier)</th> </tr> </thead> <tbody> <tr> <td>Uncertified concrete with clinker content <math>\leq 400 \text{ kg/m}^3</math></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><i>*Note: All SGBC-certified concrete are deemed to have fulfilled the requirement of clinker content <math>&lt; 400 \text{ kg/m}^3</math></i></p> <p style="text-align: center;">(Up to 2 points)</p>	*Concrete Categories	Points (or points tier)	Uncertified concrete with clinker content $\leq 400 \text{ kg/m}^3$	0.5	SGBC-certified 1-Tick concrete	1.0	SGBC-certified 2-Tick concrete	1.5	SGBC-certified 3-Tick concrete	2.0
*Concrete Categories	Points (or points tier)										
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SGBC-certified 3-Tick concrete	2.0										
<p><b>3.2b Embodied Energy</b></p> <p>This involves the computation of the carbon footprint of the development and the building life cycle analysis to better quantify the environmental impact of a building and raise awareness among key decision makers.</p>	<p style="text-align: center;"><b>Cap at 2 points</b></p> <p>To compute carbon emission of various building materials (as shown in table below)</p> <p>Up to 2 points can be scored for computing the carbon footprint of the development:</p> <table border="1" data-bbox="852 1742 1409 2000"> <thead> <tr> <th>Description</th> <th>Points</th> </tr> </thead> <tbody> <tr> <td>Declaration of Concrete, Glass and Steel</td> <td>1</td> </tr> <tr> <td>Declaration of additional materials</td> <td>0.25 points per material (cap at 1 point)</td> </tr> </tbody> </table>	Description	Points	Declaration of Concrete, Glass and Steel	1	Declaration of additional materials	0.25 points per material (cap at 1 point)				
Description	Points										
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**3.2c Sustainable Products**

**(i) Functional Systems**

The use of material and products in a building has a direct impact on the quality of the environment.

Reduced use of products should be encouraged to reduce waste and embodied carbon in buildings.

Where building uses only necessary and required products; such products should be those certified by the approved local certification bodies to help designers and consumers make informed choice in selecting products that are manufactured responsibly and has low or no emission that is detrimental to the wellbeing of the users and occupants.

Products used in building are categorized into 6 functional systems and a singular products category and points are scored by categories.

**(ii) Singular Sustainable Products outside of Functional Systems**

To encourage the use of sustainable products that do not fall into the functional systems such as

- Hardscape - Includes items such as composite timber decking, outdoor play equipment, pre-cast kerbs and drains, wheel stoppers in car parks, drainage cells etc.

**Cap at 8 points**

Whole building (include residential units)

Functional System Category	Base Group (To score this group prior to score for Finishes Group)	Finishes Group
	Coverage >60%	Coverage >60%
Internal Wall	1	2
Internal Floor	1	2
External Wall	1 (coverage >80%)	2 (coverage >80%)
Roof	0.5 (coverage >80%)	0.5 (coverage >80%)
Doors	1	0.5
Ceiling	0.5	0.5

Common area only (exclude residential units)

Functional System Category	Base Group (To score this group prior to score for Finishes Group)	Finishes Group
	Coverage >80%	Coverage >80%
Internal Wall	0.5	1
Internal Floor	0.5	1
External Wall	1	2
Roof	0.5	0.5
Doors	0.5	0.25
Ceiling	0.25	0.25

Note: The coverage for External wall and Roof system shall be >80% for both tables

(Up to 6 points)

Singular products category	Coverage >80%
Hardscape & Softscape & Building Equipment & Fixtures etc	0.25 point per product

<ul style="list-style-type: none"> <li>• Building services - Mechanical, electrical and plumbing equipment or products such as chillers, circuit boards, transformers, water pipes</li> </ul>	<p>0.25 point for each product used for <math>\geq 90\%</math> of the applicable use</p> <p>(Up to 2 points)</p>
<p><b>3.3 Waste</b></p>	
<p><b>3.3a Environmental Construction Management Plan</b></p> <p>Encourage holistic environmental management plan to facilitate better environmental performance of construction process and waste minimisation.</p>	<p><b>Cap at 1 point</b></p> <p>1 point</p>
<p><b>3.3b Operational Waste Management</b></p> <p>Encourage the provision of dedicated facilities for recycling purposes.</p> <p>(i) Provision of recycling facilities in common areas for collection and storage of different recyclable waste such as paper, glass, metal and plastic in commingled or sorted form.</p> <p>(ii) Provision of facilities for the storage and composting of horticultural waste in common areas.</p> <p>(iii) Web portal or dashboard which promotes recycling efforts</p>	<p><b>Cap at 3 points</b></p> <p>1 point</p> <p>1 point</p> <p>1 point</p>

Part 4 – Smart and Healthy Building	Green Mark Points
<b>4.1 Indoor Air Quality</b>	
<p><b>4.1a Occupant Comfort</b></p> <p>For design taking into account of non-prevailing wind and without the use of air-conditioner:</p> <p>To encourage provision of assisted mechanism to achieve thermal comfort for occupant residential spaces</p>	<p><b>Cap at 2 points</b></p> <p>For living room only - 1 point</p> <p>For all living room, bedrooms – 2 points</p>
<p><b>4.1b Contaminants</b></p> <p>(i) More Stringent VOC Limits for Interior Fittings and Finishes</p> <p>Minimise airborne contaminants, mainly from inside sources to promote a healthy indoor environment. To encourage use of low VOC emitting interior finishes that are certified by approved local certification bodies</p> <ul style="list-style-type: none"> <li>• Adhesives &amp; sealants (including tile grouting)</li> <li>• Floor coverings such as carpets, laminates and vinyl flooring (excluding tiles)</li> <li>• Ceiling coverings such as ceiling boards,</li> <li>• Wall coverings (excluding tiles)</li> <li>• Varnish, stains, lacquers or other trims (including doors and furniture)</li> </ul> <p>(ii) Waste Disposal</p> <p>Minimise airborne contaminants from waste by locating refuse chutes or waste disposal area at open ventilated areas such as service balconies or common corridors.</p> <p>(iii) Indoor Air Quality in Wet Areas</p> <p>Provision of adequate natural ventilation and daylighting in wet areas such as kitchens, bathrooms and toilets. Fumes from stove(s) should be adequately ventilated to exterior, instead of spreading to other occupied spaces</p>	<p><b>Cap at 6 points</b></p> <p>Points scored based on extent of coverage and the % of applicable areas with such provision:</p> <p>1 point for one main category of finishes (excluding tiles) for <math>\geq 90\%</math> of applicable areas</p> <p>3 points for all finishes for <math>\geq 90\%</math> of applicable areas</p> <p>(Up to 3 points)</p> <p>1 point</p> <p>Points scored based on the % of applicable areas with such provision</p> <p>1 point for 50% to 90% of applicable areas</p> <p>2 points for <math>\geq 90\%</math> of applicable areas</p> <p>(Up to 2 points)</p>

<b>4.2 Spatial Quality</b>	
<b>4.2a Lighting</b>	<b>Cap at 5 points</b>
<p><b><u>(i) Effective Daylighting</u></b></p> <p>To encourage effective daylighting and potential for visual discomfort mitigation strategies in residential units; in bedrooms, living room, family room and study room.</p> <p>Two methods are available for evaluating and reporting of daylight provision</p> <p>(i) Pre-Simulated Daylight Availability Tables Methodology</p> <p>(ii) Full simulation – refer to Simulation guideline</p>	<p><u>For Exemplary Daylit Dwelling Design</u></p> <p>Where each Residential unit to meet DA200lux,50%; with minimum 75% of applicable area of the unit to qualify to be included in the count of number of residential units are daylit. The area qualifying 75% of the applicable area shall encounter overnighting..</p> $\frac{\text{Total Residential Units meet the daylit requirement}}{\text{Total Number of Units}} \times 100\% \times 3 \text{ points}$ <p><u>For acceptable Daylit Dwelling Design</u></p> <p>Where each Residential units to meet DA200lux,50%; with minimum in 60% of applicable area of the unit to qualify in the count of number of residential units are daylit. The area qualifying 60% of the applicable area shall encounter overnighting.</p> $\frac{\text{Total Residential Units meet the daylit requirement}}{\text{Total Number of Units}} \times 100\% \times 2 \text{ points}$ <p style="text-align: center;">( Up to 3 points)</p>
<p><b><u>(ii) Potential Glare and daylight control measures</u></b></p> <p>Simple strategies to allow building occupants to adjust their environment to reduce discomfort glare during certain times of the day, whilst allowing effective daylight to enter functional areas</p>	<p>Provision of any of the strategies for at least 90% of residential units with glare:</p> <ul style="list-style-type: none"> <li>• Blinds and Screens</li> <li>• Light shelf</li> <li>• Glazing treatments (Variable opacity glazing, bi-level glazing)</li> </ul> <p>Note: for projects using simulation method; the strategies used for glare mitigation must be shown in simulation that it is effective in mitigation.</p> <p style="text-align: center;">(0.5 point)</p>
<p><b><u>(iii) Daylighting in common areas</u></b></p> <p>To encourage effective daylighting</p> <p>(i) Staircases</p>	<p>The provision of daylit spaces will be prorated to the extent of coverage (by number)</p> <p style="text-align: center;">0.5 point each (prorated by numbers)</p>

(ii) Corridors & Lift Lobbies (iii) Car parks	(Up to 1.5 points)
<b>4.2b Acoustics</b>	<b>Cap at 2 points</b>
<p><b><u>(i) Acoustics Planning</u></b></p> <p>Architectural design to avoid windows of living rooms and bedrooms to be in immediate proximity/facing to noise sources within site boundary and 70 metres away from building boundary.</p> <p>Noise sources include:</p> <ol style="list-style-type: none"> <li>1) Category 1 and category 2 road</li> <li>2) MRT tracks and stations</li> </ol>	1 point
<p><b><u>(ii) Acoustics Design</u></b></p> <p>Acoustic design report meeting relevant authority's requirement with an aggregate area of not less than 10% of the room/space to be ventilated. Credit is given for implementation of recommendations stated in the report to meet acoustic requirement.</p>	1 point
<b>4.2c Wellbeing</b>	<b>Cap at 2 points</b>
<p><b><u>(i) Biophilic Design</u></b></p> <p>Including elements of nature in comfortable spaces to nurture the human-nature relationship is important for the health and happiness of the building users.</p> <ol style="list-style-type: none"> <li>i) Provision of nature in common areas: <ol style="list-style-type: none"> <li>a) Daylighting and natural ventilation</li> <li>b) Water features</li> <li>c) Extensive greenery</li> <li>d) Fauna, beyond insect species</li> <li>e) Natural landscape and ecosystems</li> </ol> </li> <li>ii) Provision of indirect experience of nature in building design: <ol style="list-style-type: none"> <li>a) Images of nature</li> <li>b) Use of natural materials like wood and stone</li> <li>c) Use of natural colours</li> <li>d) Adoption of naturalistic shapes and forms (including plants and animals)</li> <li>e) Demonstrate the passage of time and age</li> </ol> </li> </ol>	<p style="text-align: center;">Adoption of Biophilic and Wellbeing Design</p> <p style="text-align: center;">0.15 point per element</p> <p style="text-align: center;">(Up to 1 point)</p> <p style="text-align: center;"><i>Additional 1 point can be scored under Advanced Green Effort – 5.4 Social Benefits</i></p>

<ul style="list-style-type: none"> <li>f) Use of natural geometrics including "Golden Ratio" and "Fibonacci Sequence"</li> <li>g) Adoption of biomimicry (such as big tree structure in Garden by the Bay)</li> </ul> <p>iii) Provision of features to facilitate experience of space and place:</p> <ul style="list-style-type: none"> <li>a) Design incorporating at least 2 distinct areas of prospect and refuge such as balconies, designated lookout areas along corridors</li> <li>b) Design incorporating organised complexity such as complicated patterned façade design</li> <li>c) Design incorporating integration of parts to wholes</li> <li>d) Provision of at least 3 different transitional environments between spaces such as sheltered walkway to car park, porches that link indoor to outdoor areas.</li> <li>e) Facilitate wayfinding in terms of locality and map provision in the whole development</li> <li>f) Designate as least 2 cultural defined locations</li> </ul> <p>iv) Provision of space in common areas for lifestyle wellbeing:</p> <ul style="list-style-type: none"> <li>a) Designated gardening/farming areas</li> <li>b) Playground</li> <li>c) Fitness corner</li> <li>d) Dedicated running tracks with marked distance information</li> <li>e) Designated areas for wellness activities with peaceful ambience</li> </ul>	
<p><b><u>(ii) Universal Design Mark</u></b></p> <p>Adopt a user-centric philosophy in design, operations and maintenance.</p>	<p style="text-align: center;">UD Mark Certified or Gold Award (0.5 point)</p> <p style="text-align: center;">UD Mark Gold<sup>PLUS</sup> or Platinum Award (1 point)</p>

<b>4.3 Smart Building Operations</b>	
<p><b>4.3a Energy Monitoring</b></p> <p>To encourage tracking a building and residents' energy use with data presented in a relevant manner to engage occupants to be involved in managing energy consumption, through open standards to future-proof the building's network and facilitate exchange of data with other systems.</p> <ul style="list-style-type: none"> <li>• Provision of a power meter with dashboard in the form of digital displays in common areas, or web-based and mobile applications.</li> <li>• Provision of a power meter with dashboard made available to residents / occupants, showing the energy consumption in their respective dwellings.</li> <li>• Using BACnet, Modbus or any other non-proprietary protocol as the network backbone for the building management system (BMS), with the system being able to provide scheduled export of a set of any chosen data points to commonly used file formats.</li> </ul>	<p><b>Cap at 2 points</b></p> <p>0.5 point</p> <p>0.5 point</p> <p>1 point</p>
<p><b>4.3b Demand Control</b></p> <p>To encourage adoption of automated controllers in managing energy/ resources consumption in the common areas of residential developments.</p> <ul style="list-style-type: none"> <li>• Provision of timer sensors / controls for lighting and ventilation systems in community spaces such as link buildings, community halls, etc.</li> <li>• Provision of Bi-level motion sensors for artificial lighting systems in &gt;80% of the common areas.</li> <li>• Provision of car park guidance system in multi-storey car parks.</li> <li>• Others (to be accepted by BCA on a case-to-case basis)</li> </ul>	<p><b>Cap at 2 points</b></p> <p>0.5 point each</p>
<p><b>4.3c Integration and Analytics</b></p> <p>To encourage innovative and integrative use of sensor and motion data for optimizing or attaining persistence of high performance and energy efficiency of the residential development.</p> <ul style="list-style-type: none"> <li>• Provision of website and/or accessible monthly readout per residential block / unit to engage residents.</li> </ul>	<p><b>Cap at 2 points</b></p> <p>1 point each</p>

<ul style="list-style-type: none"> <li>• Provision of energy portal and/or dashboard for residential development management team.</li> <li>• Others (to be accepted by BCA on a case-to-case basis)</li> </ul>	
<p><b><u>4.3d System Handover and Documentation</u></b></p> <p>To encourage systems verification and to ensure operational continuity from construction to building maintenance and operation.</p> <ul style="list-style-type: none"> <li>• 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 with verification requirements and show evidence of relevant schedules and documentation per residential block.</li> <li>• Proper system verification and handover of applicable mechanical and electrical systems. The project shall demonstrate a commitment to comply with verification requirements and show evidence of relevant schedules and documentation per residential unit.</li> </ul>	<p><b>Cap at 2 points</b></p> <p>1 point</p> <p>1 point</p>



Part 5 – Advanced Green Efforts	Green Mark Points
<b>5.1 Enhanced Performance</b>	<b>Cap at 15 points</b>
<p><b><u>5.1a Passive Design Strategies</u></b></p> <p>To encourage design that optimises prevailing wind conditions and facilitates air flow such as</p> <ul style="list-style-type: none"> <li>• For development with multiple blocks, staggering the blocks such that blocks behind are able to receive wind penetrating through the gaps between the blocks in the front row or arrange building according to ascending height with lower height in front and towards the direction of prevailing wind</li> <li>• Provision of either void decks at the ground floor or void spaces in between buildings to encourage air flow through and around buildings</li> <li>• Carry out macro ventilation simulation to check block layout to ensure passive design been considered from the early design stage</li> </ul>	<p>Extent of Coverage: 80% of applicable areas</p> <p>1 point for each strategy (Up to 3 points)</p>
<p><b><u>5.1b Sustainable Stormwater Management</u></b></p> <p>To reduce storm surges and improve quality of water entering the public drains through infiltration or design features.</p>	<p>1 point for projects certified under PUB ABC Waters ‘Gold Class’ certification</p>
<p><b><u>5.1c Wind Driven Rain Simulation</u></b></p> <p>To encourage design that uses wind driven rain simulation modelling to identify effective building design and layout that minimises the impact of wind-driven rain into naturally ventilated common areas such as lift lobbies and corridor areas where there might be concerns, drop-off area and communal space such as sky garden.</p>	<p>1 point to conduct wind driven rain simulation to identify effective building design and layout</p> <p>1 point for implementation of recommendations</p>
<p><b><u>5.1d Energy Efficient Features</u></b></p> <p>To encourage the use of energy efficient features which are innovative and have positive environmental impact in terms of energy saving.</p> <ul style="list-style-type: none"> <li>• Use of thermal insulation or cool paints on the east and west facing external walls</li> <li>• Provision of vertical greenery system on building facades abutting the living rooms, dining areas and bedrooms of dwelling units</li> </ul>	<p>1 point for window to wall ratio (WWR) of less than 0.5 0.5 point for WWR that is between 0.5 to 0.8</p> <p>2 points for more than 50% of building facades 1 point for at least 25% of building facades</p>

<p><b>5.1e Additional Replacement Energy</b></p> <p>To encourage additional replacement of electricity (based on building electricity consumption) by renewable energy.</p>	<p>% replacement of electricity (exclude household's usage) by renewable energy</p> <p>1 point for every 10%</p> <p>(Up to 10 points)</p>							
<p><b>5.1f Smart Water Management System</b></p> <p>Provision of smart home water management system to facilitate further water reduction opportunities and to encourage water saving habits.</p> <ul style="list-style-type: none"> <li>• System/device that allows homeowners to access to their own water usage data</li> <li>• System/device that provides homeowners the breakdown of their major water uses</li> </ul>	<p>1 point</p> <p>2 points</p>							
<p><b>5.1g Smart BIM</b></p> <p>To encourage the use of Smart BIM:</p> <ul style="list-style-type: none"> <li>• 4D(Time) BIM</li> <li>• 5D(Cost) BIM</li> <li>• 6D(Facilities Management) BIM</li> </ul> <p>To use BCA supported BIM based Concrete Usage Index (CUI) calculator to calculate CUI.</p>	<p>1 point each</p> <p>1 point</p> <p>( Up to 3 points)</p>							
<p><b>5.1h Sustainable Products</b></p> <p>To encourage the use of products with a Very Good rating (2 ticks) or above under the Singapore Green Building Product (SGBP) certification scheme.</p>	<table border="1"> <thead> <tr> <th></th> <th>Tick Rating</th> </tr> </thead> <tbody> <tr> <td rowspan="4">Additional Green Effort (by products)</td> <td>2 ticks- 0.25</td> </tr> <tr> <td>3 ticks- 0.5</td> </tr> <tr> <td>4 ticks- 1</td> </tr> <tr> <td>(Functional system and Singular Products - Up to 2 points)</td> </tr> </tbody> </table>		Tick Rating	Additional Green Effort (by products)	2 ticks- 0.25	3 ticks- 0.5	4 ticks- 1	(Functional system and Singular Products - Up to 2 points)
	Tick Rating							
Additional Green Effort (by products)	2 ticks- 0.25							
	3 ticks- 0.5							
	4 ticks- 1							
	(Functional system and Singular Products - Up to 2 points)							

<p><b>5.1i Embodied Energy</b></p> <p>To encourage additional effort in the computation of the carbon footprint of the development and the building life cycle analysis to better quantify the environmental impact of a building and raise awareness among key decision makers, such as:</p> <ul style="list-style-type: none"> <li>• Provide own material emission factors through BCA's online embodied carbon calculator</li> <li>• Computing the carbon footprint of the entire development and develop detailed carbon footprint report based on <b>ALL</b> the materials used within the project. (2 points)</li> </ul>	<p>0.25 points per material (Up to 1 point)</p> <p>2 points</p> <p>( up to 2 points)</p>
<p><b>5.1j Clean Outdoor Air</b></p> <p>Provision of a space/room in the unit with minimum outdoor air in occupant space when windows are closed, particularly when there is poor outdoor air quality condition</p>	<p>Provision of clean outdoor air (2 points) [0.3 l/s per m<sup>2</sup> floor area for that space/room]</p> <p>Provision of portable air cleaner for more than 80% of the units (0.5 point)</p> <p>(Up to 2 points)</p>
<p><b>5.1k Smart Building Operations</b></p> <p>To encourage innovative smart building operations.</p> <ul style="list-style-type: none"> <li>• Car park data collection system with open-protocol support for lighting / space control</li> <li>• Integration of systems for energy savings, etc</li> <li>• Mobile application for monitoring / controlling of electrical / water consumption</li> </ul>	<p>1 point</p> <p>0.5 point</p> <p>0.5 point</p>
<p><b>5.1l Displaying Green Mark Credential</b></p> <p>To identify and distinguish exemplary development which are green and sustainable. The development to display the Green Mark plaque/decal at prominent location (e.g. main lobby).</p>	<p>1 point</p>
<p><b>5.1m Façade Design Strategies</b></p> <p>To encourage façade design that improve thermal comfort of dwelling units</p> <ul style="list-style-type: none"> <li>• For development with WWR =&lt;0.5 and at least 70% of units with cross ventilation and facing north and/or south</li> </ul>	<p>1 point for each strategy (Up to 2 points)</p>

<ul style="list-style-type: none"> <li>• Use monsoon windows that allow the outdoor air to flow into indoors without rain</li> <li>• For development with gable walls designed with better thermal insulation (e.g. a layer of air gap, polystyrene, etc)</li> </ul>	
<p><b><u>5.1n Green transport</u></b></p> <p>To reduce the emissions from vehicular transport by providing adequate infrastructural/ facilities for electric vehicles.</p>	1 point
<p><b><u>5.1o Other green features</u></b></p> <p>To encourage the use of other green features that are innovative and have positive environmental impact.</p>	<p>Extent of coverage: <b>80%</b> of the applicable equipment type or product</p> <p>1 point for high impact item <math>\geq</math> 80%</p> <p>0.5 point for low impact item <math>\geq</math> 50%</p> <p>(Up to 2 points)</p>
<p><b>5.2 Demonstrating Cost Effective Design</b></p>	<p><b>Cap at 2 points</b></p>
<p><b><u>5.2a Cost neutral design</u></b></p> <p>To encourage projects that can demonstrate that they have achieved high levels of environmental performance without an increased capital expenditure.</p> <p>The project is designed with zero green premium when compared to conventional building design that meets the code and regulatory requirements.</p>	2 points
<p><b>5.3 Complementary Certifications</b></p>	<p><b>Cap at 1 point</b></p>
<p><b><u>5.3a Complementary certifications</u></b></p> <p>To encourage the use of an approved local or international rating tool that rates sustainability beyond the built environment.</p>	1 point
<p><b>5.4 Social Benefits</b></p>	<p><b>Cap at 2 points</b></p>
<p><b><u>5.4a Social benefits</u></b></p> <p>To encourage projects that demonstrate their social benefits or how social sustainability has been incorporated into the project. This can (but not limited to) include efforts that demonstrate enhanced considerations to wellbeing, community integration efforts and clean energy purchase through leasing contracts.</p>	0.5 point each

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### P.2 Residential Envelope and Roof Thermal Transfer

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<http://www.bca.gov.sg/PerformanceBased/others/RETV.pdf>

### P.3 Ventilation Performance

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### P.4 Air Tightness and Leakage

[3] Singapore Standard 212 – 'Specification for Aluminium Alloy Windows'; SPRING Singapore

[4] Singapore Standard 381 – Materials and Performance Tests for Aluminium Curtain Walls

#### 1.1a Climatic & Contextually Responsive Brief

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### 4.2a Occupant Comfort

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## Acknowledgements

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