



BCA GREEN MARK

BCA Green Mark for New Non-Residential Buildings Version NRB/4.0

Framework - BCA Green Mark for New Non-Residential Buildings (Version NRB/4.0)

To achieve Green Mark Award



Pre-requisite Requirement

All relevant pre-requisite requirements for the specific Green Mark Rating are to be complied with



Energy Related Requirements
Minimum 30 points

Other Green Requirements
Minimum 20 points

Elective Requirement for Energy Improvement
(Combination of the following items to meet 30 points)

Part 1 - Energy Efficiency

- Air-con { 1-1 Thermal Performance of Building Envelope - ETTV
- 1-2 Air-Conditioning System
- 1-3 Building Envelope – Design/Thermal Parameter
- Non Air-con { 1-4 Natural Ventilation / Mechanical Ventilation
- 1-5 Daylighting
- 1-6 Artificial Lighting
- 1-7 Ventilation in Carparks
- 1-8 Ventilation in Common Areas
- General { 1-9 Lifts and Escalators
- 1-10 Energy Efficient Practices & Features
- 1-11 Renewable Energy

Elective Requirement from Other Areas
(Combination of the following items to meet 20 points)

Part 2 - Water Efficiency

- 2-1 Water Efficient Fittings
- 2-2 Water Usage and Leak Detection
- 2-3 Irrigation System and Landscaping
- 2-4 Water Consumption of Cooling Towers

Part 3 – Environmental Protection

- 3-1 Sustainable Construction
- 3-2 Sustainable Products
- 3-3 Greenery Provision
- 3-4 Environmental Management Practice
- 3-5 Green Transport
- 3-6 Refrigerants
- 3-7 Stormwater Management

Part 4 - Indoor Environmental Quality

- 4-1 Thermal Comfort
- 4-2 Noise Level
- 4-3 Indoor Air Pollutants
- 4-4 Indoor Air Quality (IAQ) Management
- 4-5 High Frequency Ballasts

Part 5 – Other Green Features

- 5-1 Green Features and Innovations

Point Allocations - BCA Green Mark for New Non-Residential Buildings (Version NRB/4.0)

Category			Point Allocations	
(I) Energy Related Requirements				
Minimum 30 points	Part 1 : Energy Efficiency			
	NRB 1-1 Thermal Performance of Building Envelope - ETTV	Section (A) Applicable to air-con areas	12	
	NRB 1-2 Air-Conditioning System		30	
	Sub-Total (A) – NRB 1-1 to 1-2			42
	NRB 1-3 Building Envelope – Design/Thermal Parameter	Section (B) Applicable to non air-con areas excluding carparks and common areas	35	
	NRB 1-4 Natural Ventilation / Mechanical Ventilation		20	
	Sub-Total (B) – NRB 1-3 to 1-4			55
	NRB 1-5 Daylighting	Section (C) Generally applicable to all areas	6	
	NRB 1-6 Artificial Lighting		12	
	NRB 1-7 Ventilation in Carparks		4	
	NRB 1-8 Ventilation in Common Areas		5	
NRB 1-9 Lifts and Escalators	2			
NRB 1-10 Energy Efficient Practices & Features	12			
NRB 1-11 Renewable Energy	20			
Sub-Total (C) – NRB 1-5 to 1-11			61	
Category Score for Part 1 – Energy Efficiency Prorate Subtotal (A) + Prorate Subtotal (B) + Prorate Subtotal (C)			116 (Max)	
(II) Other Green Requirements				
Minimum 20 points	Part 2 : Water Efficiency			
	NRB 2-1 Water Efficient Fittings		10	
	NRB 2-2 Water Usage and Leak Detection		2	
	NRB 2-3 Irrigation System and Landscaping		3	
	NRB 2-4 Water Consumption of Cooling Towers		2	
	Category Score for Part 2 – Water Efficiency			17
	Part 3 : Environmental Protection			
	NRB 3-1 Sustainable Construction		10	
	NRB 3-2 Sustainable Products		8	
	NRB 3-3 Greenery Provision		8	
	NRB 3-4 Environmental Management Practice		7	
	NRB 3-5 Green Transport		4	
	NRB 3-6 Refrigerants		2	
	NRB 3-7 Stormwater Management		3	
	Category Score for Part 3 – Environmental Protection			42
	Part 4 : Indoor Environmental Quality			
	NRB 4-1 Thermal Comfort		1	
NRB 4-2 Noise Level		1		
NRB 4-3 Indoor Air Pollutants		2		
NRB 4-4 Indoor Air Quality (IAQ) Management		2		
NRB 4-5 High Frequency Ballasts		2		
Category Score for Part 4 – Indoor Environmental Quality			8	
Part 5 : Other Green Features				
NRB 5-1 Green Features & Innovations		7		
Category Score for Part 5 – Other Green Features			7	
Green Mark Score :			190 (Max)	

BCA Green Mark Award Rating and Prerequisite Requirements

Green Mark Score	Green Mark Rating
90 and above	Green Mark Platinum
85 to < 90	Green Mark Gold ^{Plus}
75 to < 85	Green Mark Gold
50 to <75	Green Mark Certified

Pre-requisite Requirements for Non-Residential Building Criteria

Air-Conditioned Buildings

- (1) Building envelope design with Envelope Thermal Transfer Value (ETTV) computed based on the methodology and guidelines stipulated in the Code on Envelope Thermal Performance for Buildings and this Standard.

Green Mark Gold^{Plus} – ETTV of 42 W/m² or lower
 Green Mark Platinum – ETTV of 40 W/m² or lower

- (2) To demonstrate the stipulated energy savings over its reference model using an energy modeling framework set out. Details and submission requirements on energy modeling can be found in Appendix E of the Certification Standard.

Green Mark Gold^{Plus} – At least 25% energy savings
 Green Mark Platinum – At least 30% energy savings

- (3) Prescribed system efficiency of air-conditioning system to be as follows:

(i) For Buildings using Water Cooled Chilled-Water Plant:

Green Mark Rating	Peak Building Cooling Load (RT)	
	< 500	≥ 500
	Efficiency ⁽¹⁾ (kW/RT)	
Certified	0.80	0.70
Gold	0.80	0.70
Gold ^{Plus}	0.70	0.65
Platinum	0.70	0.65

(ii) For Buildings using Air Cooled Chilled-Water Plant or Unitary Air-Conditioners:

Green Mark Rating	Peak Building Cooling Load (RT)	
	< 500	≥ 500
	Efficiency ⁽¹⁾ (kW/RT)	
Certified	0.90	0.80
Gold	0.90	Not applicable ⁽²⁾
Gold ^{Plus}	0.85	
Platinum	0.78	

Related Criteria

NRB 1-1 – Thermal Performance of Building Envelope

NRB 1-2(a) – Air-Conditioning System

Pre-requisite Requirement for Non-Residential Building Criteria

Note⁽¹⁾ The performance of the overall air-conditioning system for the building can either be based on the efficiency at full installed capacity (exclude standby) of the system or expected operating efficiency of the system at part-load condition during the specific building operation hours as defined below:

Office Building:

Monday to Friday: 9 a.m. to 6 p.m.
Saturday: 9 a.m. to 11 a.m.

Retail Mall:

Monday to Sunday: 10 a.m. to 9 p.m.

Institutional:

Monday to Friday: 9 a.m. to 5 p.m.

Hotel and Hospital:

24-hour

Industrial and Other Building Types:

To be determined based on the operating hours

Related Criteria

NRB 1-2(b) – Air-Conditioning System

Note⁽²⁾ For building with peak building cooling load of more than 500 RT, the use of air cooled central chilled-water plant or other unitary air-conditioners are not applicable for Gold and higher ratings. In general, the system efficiency of the air cooled central chilled-water plant and other unitary air-conditioners are to be comparable with the stipulated efficiency for water cooled central chilled-water plant. Buildings that are designed with air-cooled systems and for higher Green Mark rating will be assessed on a case by case basis.

(4) Instrumentation for monitoring the water cooled chilled-water plant efficiency is to be provided in accordance with the requirement set in the criteria.

NRB 1-2(d) – Air-Conditioning System

(5) Minimum score under NRB 3-1 Sustainable Construction

Green Mark Gold^{Plus} ≥ 3 points

Green Mark Platinum ≥ 5 points

NRB 3-1 – Sustainable Construction

Pre-requisite Requirement for Non-Residential Building Criteria

Non Air-Conditioned Buildings

(1) To be eligible for Green Mark Platinum rating, it is a requirement to use ventilation simulation modeling and analysis 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. Details and submission requirements on ventilation simulation can be found in Appendix C of the Certification Standard.

Related Criteria

NRB 1-4(a)(ii) – Natural Ventilation

(2) Minimum score under NRB 3-1 Sustainable Construction

Green Mark Gold^{Plus} ≥ 3 points

Green Mark Platinum ≥ 5 points

NRB 3-1 – Sustainable Construction

Non-Residential Building Criteria

Part 1 – Energy Efficiency	Green Mark Points								
(A) Applicable to Air-Conditioned Building Areas (with an aggregate air-conditioned areas > 500 m ²)									
<p><u>NRB 1-1 Thermal Performance of Building Envelope – Envelope Thermal Transfer Value (ETTV)</u></p> <p>Enhance the overall thermal performance of building envelope to minimise heat gain thus reducing the overall cooling load requirement.</p> <p><u>Baseline</u> : Maximum Permissible ETTV = 50 W/m²</p> <p><u>Prerequisite Requirement</u> : Green Mark Gold^{plus} – ETTV of 42 W/m² or less Green Mark Platinum – ETTV of 40 W/m² or less</p>	<p>1.2 points for every reduction of 1 W/m² in ETTV from the baseline</p> <p>Points scored = 1.2 x (50 - ETTV) where ETTV ≤ 50 W/m²</p> <p>(Up to 12 points)</p>								
<p><u>NRB 1-2 Air-Conditioning System</u></p> <p>Encourage the use of better energy efficient air-conditioned equipment to minimise energy consumption.</p> <p>(a) Water-Cooled Chilled-Water Plant :</p> <ul style="list-style-type: none"> • Water-Cooled Chiller • Chilled-Water Pump • Condenser Water Pump • Cooling Tower <table border="1"> <thead> <tr> <th rowspan="2">Baseline</th> <th colspan="2">Peak Building Cooling Load</th> </tr> <tr> <th>≥ 500 RT</th> <th>< 500 RT</th> </tr> </thead> <tbody> <tr> <td><u>Prerequisite Requirements</u> Minimum central chilled-water plant efficiency</td> <td>0.70 kW/RT</td> <td>0.80 kW/RT</td> </tr> </tbody> </table> <p><u>Prerequisite Requirements for Higher Green Mark Rating</u> : Green Mark Gold^{plus} & Platinum : Minimum central chilled water plant efficiency of 0.65 kW/RT for peak building cooling load ≥ 500 RT and 0.7 kW/RT for peak building cooling load < 500 RT</p> <p>(b) Air Cooled Chilled-Water Plant / Unitary Air-Conditioners</p> <p>Air Cooled Chilled-Water Plant :</p> <ul style="list-style-type: none"> • Air-Cooled Chiller • Chilled-Water Pump <p>Unitary Air-Conditioners :</p> <ul style="list-style-type: none"> • Variable Refrigerant Flow (VRF) system • Single-Split Unit • Multi-Split Unit 	Baseline	Peak Building Cooling Load		≥ 500 RT	< 500 RT	<u>Prerequisite Requirements</u> Minimum central chilled-water plant efficiency	0.70 kW/RT	0.80 kW/RT	<p>(a) <u>Water-Cooled Chilled-Water Plant</u></p> <div style="border: 1px solid black; padding: 5px; text-align: center;">Peak building cooling load ≥ 500 RT</div> <p>15 points for meeting the prescribed chilled-water plant efficiency of 0.70 kW/RT</p> <p>0.25 point for every percentage improvement in the chilled-water plant efficiency over the baseline</p> <p>Points scored = 0.25 x (% improvement)</p> <div style="border: 1px solid black; padding: 5px; text-align: center;">Peak building cooling load < 500 RT</div> <p>12 points for meeting the prescribed chilled-water plant efficiency of 0.80 kW/RT</p> <p>0.45 point for every percentage improvement in the chilled-water plant efficiency over the baseline</p> <p>Points scored = 0.45 x (% improvement)</p> <p>(Up to 20 points)</p> <p>(b) <u>Air Cooled Chilled-Water Plant/ Unitary Air-Conditioners</u></p> <div style="border: 1px solid black; padding: 5px; text-align: center;">Peak building cooling load ≥ 500 RT</div> <p>12 points for meeting the prescribed air-conditioning system efficiency of 0.80 kW/RT</p> <p>1.3 points for every percentage improvement in the air-conditioning system efficiency over the baseline</p> <p>Points scored = 1.3 x (% improvement)</p>
Baseline		Peak Building Cooling Load							
	≥ 500 RT	< 500 RT							
<u>Prerequisite Requirements</u> Minimum central chilled-water plant efficiency	0.70 kW/RT	0.80 kW/RT							

Part 1 – Energy Efficiency	Green Mark Points														
(A) Applicable to Air-Conditioned Building Areas (with an aggregate air-conditioned areas > 500 m²)															
<p>(b) Air Cooled Chilled-Water Plant / Unitary Air-Conditioners – <i>Cont'd</i></p> <table border="1"> <thead> <tr> <th rowspan="2">Baseline</th> <th colspan="2">Peak Building Cooling Load</th> </tr> <tr> <th>≥ 500 RT</th> <th>< 500 RT</th> </tr> </thead> <tbody> <tr> <td><i>Prerequisite Requirements</i> Minimum system efficiency of air cooled chilled-water plant or unitary conditioners</td> <td>0.80 kW/RT</td> <td>0.90 kW/RT</td> </tr> </tbody> </table> <p><i>Prerequisite Requirements for Higher Green Mark Rating :</i> <i>Green Mark Gold^{Plus} : Minimum system efficiency of 0.85kW/RT for peak building cooling load < 500 RT</i> <i>Green Mark Platinum: Minimum system efficiency of 0.78kW/RT for peak building cooling load < 500 RT</i></p> <p>Note (1) : Where there is a combination of central chilled water plant with unitary conditioners, the points scored will only be based on the air-conditioning system with a larger aggregate capacity.</p> <p>(c) Air Distribution System :</p> <ul style="list-style-type: none"> • Air Handling Units (AHUs) • Fan Coil Units (FCUs) <p><u>Baseline</u> : SS553:2009 Table 2 – Fan power limitation in air-conditioning systems</p> <table border="1"> <thead> <tr> <th colspan="2">Allowable nameplate motor power</th> </tr> <tr> <th>Constant volume</th> <th>Variable volume</th> </tr> </thead> <tbody> <tr> <td>1.7 kW/m³/s</td> <td>2.4 kW/m³/s</td> </tr> </tbody> </table> <p>Note (2) : For buildings using district cooling system, there is no need to compute the plant efficiency under NRB 1-2(a) and (b). The points obtained will be pro-rated based on the air distribution system efficiency under NRB 1-2(c).</p> <p>(d) <i>Prerequisite Requirements</i> : Provision of permanent measuring instruments for monitoring of water-cooled chilled-water plant efficiency. The installed instrumentation shall have the capability to calculate a resultant plant efficiency (i.e. kW/RT) within 5 % of its true value and in accordance with ASHRAE Guide 22 and AHRI 550/590. The following instrumentation and installation are also required to be complied with :</p> <ol style="list-style-type: none"> (i) Location and installation of the measuring devices to meet the manufacturer's recommendation. (ii) Data acquisition system to have a minimum resolution of 16 bit. (iii) All data logging with capability to trend at 1 minute sampling time interval. 	Baseline	Peak Building Cooling Load		≥ 500 RT	< 500 RT	<i>Prerequisite Requirements</i> Minimum system efficiency of air cooled chilled-water plant or unitary conditioners	0.80 kW/RT	0.90 kW/RT	Allowable nameplate motor power		Constant volume	Variable volume	1.7 kW/m ³ /s	2.4 kW/m ³ /s	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p align="center">Peak building cooling load < 500 RT</p> </div> <p>10 points for meeting the prescribed air-conditioning system efficiency of 0.90 kW/RT</p> <p>0.6 point for every percentage improvement in the air-conditioning system efficiency over the baseline</p> <p>Points scored = 0.6 x (% improvement)</p> <p align="center">(Up to 20 points)</p> <p><u>(c) Air Distribution System</u></p> <p>0.2 point for every percentage improvement in the air distribution system efficiency over the baseline</p> <p>Points scored = 0.2 x (% improvement)</p> <p align="center">(Up to 6 points)</p> <p>Applicable only to buildings with provision of water cooled chilled-water plant</p> <p align="center">1 point</p>
Baseline		Peak Building Cooling Load													
	≥ 500 RT	< 500 RT													
<i>Prerequisite Requirements</i> Minimum system efficiency of air cooled chilled-water plant or unitary conditioners	0.80 kW/RT	0.90 kW/RT													
Allowable nameplate motor power															
Constant volume	Variable volume														
1.7 kW/m ³ /s	2.4 kW/m ³ /s														

Part 1 – Energy Efficiency	Green Mark Points
(A) Applicable to Air-Conditioned Building Areas (with an aggregate air-conditioned areas > 500 m²)	
<p>(iv) Flow meters to be provided for chilled-water and condenser water loop and shall be of ultrasonic / full bore magnetic type or equivalent.</p> <p>(v) Temperature sensors with minimum accuracy of ± 0.05 °C @ 0°C to be provided for chilled water and condenser water loop. All thermo-wells shall be installed in a manner which ensures that the sensors can be in direct contact with fluid flow. Provisions shall be made for each temperature measurement location to have two spare thermo-wells located at both side of the temperature sensor for verification of measurement accuracy.</p> <p>(e) Verification of central chilled-water plant instrumentation : Heat balance – substantiating test for water cooled chilled-water plant to be computed in accordance with AHRI 550/590.</p> <p>(f) Provision of variable speed controls for chiller plant equipment such as chilled-water pumps and cooling tower fans to ensure better part-load plant efficiency.</p> <p>(g) Sensors or similar automatic control devices are used to regulate outdoor air flow rate to maintain the concentration of carbon dioxide in accordance with Table 1 – Recommended IAQ Parameters of SS 554.</p> <p>Carbon dioxide acceptable range: ≤ 700 ppm above outdoor.</p>	<p>1 point</p> <p>1 point</p> <p>1 point</p>
<p><i>Exception: For buildings that are underground, NRB 1-1 may be excluded in the computation. The score under NRB 1-2 will be pro-rated accordingly.</i></p>	
<p>Sub-Total (A) :</p>	<p>Sum of Green Mark Points obtained from NRB 1-1 to 1-2</p>

Part 1 – Energy Efficiency	Green Mark Points												
(B) Applicable to Non Air-Conditioned Building Areas (with an aggregate non air-conditioned areas > 10 % of total floor area excluding carparks and common areas)													
<p><u>NRB 1-3 Building Envelope – Design / Thermal Parameters</u></p> <p>Enhance the overall thermal performance of building envelope to minimise heat gain which would improve indoor thermal comfort and encourage natural ventilation or mechanical ventilation.</p> <p>(a) Minimum direct west facing façade through building design orientation.</p> <p>Note (3) : Orientation of façade that falls within the range of 22.5° N of W and 22.5° S of W will be defined as west facing facade. Core walls for lifts or staircases and toilets that are located within this range are exempted in computation.</p> <p>(b)(i) Minimum west facing window openings.</p> <p>(b)(ii) Effective sunshading provision for windows on the west façade with minimum shading of 30%.</p> <p>(c) Better thermal transmittance (U-value) of external west facing walls.</p> <p>The U-value of external west facing walls should be equal or less than 2 W/m²K.</p> <p>(d) Better thermal transmittance (U-value) of roof.</p> <p><u>Baseline</u>: U-value for roof stated below depending on the weight range of roof structure:</p> <table border="1"> <thead> <tr> <th>Weight Group</th> <th>Weight range (kg/m²)</th> <th>Maximum Thermal Transmittance (W/m²K)</th> </tr> </thead> <tbody> <tr> <td>Light</td> <td>Under 50</td> <td>0.8</td> </tr> <tr> <td>Medium</td> <td>50 to 230</td> <td>1.1</td> </tr> <tr> <td>Heavy</td> <td>Over 230</td> <td>1.5</td> </tr> </tbody> </table>	Weight Group	Weight range (kg/m ²)	Maximum Thermal Transmittance (W/m ² K)	Light	Under 50	0.8	Medium	50 to 230	1.1	Heavy	Over 230	1.5	<p>Points scored = $15 - 0.3 \times (\% \text{ of west facing facade areas over total facade areas})$</p> <p>(Up to 15 points)</p> <p>Where there is no west facing façade, the total points scored for this item will be <u>30 points</u>; the NRB 1-3 b(i), b(ii) and (c) as listed below will not be applicable.</p> <p>Points scored = $10 - 0.1 \times (\% \text{ of west facing window areas over total west facing facade areas})$</p> <p>Points scored = $0.1 \times (\% \text{ of west facing window areas with sunshading devices over total west facing facade areas})$</p> <p>(Up to 10 points for NRB 1-3 b(i) & b(ii))</p> <p>Points scored = $0.05 \times (\% \text{ of the external west facing walls areas with U value of } 2 \text{ W/m}^2\text{K or less over total west facing facades areas})$</p> <p>(Up to 5 points)</p> <p>1 point for every 0.1 W/m²K reduction from the baseline roof U-value</p> <p>(Up to 5 points)</p>
Weight Group	Weight range (kg/m ²)	Maximum Thermal Transmittance (W/m ² K)											
Light	Under 50	0.8											
Medium	50 to 230	1.1											
Heavy	Over 230	1.5											

Part 1 – Energy Efficiency	Green Mark Points						
(B) Applicable to Non Air-Conditioned Building Areas (with an aggregate non air-conditioned areas > 10 % of total floor area excluding carparks and common areas)							
<p><u>NRB 1-4 Natural Ventilation / Mechanical Ventilation</u></p> <p>(a) <u>Natural Ventilation</u></p> <p>Encourage building design that facilitates good natural ventilation.</p> <p>(i) Proper design of building layout that utilises prevailing wind conditions to achieve adequate cross ventilation.</p> <p>(ii) Use of ventilation simulation modeling and analysis or wind tunnel testing to identify the most effective building design and layout to achieve good natural ventilation</p> <p><i>Prerequisite Requirement :</i> <i>Green Mark Platinum : Ventilation simulation modeling and analysis are to be carried out. The recommendations and results from simulation are to be implemented in design to ensure good natural ventilation.</i></p> <p>(b) <u>Mechanical Ventilation</u></p> <p>Encourage energy efficient mechanical ventilation system design as the preferred ventilation mode to air-conditioning in buildings.</p> <p><u>Baseline:</u> SS553:2009 Table 8 – Fan power limitation in mechanical ventilation systems</p> <table border="1"> <thead> <tr> <th colspan="2">Allowable nameplate motor power</th> </tr> <tr> <th>Constant volume</th> <th>Variable volume</th> </tr> </thead> <tbody> <tr> <td>1.7 kW/m³/s</td> <td>2.4 kW/m³/s</td> </tr> </tbody> </table> <p>Note (4) : Where there is a combination of naturally ventilated and mechanical ventilated spaces, the points scored will only be based on the predominant ventilation modes of normally occupied spaces.</p>	Allowable nameplate motor power		Constant volume	Variable volume	1.7 kW/m ³ /s	2.4 kW/m ³ /s	<p>1 point for every 10% of units/rooms with window openings facing north and south directions Points scored = 1 x (% of units/10) (Up to 10 points)</p> <p>5 points Additional 5 points if the recommendations are implemented (Up to 10 points)</p> <p>0.6 point for every percentage improvement in the air distribution system efficiency. Points scored = 0.6 x (% improvement) (Up to 15 points)</p>
Allowable nameplate motor power							
Constant volume	Variable volume						
1.7 kW/m ³ /s	2.4 kW/m ³ /s						
<p><i>Exception : For existing buildings, NRB 1-3(a) may be excluded in computation, the total score obtained under NRB 1-3 (b), (c) and (d) will be prorated accordingly.</i></p>							
<p align="right">Sub-Total (B) :</p>	<p align="center">Sum of Green Mark Points obtained from NRB 1-3 to 1-4</p>						

Part 1 - Energy Efficiency	Green Mark Points								
(C) General									
<p><u>NRB 1-5 Daylighting</u></p> <p>Encourage design that optimises the use of effective daylighting to reduce energy use for artificial lighting.</p> <p>(a) Use of daylighting and glare simulation analysis to verify the adequacy of ambient lighting levels in meeting the illuminance level and Unified Glare Rating (UGR) stated in SS 531:Part 1:2006 – Code of Practice for Lighting of Work Places.</p> <p>(b) Daylighting for the following common areas:</p> <ul style="list-style-type: none"> (i) Toilets (ii) Staircases (iii) Corridors (iv) Lift Lobbies (v) Atriums (vi) Carparks <p>Note (5) : All daylit areas must be integrated with automatic electric lighting control system.</p>	<p>Extent of coverage: At least 75% of the units with daylighting provisions meet the minimum illuminance level and are within the acceptable glare exposure.</p> <p>Points scored based on the extent of perimeter daylight zones</p> <table border="1"> <thead> <tr> <th>Distance from the Façade Perimeters (m)</th> <th>Points Allocation</th> </tr> </thead> <tbody> <tr> <td>≥ 3.0</td> <td>1</td> </tr> <tr> <td>4.0 – 5.0</td> <td>2</td> </tr> <tr> <td>> 5.0</td> <td>3</td> </tr> </tbody> </table> <p>(Up to 3 points)</p> <p>Extent of Coverage : At least 80 % of each applicable area</p> <p>0.5 point each</p> <p>(Up to 3 points)</p>	Distance from the Façade Perimeters (m)	Points Allocation	≥ 3.0	1	4.0 – 5.0	2	> 5.0	3
Distance from the Façade Perimeters (m)	Points Allocation								
≥ 3.0	1								
4.0 – 5.0	2								
> 5.0	3								
<p><u>NRB 1-6 Artificial Lighting</u></p> <p>Encourage the use of energy efficient lighting to minimise energy consumption from lighting usage while maintaining proper lighting level.</p> <p><u>Baseline</u> = Maximum lighting power budget stated in SS 530</p>	<p>0.3 point for every percentage improvement in lighting power budget</p> <p>Points scored = 0.3 x (% improvement) (Including tenant lighting provision) (Up to 12 points)</p> <p>(Excluding tenant lighting provision) (Up to 5 points)</p>								
<p><u>NRB 1-7 Ventilation in Carparks</u></p> <p>Encourage the use of energy efficient design and control of ventilation systems in carparks.</p> <p>(a) Carparks designed with natural ventilation.</p> <p>(b) CO sensors are used to regulate the demand for mechanical ventilation (MV).</p> <p>Note (6) : Where there is a combination of different ventilation mode adopted for carpark design, the points obtained under NRB 1-7 will be prorated accordingly.</p>	<p>Naturally ventilated carparks – 4 points</p> <p>Points scored based on the mode of mechanical ventilation provided</p> <p>Fume extract – 2.5 points</p> <p>MV with or without supply - 2 points</p> <p>(Up to 4 points)</p>								

Part 1 - Energy Efficiency	Green Mark Points
(C) General	
<p><u>NRB 1-8 Ventilation in Common Areas</u></p> <p>Encourage the use of energy efficient design and control of ventilation systems in the following common areas :</p> <p>(a) Toilets (b) Staircases (c) Corridors (d) Lift lobbies (e) Atrium</p>	<p>Extent of Coverage : At least 90 % of each applicable area</p> <p>Points scored based on the mode of ventilation provided in the applicable areas</p> <p>Natural ventilation – 1.5 points for each area</p> <p>Mechanical ventilation – 0.5 point for each area</p> <p>(Up to 5 points)</p>
<p><u>NRB 1-9 Lifts and Escalators</u></p> <p>Encourage the use of energy efficient lifts and escalators.</p> <p>Lifts and/or escalators with AC variable voltage and variable frequency (VVVF) motor drive and sleep mode features.</p>	<p>Extent of Coverage : All lifts and escalators</p> <p>Lifts – 1 point</p> <p>Escalators – 1 point</p>
<p><u>NRB 1-10 Energy Efficient Practices & Features</u></p> <p>Encourage the use of energy efficient practices and features which are innovative and/or have positive environmental impact.</p> <p>(a) Computation of energy consumption based on design load in the form of energy efficiency index (EEI).</p> <p>(b) Use of vertical greenery system on east and west façade to reduce heat gain through building envelope.</p> <p>(c) Use of energy efficient features.</p> <p>Examples:</p> <ul style="list-style-type: none"> ■ Heat recovery system ■ Sun pipes ■ Lifts with gearless drive ■ Re-generative lift ■ Light shelves ■ Photocell sensors to maximise the use of daylighting ■ Heat pumps etc 	<p>1 point</p> <p>1 point for high impact 0.5 point for low impact</p> <p>3 points for every 1% energy saving over the total building energy consumption</p> <p>(Up to 10 points)</p>

Part 1 – Energy Efficiency	Green Mark Points											
(C) General												
<p><u>NRB 1-11 Renewable Energy</u> Encourage the application of renewable energy sources in buildings.</p>	<p>Point scored based on the expected energy efficiency index (EEI) and % replacement of electricity by renewable energy source</p> <table border="1"> <thead> <tr> <th rowspan="2">Expected Energy Efficiency Index (EEI)</th> <th colspan="2">Every 1 % replacement of electricity (based on total electricity consumption) by renewable energy source</th> </tr> <tr> <th>Include tenant's usage</th> <th>Exclude tenant's usage</th> </tr> </thead> <tbody> <tr> <td>≥ 30 kWh/m²/yr</td> <td>5 points</td> <td>3 points</td> </tr> <tr> <td>< 30 kWh/m²/yr</td> <td>3 points</td> <td>1.5 points</td> </tr> </tbody> </table> <p>(Up to 20 Points)</p>	Expected Energy Efficiency Index (EEI)	Every 1 % replacement of electricity (based on total electricity consumption) by renewable energy source		Include tenant's usage	Exclude tenant's usage	≥ 30 kWh/m ² /yr	5 points	3 points	< 30 kWh/m ² /yr	3 points	1.5 points
Expected Energy Efficiency Index (EEI)	Every 1 % replacement of electricity (based on total electricity consumption) by renewable energy source											
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Sub-Total (C) :	Sum of Green Mark Points obtained from NRB 1-5 to 1-11											
PART 1 – ENERGY EFFICIENCY CATEGORY SCORE :	<p>Sub-Total (A) X $\frac{\text{Air-Conditioned Building Floor Area}}{\text{Total Floor Area}}$ + Sub-Total (B) X $\frac{\text{Non Air-Conditioned Building Floor Area}}{\text{Total Floor Area}}$ + Sub-Total (C)</p> <p>where Sub-Total (A) = Sum of Green Mark Points obtained under Section (A) that is NRB 1-1 to 1-2</p> <p>Sub-Total (B) = Sum of Green Mark Points obtained under Section (B) that is NRB 1-3 to 1-4</p> <p>Sub-Total (C) = Sum of Green Mark Points obtained under Section (C) that is NRB 1-5 to 1-11</p>											

Part 2 – Water Efficiency	Green Mark Points										
<p><u>NRB 2-1 Water Efficient Fittings</u> Encourage the use of water efficient fittings covered under the Water Efficiency Labelling Scheme (WELS).</p> <p>(a) Basin taps and mixers (b) Flushing cistern (c) Shower taps, mixers or showerheads (d) Sink/Bib taps and mixers (e) Urinals and urinal flush valve</p>	<table border="1"> <tr> <th colspan="2">Rating based on Water Efficiency Labelling Scheme (WELS)</th> <td rowspan="4" style="vertical-align: top;"> Points scored based on the number and water efficiency rating of the fitting type used (Up to 10 points) </td> </tr> <tr> <td>Very Good</td> <td>Excellent</td> </tr> <tr> <th colspan="2">Weightage</th> </tr> <tr> <td>8</td> <td>10</td> </tr> </table>		Rating based on Water Efficiency Labelling Scheme (WELS)		Points scored based on the number and water efficiency rating of the fitting type used (Up to 10 points)	Very Good	Excellent	Weightage		8	10
Rating based on Water Efficiency Labelling Scheme (WELS)		Points scored based on the number and water efficiency rating of the fitting type used (Up to 10 points)									
Very Good	Excellent										
Weightage											
8	10										
<p><u>NRB 2-2 Water Usage and Leak Detection</u> Promote the use of sub-metering and leak detection system for better control and monitoring.</p> <p>(a) Provision of private meters to monitor the major water usage such as irrigation, cooling tower and tenants' usage.</p> <p>(b) Linking all private meters to the Building Management System (BMS) for leak detection.</p>	<p style="text-align: right;">1 point</p> <p style="text-align: right;">1 point</p>										
<p><u>NRB 2-3 Irrigation System and Landscaping</u> Provision of suitable systems that utilise rainwater or recycled water and use of plants that require minimal irrigation to reduce potable water consumption.</p> <p>(a) Use of non potable water including rainwater for landscape irrigation.</p> <p>(b) Use of automatic water efficient irrigation system with rain sensor.</p> <p>(c) Use of drought tolerant plants that require minimal irrigation.</p>	<p style="text-align: right;">1 point</p> <p style="text-align: right;">Extent of Coverage : At least 50% of the landscape areas are served by the system 1 point</p> <p style="text-align: right;">Extent of Coverage : At least 80% of the landscape areas 1 point</p>										
<p><u>NRB 2-4 Water Consumption of Cooling Tower</u> Reduce potable water use for cooling purpose.</p> <p>(a) Use of cooling tower water treatment system which can achieve 7 or better cycles of concentration at acceptable water quality.</p> <p>(b) Use of NEWater or on-site recycled water from approved sources.</p>	<p style="text-align: right;">1 point</p> <p style="text-align: right;">1 point</p>										
PART 2 – WATER EFFICIENCY CATEGORY SCORE :	Sum of Green Mark Points obtained from NRB 2-1 to 2-4										

Part 3 – Environmental Protection	Green Mark Points														
<p><u>NRB 3-1 Sustainable Construction</u></p> <p>Encourage recycling and the adoption of building designs, construction practices and materials that are environmentally friendly and sustainable</p> <p>(a) Use of Sustainable and Recycled Materials</p> <p>(i) Green Cements with approved industrial by-product (such as Ground Granulated Blastfurnace Slag (GGBS), silica fume, fly ash) to replace Ordinary Portland Cement (OPC) by at least 10% by mass for superstructural works.</p> <p>(ii) Recycled Concrete Aggregates (RCA) and Washed Copper Slag (WCS) from approved sources to replace coarse and fine aggregates for concrete production of main building elements.</p> <p>Note (7) : For structural building elements, the use of RCA and WCS shall be limited to maximum 10% replacement by mass of coarse/fine aggregates respectively or as approved by the relevant authorities.</p> <p>(b) Concrete Usage Index (CUI)</p> <p>Encourage designs with efficient use of concrete for building components.</p> <p><i>Prerequisite Requirement:</i> <i>Minimum points to be scored under this criterion:</i> <i>Green Mark Gold^{plus} ≥ 3 points</i> <i>Green Mark Platinum ≥ 5 points</i></p>	<p>1 point</p> <p>Extent of Coverage : The total quantity used (in tonnage) for replacement of the coarse or fine aggregates must not be less than the minimum usage requirement that is [0.03 x Gross Floor Area (GFA in m²)]</p> <p>2 points for the use of RCA to replace coarse aggregates</p> <p>2 points for the use of WCS to replace fine aggregates</p> <p>Where the total quantity used (in tonnage) for replacement of coarse or fine aggregates is at least two times (2x) that of the minimum usage requirement.</p> <p>4 points for the use of RCA</p> <p>4 points for the use of WCS</p> <p>(Up to 5 points for NRB 3-1(a)(i) and (a)(ii))</p> <table border="1"> <thead> <tr> <th>Project CUI (m³/m²)</th> <th>Points Allocation</th> </tr> </thead> <tbody> <tr> <td>≤ 0.70</td> <td>1 point</td> </tr> <tr> <td>≤ 0.60</td> <td>2 points</td> </tr> <tr> <td>≤ 0.50</td> <td>3 points</td> </tr> <tr> <td>≤ 0.40</td> <td>4 points</td> </tr> <tr> <td>≤ 0.35</td> <td>5 points</td> </tr> </tbody> </table>			Project CUI (m ³ /m ²)	Points Allocation	≤ 0.70	1 point	≤ 0.60	2 points	≤ 0.50	3 points	≤ 0.40	4 points	≤ 0.35	5 points
Project CUI (m ³ /m ²)	Points Allocation														
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<p><u>NRB 3-2 Sustainable Products</u></p> <p>Promote use of environmentally friendly products that are certified by approved local certification body and are applicable to non-structural and architectural related building components.</p>	<table border="1"> <thead> <tr> <th colspan="3">Weightage based on the extent of environmental friendliness of products</th> <th rowspan="2">Points scored based on the weightage and the extent of coverage & impact</th> </tr> <tr> <th>Good</th> <th>Very Good</th> <th>Excellent</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>1.5</td> <td>2</td> <td>1 point for high impact item 0.5 point for low impact item (Up to 8 points)</td> </tr> </tbody> </table>			Weightage based on the extent of environmental friendliness of products			Points scored based on the weightage and the extent of coverage & impact	Good	Very Good	Excellent	1	1.5	2	1 point for high impact item 0.5 point for low impact item (Up to 8 points)	
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Part 3 – Environmental Protection	Green Mark Points														
<p><u>NRB 3-3 Greenery Provision</u></p> <p>Encourage greater use of greenery, restoration of trees to reduce heat island effect.</p> <p>(a) Green Plot Ratio (GnPR) is calculated by considering the 3D volume covered by plants using the prescribed Leaf Area Index (LAI). (Reference : http://floraweb.nparks.gov.sg/)</p> <p>(b) Restoration of trees on site, conserving or relocating of existing trees on site.</p> <p>(c) Use of compost recycled from horticulture waste.</p>	<table border="1"> <thead> <tr> <th>GnPR</th> <th>Points Allocation</th> </tr> </thead> <tbody> <tr> <td>0.5 to < 1.0</td> <td>1</td> </tr> <tr> <td>1.0 to < 1.5</td> <td>2</td> </tr> <tr> <td>1.5 to < 3.0</td> <td>3</td> </tr> <tr> <td>3.0 to < 3.5</td> <td>4</td> </tr> <tr> <td>3.5 to < 4.0</td> <td>5</td> </tr> <tr> <td>≥ 4.0</td> <td>6</td> </tr> </tbody> </table> <p>1 point</p> <p>1 point</p>	GnPR	Points Allocation	0.5 to < 1.0	1	1.0 to < 1.5	2	1.5 to < 3.0	3	3.0 to < 3.5	4	3.5 to < 4.0	5	≥ 4.0	6
GnPR	Points Allocation														
0.5 to < 1.0	1														
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3.5 to < 4.0	5														
≥ 4.0	6														
<p><u>NRB 3-4 Environmental Management Practice</u></p> <p>Encourage the adoption of environmental friendly practices during construction and building operation.</p> <p>(a) Implement effective environmental friendly programmes including monitoring and setting targets to minimise energy use, water use and construction waste.</p> <p>(b) Main builder that has good track records in the adoption of sustainable, environmentally friendly and considerate practices during construction such as the Green and Gracious Builder Award.</p> <p>(c) Building quality assessed under the Construction Quality Assessment System (CONQUAS).</p> <p>(d) Developer, main builder, M & E consultant and architect that are ISO 14000 certified.</p> <p>(e) Project team comprises Certified Green Mark Manager (GMM), Green Mark Facilities Manager (GMFM) and Green Mark Professional (GMP).</p> <p>(f) Provision of building users' guide which should include details of the environmental friendly facilities and features within the building and their functionalities in achieving the intended environmental performance during building operation.</p> <p>(g) Provision of facilities or recycling bins for collection and storage of different recyclable waste such as paper, glass, plastic food waste etc.</p>	<p>1 point</p> <p>1 point</p> <p>1 point</p> <p>0.25 point for each firm (Up to 1 point)</p> <p>0.5 point for certified GMM 0.5 point for certified GMFM 1 point for certified GMP (Up to 1 point)</p> <p>1 point</p> <p>1 point</p>														

Part 3 – Environmental Protection	Green Mark Points
<p><u>NRB 3-5 Green Transport</u></p> <p>Promote environmental friendly transport options and facilities to reduce pollution from individual car use.</p> <p>(a) Good access to nearest MRT/LRT or bus stops.</p> <p>(b) Provision of covered walkway to facilitate connectivity and the use of public transport.</p> <p>(c) Provision of electric vehicle charging stations and priority parking lots within the development.</p> <p>(d) Provision of sheltered bicycle parking lots with adequate shower and changing facilities.</p>	<p>1 point</p> <p>1 point</p> <p>1 point</p> <p>Extent of Coverage : Minimum 10 number of bicycle parking lots, cap at 50 where applicable</p> <p>Points scored based on the number of bicycle parking lots provided (<i>with adequate shower and changing facilities</i>)</p> <p>1 point if the number provided $\geq 3\% \times \text{Gross Floor Area (GFA)}/10$</p> <p>0.5 point if the number provided $\geq 1.5\% \times \text{Gross Floor Area (GFA)}/10$</p>
<p><u>NRB 3-6 Refrigerants</u></p> <p>Reduce the potential damage to the ozone layer and the increase in global warming through the release of ozone depleting substances and greenhouse gases.</p> <p>(a) Refrigerants with ozone depletion potential (ODP) of zero or with global warming potential (GWP) of less than 100.</p> <p>(b) Use of refrigerant leak detection system at critical areas of plant rooms containing chillers and other equipments with refrigerants.</p>	<p>1 point</p> <p>1 point</p>
<p><u>NRB 3-7 Stormwater Management</u></p> <p>Encourage treatment of stormwater run-off before discharge to the public drains.</p> <p>Provision of infiltration features or design features as recommended in PUB's ABC Waters Design Guidelines :</p> <ul style="list-style-type: none"> ▪ Bioretention swales/ other bioretention systems ▪ Rain gardens ▪ Constructed wetlands ▪ Cleansing biotopes ▪ Retention ponds 	<p>Points scored based on the extent of the stormwater treatment.</p> <p>3 points for treatment of run-off from more than 35% of total site area or paved area</p> <p>2 points for treatment of run-off from 10% to 35% of total site area</p> <p>1 point for treatment of run-off from up to 10% of total site area</p>
<p align="center">PART 3 – ENVIRONMENTAL PROTECTION CATEGORY SCORE :</p>	<p align="center">Sum of Green Mark Points obtained from NRB 3-1 to 3-7</p>

Part 4 – Indoor Environmental Quality	Green Mark Points
<p><u>NRB 4-1 Thermal Comfort</u></p> <p>Air-conditioning system is designed to allow for cooling load variation due to fluctuations in ambient air temperature to ensure consistent indoor conditions for thermal comfort.</p> <p>Indoor operative temperature between 24 °C to 26 °C Relative Humidity < 65%</p>	<p>1 point</p>
<p><u>NRB 4-2 Noise Level</u></p> <p>Occupied spaces in buildings are designed with good ambient sound levels as recommended in SS 553 Table 8 – Recommended ambient sound level.</p>	<p>1 point</p>
<p><u>NRB 4-3 Indoor Air Pollutants</u></p> <p>Minimise airborne contaminants, mainly from inside sources to promote a healthy indoor environment.</p> <p>(a) Use of low volatile organic compounds (VOC) paints certified by approved local certification body.</p> <p>(b) Use of environmental friendly adhesives certified by approved local certification body.</p>	<p>Extent of Coverage : At least 90% of the total internal wall areas 1 point</p> <p>Extent of Coverage : At least 90% of the applicable areas 1 point</p>
<p><u>NRB 4-4 Indoor Air Quality (IAQ) Management</u></p> <p>Ensure that building ventilation systems are designed and installed to provide acceptable IAQ under normal operating conditions.</p> <p>(a) Provision of filtration media and differential pressure monitoring equipment in Air Handling Units (AHUs) in accordance with SS 554: Clause 4.3.4.5 and Annex E.</p> <p>(b) Implement effective IAQ management plan to ensure that building ventilation systems are clean and free from residuals left over from construction activities. Internal surface condition testing for ACMV systems are to be included.</p>	<p>1 point</p> <p>1 point</p>
<p><u>NRB 4-5 High Frequency Ballasts</u></p> <p><i>Applicable to offices, classrooms and the like</i></p> <p>Improve workplace lighting quality by avoiding low frequency flicker associated with fluorescent lighting with the use of high frequency ballasts in the fluorescent luminaries.</p>	<p>Extent of Coverage : At least 90% of all applicable areas that are served by fluorescent luminaries 2 points</p>
<p>PART 4 – INDOOR ENVIRONMENTAL QUALITY CATEGORY SCORE :</p>	<p>Sum of Green Mark Points obtained from NRB 4-1 to 4-5</p>

Part 5 – Other Green Features	Green Mark Points
<p><u>NRB 5-1 Green Features and Innovations</u></p> <p>Encourage the use of other green features which are innovative and/or have positive environmental impact.</p> <p>Examples :</p> <ul style="list-style-type: none"> ▪ Pneumatic waste collection system ▪ Carbon footprint of development ▪ Dual chute system ▪ Self cleaning façade system ▪ Conservation of existing building structure ▪ etc 	<p>2 points for high impact item</p> <p>1 point for medium impact item</p> <p>0.5 point for low impact item</p> <p>(Up to 7 points)</p>
<p>PART 5 – OTHER GREEN FEATURES CATEGORY SCORE :</p>	<p>Sum of Green Mark Points obtained from NRB 5-1</p>
<p>Green Mark Score (Non-Residential)</p> <p>Green Mark Score (Non-Res) = \sumCategory Score [(Part 1 – Energy Efficiency) + (Part 2 – Water Efficiency) + (Part 3 – Environmental Protection) + (Part 4 – Indoor Environmental Quality) + (Part 5 – Other Green Features)]</p> <p>where Category Score for Part 1 \geq 30 points and \sumCategory Score for Part 2, 3, 4 & 5 \geq 20 points</p>	