Building and Construction Authority

BCA Green Mark

Certification Standard for New Buildings

GM Version 3.0

The BCA Green Mark Certification Standard for New Buildings
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Building and Construction Authority

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BCA GREEN MARK CERTIFICATION STANDARD FOR NEW BUILDINGS

APPENDIXES

INTRODUCTION

The intent of this Certification Standard for New Buildings (referred to as “this Standard”) is to establish environmentally friendly practices for the planning, design and construction of buildings, which would help to mitigate the environmental impact of built structures.

This Standard sets out the requirement for assessing the environmental performance of a building development.

This Standard is not intended to abridge safety, health, environmental or related requirements contained in other applicable laws, codes or policies administered by relevant authorities. Where there is a conflict between a requirement of this Standard and such other laws affecting the design and construction of the building, precedence shall be determined by the relevant authorities.

If you need clarification on any aspect of this Standard, please contact the Building and Construction Authority, Singapore.

1 SCOPE

This Standard sets out the requirement for assessing the environmental performance of a building development. It provides the assessment criteria in determining the level of environmental performance of a building development.

The provisions of this Standard are applicable to :

a. New buildings and related building systems ; and

b. New building works and related building systems in existing buildings undergoing major retrofitting.

2 NORMATIVE REFERENCES

The following referenced codes, standards and other documents referred in this Standard shall be considered part of the requirements of this Standard to the extent as prescribed.

a. Code on Envelope Thermal Performance for Buildings

b. SS 530 - Code of Practice for Energy Efficiency Standard for Building Services and Equipment

c. SS CP 13 - Code of Practice for Mechanical Ventilation and Air-Conditioning in Buildings

d. SS CP 38 - Code of Practice for Artificial Lighting in Buildings

e. SS 531-1 - Code of Practice for Lighting of Work Places - Indoor

3 TERMS AND DEFINITIONS

For the purpose of this Standard, the following terms and definitions shall apply:

Dwelling unit — A unit within residential development that provides complete, independent living facilities for one or more person.

Green Mark Score — The score for environmental performance of buildings computed in accordance with the criteria and the scoring methodology set out in this Standard.

Gross Floor Area — The gross floor area is calculated using the definition by the Urban Redevelopment Authority (URA).

Major Retrofitting — The provision, extension or substantial alteration of the building envelope and building services in or in connection with an existing building.

In instances where terms are not expressly stated in this Standard and are defined in other referenced documents, such terms shall have the meanings as determined in those documents.

4 CERTIFICATION PROCESS

The BCA Green Mark Certification Process is as follows :

- 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.

- A pre-assessment audit will be conducted to give the project team a better understanding of the criteria and evaluation of the certification level sought.

- Actual assessment to be conducted once the design and documentary evidences are ready.
- Assessment process includes design and documentary reviews to verify if the building project meets (a) the intents of the criteria and certification level; and (b) the pre-requisite requirement for BCA Green Mark Gold^{Plus} and Platinum rating where applicable.
- Letter of award showing the BCA Green Mark rating will be issued at this stage.

- Site verification to be conducted upon project completion.
- For projects with BCA Gold^{Plus} and Platinum rating, energy Modeling for reference model using actual data is to be carried out to ascertain the energy savings.
- A certificate will be issued at this stage.

5 ASSESSMENT FRAMEWORK

5.1 General

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 (as shown in Appendix A and B) and the pre-requisite requirements on the level of building performance as specified in this Standard. 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 four rating namely BCA Green Mark Certified, Gold , Gold^{Plus} or Platinum (see Table 5.2). The design of the building development shall also meet all the relevant mandatory requirements regulated under Part IV of the Building Control Regulations 2003.

5.2 Environmental Performance of Buildings for Certification

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 5.2 states the corresponding Green Mark Score to the respective Green Mark rating and the pre-requisite requirements to attain the BCA Gold^{Plus} and Platinum Rating.

Table 5.2 – BCA Green Mark Award Rating and Pre-requisite 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 BCA Green Mark Gold^{Plus} and Platinum Rating

Residential Building Criteria

- Building envelope design with Residential Envelope Thermal Transmittance (RETV) computed based on the methodology and guidelines stipulated in the Code on Envelope Thermal Performance for Buildings and this Standard.

  Green Mark Gold^{Plus} – RETV of 22 W/m^2 or lower
  Green Mark Platinum – RETV of 20 W/m^2 or lower

- To be eligible for Green Mark Platinum Rating, ventilation simulation must be carried out 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 this Standard.

Non-Residential Building Criteria

Air-Conditioned Buildings

- 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/m^2 or lower
  Green Mark Platinum – ETTV of 40 W/m^2 or lower

- To demonstrate the stipulated energy savings over its reference model using an energy modelling framework set out. Details and submission requirements on energy modelling can be found in Appendix D of this Standard.

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

Non Air-Conditioned Buildings

- To be eligible for Green Mark Platinum Rating, ventilation simulation must be carried out 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 this Standard.

5.3 Assessment Criteria

5.3.1 There are basically two sets of criteria in this Standard namely, the Residential Building Criteria and Non-Residential Building Criteria. The framework and point allocations for the respective assessment criteria are as illustrated in Table 5.3.1(a) and (b).

5.3.2 The criteria consist of five(5) environmental impact categories namely :

(a) *Part 1 – Energy Efficiency :* This category focuses on the approach that can be used in the building design and system selection to optimise the energy efficiency of buildings.

(b) *Part 2 – Water Efficiency :* This category focuses on the selection of water use efficiency during construction and building operations.

(c) *Part 3 – Environmental Protection :* This category focuses on the design, practices and selection of materials and resources that would reduce the environmental impacts of built structures.

(d) *Part 4 – Indoor Environmental Quality* : This category focuses on the design strategies that would enhance the indoor environmental quality which includes air quality, thermal comfort, acoustic control and daylighting.

(e) *Part 5 – Other Green Features* : This category focuses on the adoption of green practices and new technologies that are innovative and have potential environmental benefits.

5.3.3 These environmental impact categories are broadly classified under two main groupings namely (I) Energy Related Requirements and (II) Other Green Requirements.

5.3.4 Energy Related Requirements consist of Part 1- Energy Efficiency where points are allocated for the various energy efficient designs, practices and features used. A minimum of 30 points must be obtained from this group to be eligible for certification. The number of points achievable for this group is capped at 50 points (exclude 20 bonus points that are obtainable under RB 1-8 and NRB 1-10 - Renewable Energy).

5.3.5 Other Green Requirements consist of Part 2 – Water Efficiency, Part 3 – Environmental Protection, Part 4 – Indoor Environmental Quality and Part 5 – Other Green Features. Points are allocated for the water efficient features, environmentally friendly design practices and innovative green features used. A minimum of 20 points must be obtained from this grouping to be eligible for certification. The number of points achievable for this group is also capped at 50 points.

5.3.6 The maximum Green Mark score achievable for a project is capped at 100 points and this does not include 20 bonus points that are obtainable under Energy Related Requirements if a project uses renewable energy sources.

5.3.7 Under the non-residential building criteria, the environmental impact category Part 1 – Energy Efficiency applies to both air-conditioned and non air-conditioned spaces. Where there is a combination of air-conditioned and non air-conditioned spaces, the points allocated are to be prorated in accordance with the respective floor areas. For simplicity, points applicable to air-conditioned areas are accounted only if the aggregate air-conditioned areas

exceed 500 m^2. Similarly, points applicable to non air-conditioned areas are accounted only if the aggregate non air-conditioned areas are more than 10% of the total floor areas excluding carparks.

5.3.8 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 listed in Table 5.3.8(a) and (b) and the scoring methodology stated in Appendix A and B.

Table 5.3.1(a) : Framework and Point Allocations for Residential Building Criteria

		Category	Point Allocations
(I)		**Energy Related Requirements**	
Maximum Cap of 50 points	**Minimum 30 points**	**Part 1 : Energy Efficiency**	
		RB 1-1 Building Envelope – RETV	15
		RB 1-2 Dwelling Unit Indoor Comfort	16
		RB 1-3 Natural Ventilation in Common Areas	2
		RB 1-4 Lighting	15
		RB 1-5 Ventilation in Carparks	8
		RB 1-6 Lifts	2
		RB 1-7 Energy Efficient Features	7
		Category Score for Part 1 – Energy Efficiency (Exclude Bonus Points)	**65**
Bonus 20 points		RB 1-8 Renewable Energy (Bonus Points)	20
(II)		**Other Green Requirements**	
Maximum Cap of 50 points	**Minimum 20 points**	**Part 2 : Water Efficiency**	
		RB 2-1 Water Efficient Fittings	10
		RB 2-2 Water Usage	1
		RB 2-3 Irrigation System	2
		Category Score for Part 2 – Water Efficiency	**13**
		Part 3 : Environmental Protection	
		RB 3-1 Sustainable Construction	12
		RB 3-2 Greenery	6
		RB 3-3 Environmental Management Practice	9
		RB 3-4 Public Transport Accessibility	2
		Category Score for Part 3 – Environmental Protection	**29**
		Part 4 : Indoor Environmental Quality	
		RB 4-1 Noise Level	1
		RB 4-2 Indoor Air Pollutants	3
		RB 4-3 Waste Disposal	1
		RB 4-4 Indoor Air Quality in Wet Areas	1
		Category Score for Part 4 – Indoor Environmental Quality	**6**
		Part 5 : Other Green Features	
		RB 5-1 Green Features & Innovations	7
		Category Score for Part 5 – Other Green Features	**7**
		Total Points Allocated :	**120**
		Total Point Allocated (Include BONUS points):	**140**
		Green Mark Score (Max) :	**100 + Bonus 20 points**

Table 5.3.1(b) : Framework and Point Allocations for Non-Residential Building Criteria

Category			Point Allocations
(I) Energy Related Requirements			
Maximum Cap of 50 points / Minimum 30 points	**Part 1 : Energy Efficiency**		
	NRB 1-1 Building Envelope – ETTV NRB 1-2 Air-Conditioning System	Section (A) Applicable to air-con areas	15 27
	Sub-Total (A) - NRB 1-1 to 1-2		42
	NRB 1-3 Building Envelope – Design/Thermal Parameters NRB 1-4 Natural Ventilation (exclude carparks)	Section (B) Applicable to non air-con areas	29 13
	Sub-Total (B) - NRB 1-3 to 1-4		42
	NRB 1-5 Artificial Lighting NRB 1-6 Ventilation in Carparks NRB 1-7 Ventilation in Common Areas NRB 1-8 Lifts and Escalators NRB 1-9 Energy Efficient Practices & Features	Section (C) Generally applicable to all areas	12 5 5 3 12
	Sub-Total (C) - NRB 1-5 to 1-9		37
	Category Score for Part 1 – Energy Efficiency (Exclude Bonus Points) **Prorate Subtotal (A) + Prorate Subtotal (B) + Subtotal (C)**		**79**
Bonus 20 points / Minimum 30 points	NRB 1-10 Renewable Energy *(Bonus Points)*		20
(III) Other Green Requirements			
Maximum Cap of 50 points / Minimum 20 points	**Part 2 : Water Efficiency**		
	NRB 2-1 Water Efficient Fittings		8
	NRB 2-2 Water Usage and Leak Detection		2
	NRB 2-3 Irrigation System		2
	NRB 2-4 Water Consumption of Cooling Tower		2
	Category Score for Part 2 – Water Efficiency		**14**
	Part 3 : Environmental Protection		
	NRB 3-1 Sustainable Construction		14
	NRB 3-2 Greenery		6
	NRB 3-3 Environmental Management Practice		8
	NRB 3-4 Public Transport Accessibility		2
	NRB 3-5 Refrigerants		2
	Category Score for Part 3 – Environmental Protection		**32**
	Part 4 : Indoor Environmental Quality		
	NRB 4-1 Thermal Comfort		2
	NRB 4-2 Noise Level		2
	NRB 4-3 Indoor Air Pollutants		2
	NRB 4-4 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**
		Total Points Allocated :	**140**
		Total Point Allocated (Include BONUS points):	**160**
		Green Mark Score (Max) :	**100 + Bonus 20 points**

Table 5.3.8(a) : Residential Building Criteria

Part 1 - Energy Efficiency	Green Mark Points
RB 1-1 Building Envelope – RETV Enhance the overall thermal performance of building envelope to minimise heat gain thus reducing the overall cooling load when required. Baseline : Maximum Permissible RETV = 25 W/m^2 *Pre-requisite Requirement :* *Green Mark Gold^{Plus} - RETV of 22 W/m^2 or less* *Green Mark Platinum – RETV of 20 W/m^2 or less*	3 points for every reduction of 1 W/m^2 in RETV from the baseline Points scored = 75 – [3 x (RETV)] where RETV ≤ 25 W/m^2 (Up to 15 points)
RB 1-2 Dwelling Unit Indoor Comfort Enhance dwelling unit indoor comfort either through the provision of better efficient air-conditioners or good natural ventilation design. (a)(i) Use of energy efficient air-conditioners that are certified under the Singapore Energy Labelling Scheme. OR (a)(ii) Design for natural ventilation (applicable to development where air-conditioners are not provided). • Building layout design : Proper design of building layout that utilises prevailing wind conditions to achieve adequate cross ventilation. • Dwelling unit design : Good ventilation in indoor units through sufficient openings. (b) Use of ventilation simulation software to identify the most effective building design and layout to achieve good natural ventilation. *Pre-requisite Requirement :* *Ventilation simulation must be carried out to be eligible for Green Mark Platinum rating.*	Extent of Coverage : At least 90% of the air-conditioners used in all dwelling units Air-conditioners labelled with : Two Ticks – 2 points Three Ticks – 6 points Four Ticks – 12 points OR 0.6 point for every 10% of units with window openings facing north and south directions Points scored = 0.6 x (% of units/10) (Up to 6 points) 0.6 point for every 10 % of living rooms and bedrooms designed with true cross ventilation Points scored = 0.6 x (% rooms /10) (Up to 6 points) Points can only be scored if the recommendations from ventilation simulations are implemented 4 points
RB 1-3 Natural Ventilation in Common Areas Design for natural ventilation in following common areas : (a) Lift lobbies and corridors (b) Staircases	Extent of Coverage : All applicable areas 1 point 1 point

Part 1 - Energy Efficiency	Green Mark Points
RB 1-4 Lighting Encourage the use of better efficient lighting and daylighting in common areas to minimise energy consumption from lighting usage while maintaining proper lighting level. (a) Artificial lighting in common areas. Baseline = Maximum lighting power budget stated in SS 530 (b) Daylighting in the following areas : (i) Lift lobbies and corridors (ii) Staircases (iii) Carparks	0.3 point for every percentage improvement in the lighting power budget Points scored = 0.3 x (% improvement) (Up to 12 points) 1 point 1 point 1 point
RB 1-5 Ventilation in Carparks Encourage the use of energy efficient design and control of ventilation systems in carparks. (a) Carparks designed with natural ventilation. (b) CO sensors are used to regulate the demand for mechanical ventilation (MV). Note (1) : Where there is a combination of different ventilation modes adopted for carpark design, the points obtained will be prorated accordingly.	Naturally ventilated carparks - 8 points Points scored based on the mode of mechanical ventilation provided Fume extract – 6 points MV with or without supply - 4 points
RB 1-6 Lifts Encourage the use of lifts with the following energy efficient features : (a) AC variable voltage and variable frequency (VVVF) motor drive or equivalent. (b) Sleep mode features or equivalent.	Extent of Coverage : All lifts 1 point 1 point
RB 1-7 Energy Efficient Features Encourage the use of energy efficient features which are innovative and have positive environmental impact. Examples : ▪ Heat recovery devices ▪ Cool paints ▪ Motion sensors at staircase half landing ▪ Heat elevators ▪ Gas heaters ▪ Sun pipes ▪ etc	2 points for high impact item 1 point for medium impact item 0.5 point for low impact item (Up to 7 points)
Sub-Total (A) :	Sum of Green Mark Points obtained from RB 1-1 to 1-7

Part 1 - Energy Efficiency	Green Mark Points
RB 1-8 Renewable Energy Encourage the application of renewable energy sources in buildings. (a) Solar energy (b) Other renewable energy	***(Bonus points)*** 1 point for every 3 kWp of solar energy 1 point for every 1% replacement of electricity (exclude household's usage) by renewable energy (Up to 20 points)
PART 1 – ENERGY EFFICIENCY CATEGORY SCORE :	Sub-total (A) + Bonus points (RB 1-8) where Sub-Total (A) = Sum of Green Mark Points obtained from RB 1-1 to 1-7

<table>
<tr><th>Part 2 – Water Efficiency</th><th colspan="4">Green Mark Points</th></tr>
<tr><td rowspan="3"><u>RB 2-1 Water Efficient Fittings</u>

Encourage the use of water efficient fittings that are certified under the Water Efficiency Labelling Scheme (WELS).

(a) Basin taps and mixers
(b) Flushing cisterns
(c) Showerheads, taps and mixers
(d) Sink/Bib taps and mixers
(e) All other water fittings</td><td colspan="3">Rating based on Water Efficiency Labelling Scheme (WELS)</td><td rowspan="3">Extent of coverage :

At least 90% of the fitting type used

(Up to 10 points)</td></tr>
<tr><td>Good</td><td>V Good</td><td>Excellent</td></tr>
<tr><td>0.5 point</td><td>1 point</td><td>2 points</td></tr>
<tr><td><u>RB 2-2 Water Usage</u>

Provision of sub-meters to monitor the major water usage such as irrigation, swimming pools and other water features.</td><td colspan="4">1 point</td></tr>
<tr><td><u>RB 2-3 Irrigation System</u>

Provision of suitable systems that utilise rainwater or recycled water for landscape irrigation to reduce potable water consumption.

(a) Use of non potable water including rainwater for landscape irrigation.

(b) Use of water efficient irrigation system.</td><td colspan="4">1 point

Extent of Coverage : At least 50% of the landscape areas are served by the system

1 point</td></tr>
<tr><td>PART 2 – WATER EFFICIENCY CATEGORY SCORE :</td><td colspan="4">Sum of Green Mark Points obtained from RB 2-1 to 2-3</td></tr>
</table>

Part 3 – Environmental Protection	Green Mark Points
RB 3-1 Sustainable Construction Encourage the adoption of building designs, construction practices and materials that are environmentally friendly and sustainable.	
(a) More efficient concrete usage for building components.	0.1 point for every percentage reduction in the prescribed Concrete Usage Index (CUI) limit for residential buildings *(refer to page 49 for CUI limit)* (Up to 4 points)
(b) Conservation of existing building structure. Applicable to existing structural elements or building envelope.	Extent of Coverage : Conserve at least 50 % of the existing structural elements or building envelope (by area) 2 points
(c) Use of sustainable materials and products in building construction such as :	
(i) Environmental friendly products that are certified under the Singapore Green Labelling Scheme (SGLS).	1 point for high impact item 0.5 point for low impact item (Cap at 3 points)
(ii) Products with at least 30% recycled content by weight or volume (applicable only to non-structural elements). Note (2) : For products that are certified under SGLS and with at least 30% recycled contents, points can only be scored either from RB 3-1(c)(i) or (c)(ii).	1 point for high impact item 0.5 point for low impact item (Cap at 3 points) (Up to 6 points)
RB 3-2 Greenery Encourage greater use of greenery, restoration of trees to reduce heat island effect.	
(a) Greenery Provision (GnP) is calculated by considering the 3D volume covered by plants using the following Green Area Index (GAI) : Grass GAI = 1 ; Shrubs GAI = 3; Palms Trees GAI = 4; Trees GAI = 6	GnP = 2.0 to < 3.0 – 1 point GnP = 3.0 to < 3.5 – 2 points GnP = 3.5 to < 4.0 – 3 points GnP ≥ 4.0 – 4 points
(b) Restoration of trees on site, conserving or relocating of existing trees on site.	1 point
(c) Use of compost recycled from horticulture waste.	1 point

Part 3 – Environmental Protection	Green Mark Points
RB 3-3 Environmental Management Practice Encourage the adoption of environmental friendly practices during construction and building operation.	
(a) Implement effective environmental management programmes including monitoring and setting of targets to minimise energy use, water use and construction waste.	1 point
(b) Building quality assessed under the Construction Quality Assessment System (CONQUAS) and Quality Mark Scheme.	1 point each (Up to 2 points)
(c) Developer, main builder, M & E consultant and architect that are ISO 14000 certified.	0.25 point for each firm (Up to 1 point)
(d) Project team comprises one Certified Green Mark Manager (GMM) and/or one Certified Green Mark Professional (GMP).	1 point for GMM / 2 points for GMP (Up to 3 points)
(e) Provision of building users' guide including details of the environmental friendly facilities and features within the building and their uses in achieving the intended environmental performance during building operation.	1 point
(f) Provision of facilities or recycling bins for collection and storage of different recyclable waste such as paper, glass, plastic etc.	1 point
RB 3-4 Public Transport Accessibility Promote the use of public transport or bicycles to reduce pollution from individual car use with the following provision :	
(a) Good access to nearest MRT/LRT stations or bus stops.	1 point
(b) Adequate bicycle parking lots.	1 point
PART 3 – ENVIRONMENTAL PROTECTION CATEGORY SCORE :	Sum of Green Mark Points obtained from RB 3-1 to 3-4

Part 4 – Indoor Environmental Quality	Green Mark Points
RB 4-1 Noise Level Building design to achieve ambient internal noise level as specified : 55 dB (6am-10pm) LeqA 45 dB (10pm-6 am) LeqA	1 point
RB 4-2 Indoor Air Pollutants Minimise airborne contaminants, mainly from inside sources to promote a healthy indoor environment. (a) Use of low volatile organic compounds (VOC) paints certified under the Singapore Green Labelling Scheme (SGLS). (b) Use of adhesives certified under the Singapore Green Labelling Scheme (SGLS) for composite wood products.	Extent of Coverage : At least 90% of the total internal wall areas 2 points 1 point
RB 4-3 Waste Disposal Minimise airborne contaminants from waste by locating refuse chutes at open ventilation areas such as service balconies or common corridors.	1 point
RB 4-4 Indoor Air Quality in Wet Areas Provision of adequate natural ventilation and daylighting in wet areas such as kitchens, bathrooms and toilets.	Extent of Coverage : At least 90% of all applicable areas 1 point
PART 4 – INDOOR ENVIRONMENTAL QUALITY CATEGORY SCORE :	Sum of Green Mark Points obtained from RB 4-1 to 4-4

Part 5 – Other Green Features	Green Mark Points
RB 5-1 Green Features and Innovations Encourage the use of other green features which are innovative and have positive environmental impact. Examples : ▪ Pneumatic waste collection system ▪ Dual chute system ▪ Self cleaning façade system ▪ Infiltration trenches ▪ Integrated storm water retention/treatment into landscaping ▪ etc	2 points for high impact item 1 point for medium impact item 0.5 point for low impact item (Up to 7 points)
PART 5 – OTHER GREEN FEATURES CATEGORY SCORE :	Sum of Green Mark Points obtained from RB 5-1

Green Mark Score (Residential)

Green Mark Score (Res) = ∑Category Score [(Part 1 – Energy Efficiency) +
(Part 2 – Water Efficiency) +
(Part 3 – Environmental Protection) +
(Part 4 – Indoor Environmental Quality) +
(Part 5 – Other Green Features)]

where Category Score for Part 1 ≥ 30 points and
∑Category Score for Part 2, 3, 4 & 5 ≥ 20 points

Table 5.3.8(b) : 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)	
NRB 1-1 Building Envelope – ETTV Enhance the overall thermal performance of building envelope to minimise heat gain thus reducing the overall cooling load requirement. Baseline : Maximum Permissible ETTV = 50 W/m^2 *Pre-requisite Requirement :* *Green Mark Gold^{Plus} - ETTV of 42 W/m^2 or less* *Green Mark Platinum – ETTV of 40 W/m^2 or less*	2 points for every reduction of 1 W/m^2 in ETTV from the baseline Points scored = 100 – [2 x (ETTV)] where ETTV ≤ 50 W/m^2 (Up to 15 points)
NRB 1-2 Air-Conditioning System Encourage the use of better efficient air-conditioned equipment to minimise energy consumption. Baseline : Minimum efficiency requirement of the air-conditioning system stated in SS 530 & SS CP 13. The systems to be considered are as follows - (a)(i) Air-Conditioned Plant : • Chiller • Chilled-water pump • Condenser water pump • Cooling tower (a)(ii) Air Distribution System : • Air Handling Units (AHUs) • Fan Coil Units (FCUs) Note (1) : For buildings using district cooling system, there is no need to compute the plant efficiency under NRB 1-2 (a)(i). The points obtained will be pro-rated based on the air distribution system efficiency under NRB 1-2(a)(ii). OR (b) Unitary Air-Conditioners/Condensing Units : • Single-Spilt Unit • Multi-Spilt Unit • Variable Refrigerant Volume (VRV) System Note (2) : Where there is a combination of centralised air-con system with unitary air-conditioned system, the computation for the points scored will only be based on the air-conditioning system with a larger aggregate capacity. (c) Sensors or similar automatic control devices are used to regulate outdoor air flow rate to maintain the concentration of carbon dioxide below 1000ppm	(a)(i) Air-Conditioned Plant 1.45 points for every percentage improvement in the efficiency of chiller, chilled-water pump and condenser water pump. Points scored = 1.45 x (% improvement) 0.05 point for every percentage improvement in the performance required for cooling tower. Points scored = 0.05 x (% improvement) (Up to 20 points) (a)(ii) Air Distribution System 0.5 points for every percentage improvement in the air distribution system efficiency. Points scored = 0.5 x (% improvement) (Up to 5 points) OR (b) Unitary Air-Conditioners/Condensing Units 1.5 points for every percentage (average) improvement in the efficiency of all unitary air-conditioners/ condensing units. Points scored = 1.5 x (% improvement) (Up to 25 points) 2 points
Sub-Total (A) :	Sum of Green Mark Points obtained from NRB 1-1 to 1-2

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)	
NRB 1-3 Building Envelope – Design / Thermal Parameters Enhance the overall thermal performance of building envelope to minimise heat gain which would improve indoor thermal comfort and encourage natural ventilation.	
(a) Minimum direct west facing façade through building design orientation. 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.	Points scored = 10 – [0.2 x (% of west facing facade areas over total façade areas)] (Up to 10 points) Where there is no west facing façade, the total points scored for this item will be 24 points; the NRB 1-3 b(i), b(ii) and (c) as listed below will not be applicable.
(b)(i) Minimum west facing window openings.	Points scored = 10 – [0.1 x (% of west facing window areas over total west facing façade areas)]
(b)(ii) Effective sunshading provision for windows on the west façade with minimum shading of 30%.	Points scored = 0.1 x (% of west facing window areas with sunshading devices over total west facing façade areas) (Up to 10 points for NRB 1-3b(i) & b(ii))
(c) Better thermal transmittance (U-value) of external west facing walls. The U-value of external west facing walls should be equal or less than 2 W/m^{2}K.	Points scored = 0.04 x (% of the external west facing walls areas with U value of 2 W/m^{2}K or less over total west facing facades areas) (Up to 4 points)
(d) Better thermal transmittance (U-value) of roof. Baseline: U-value for roof stated below depending on the weight range of roof structure: 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	2 points for every 0.1 W/m^{2}K reduction (Up to 5 points)

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)	
NRB 1-4 Natural Ventilation (exclude carparks) Enhance building design to achieve good natural ventilation. (a) Proper design of building layout that utilizes prevailing wind conditions to achieve adequate cross ventilation. (b) Use of ventilation simulation software to identify the most effective building design and layout to achieve good natural ventilation. *Pre-requisite Requirement :* *Ventilation simulation must be carried out to be eligible for Green Mark Platinum rating.*	0.8 point for every 10% of units/rooms with window openings facing north and south directions Points scored = 0.8 x (% of units/10) (Up to 8 points) Points can only be scored if the recommendations from ventilation simulations are implemented (5 points)
Exception : For existing buildings, NRB 1-3(a) may be excluded in computation, the total Green Mark Points for Sub-Total (B) under Part 1 will be prorated accordingly.	
Sub-Total (B) :	Sum of Green Mark Points obtained from NRB 1-3 to 1-4

Part 1 - Energy Efficiency	Green Mark Points
(C) General	
NRB 1-5 Artificial Lighting Encourage the use of better efficient lighting to minimise energy consumption from lighting usage while maintaining proper lighting level. Baseline = Maximum lighting power budget stated in SS 530	0.5 point for every percentage improvement in lighting power budget Points scored = 0.5 x (% improvement) (Including tenant lighting provision) (Up to 12 points) (Excluding tenant lighting provision) (Up to 5 points)
NRB 1-6 Ventilation in Carparks Encourage the use of energy efficient design and control of ventilation systems in carparks. (a) Carparks designed with natural ventilation. (b) CO sensors are used to regulate the demand for mechanical ventilation (MV). Note (4) : Where there is a combination of different ventilation modes adopted for carpark design, the points obtained will be prorated accordingly.	Naturally ventilated carparks – 5 points Points scored based on the mode of mechanical ventilation provided Fume extract – 4 points MV with or without supply - 3 points (Up to 5 points)

Part 1 – Energy Efficiency	Green Mark Points
(C) General	
NRB 1-7 Ventilation in Common Areas Encourage the use of energy efficient design and control of ventilation systems in the following common areas : (a) Toilets (b) Staircases (c) Corridors (d) Lift lobbies (e) Atriums	Extent of Coverage : At least 90 % of each applicable area Points scored based on the mode of ventilation provided in the applicable areas Natural ventilation – 1.5 points for each area Mechanical ventilation – 0.5 point for each area (Up to 5 points)
NRB 1-8 Lifts and Escalators Encourage the use of efficient lifts and escalators. (a) Lifts with the following energy efficient features : (i) AC variable voltage and variable frequency (VVVF) motor drive or equivalent. (ii) Sleep mode features or equivalent. (b) Escalators with energy efficient features such as motion sensors.	Extent of Coverage : All lifts and/or escalators 1 point 1 point 1 point
NRB 1-9 Energy Efficient Practices & Features Encourage the use of energy efficient practices and features which are innovative and have positive environmental impact. (a) Computation of energy consumption based on design load in the form of energy efficiency index (EEI). (b) Use of energy efficient features : Examples: ▪ Heat recovery system ▪ Motion sensors for staircase half landing ▪ Ductless fan for basement ventilation ▪ Sun pipes ▪ etc	1 point 3 points for every 1% energy saving over the total building energy consumption (Up to 11 points)
Sub-Total (C) :	Sum of Green Mark Points obtained from NRB 1-5 to 1-9

Part 1 – Energy Efficiency	Green Mark Points
(C) General	
NRB 1-10 Renewable Energy Encourage the application of renewable energy sources in buildings.	***(Bonus Points)*** 5 points for every 1% replacement of electricity (based on the total electricity consumption including tenant's usage) by renewable energy OR 3 points for every 1% replacement of electricity (based on the total electricity consumption excluding tenant's usage) by renewable energy (Up to 20 points)
PART 1 – ENERGY EFFICIENCY CATEGORY SCORE :	Sub-Total (A) X Air-Conditioned Building Floor Area / Total Floor Area + Sub-Total (B) X Non Air-Conditioned Building Floor Area / Total Floor Area + Sub-Total (C) + Bonus points (NRB 1-10) where Sub-Total (A) = Sum of Green Mark Points obtained under Section (A) that is NRB 1-1 to 1-2 Sub-Total (B) = Sum of Green Mark Points obtained under Section (B) that is NRB 1-3 to 1-4 Sub-Total (C) = Sum of Green Mark Points obtained under Section (C) that is NRB 1-5 to 1-9 If either Section (A) or Section (B) is not applicable, no prorating of areas is required for the score computation.

<table>
<tr><th>Part 2 – Water Efficiency</th><th colspan="4">Green Mark Points</th></tr>
<tr><td rowspan="4"><u>NRB 2-1 Water Efficient Fittings</u>
Encourage the use of water efficient fittings that are certified under the Water Efficiency Labelling Scheme (WELS).</td><td colspan="3">Rating based on Water Efficiency Labelling Scheme (WELS)</td><td rowspan="4">Points scored based on the number and water efficiency rating of the fitting type used

(Up to 8 points)</td></tr>
<tr><td>Good</td><td>V Good</td><td>Excellent</td></tr>
<tr><td colspan="3">Weightage</td></tr>
<tr><td>4</td><td>6</td><td>8</td></tr>
<tr><td><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.

(a) Provision of sub-meters for major water uses which includes irrigation, cooling tower and tenants' usage.

(b) Linking all sub-meters to the Building Management System (BMS) for leak detection.</td><td colspan="4">1 point

1 point</td></tr>
<tr><td><u>NRB 2-3 Irrigation System</u>
Provision of suitable systems that utilise rainwater or recycled water for landscape irrigation to reduce potable water consumption.

(a) Use of non potable water including rainwater for landscape irrigation.

(b) Use of water efficient irrigation system.</td><td colspan="4">1 point

Extent of Coverage : At least 50% of the landscape areas are served by the system
1 point</td></tr>
<tr><td><u>NRB 2-4 Water Consumption of Cooling Tower</u>
Reduce potable water use for cooling purpose.

(a) Use of cooling tower water treatment system which can achieve 6 or better cycles of concentration at acceptable water quality.

(b) Use of NEWater or on-site and recycled water from approved sources.</td><td colspan="4">1 point

1 point</td></tr>
<tr><td>PART 2 – WATER EFFICIENCY CATEGORY SCORE :</td><td colspan="4">Sum of Green Mark Points obtained from NRB 2-1 to 2-4</td></tr>
</table>

Part 3 – Environmental Protection	Green Mark Points
NRB 3-1 Sustainable Construction Encourage the adoption of building designs, construction practices and materials that are environmentally friendly and sustainable.	
(a) More efficient concrete usage for building components.	0.1 point for every percentage reduction in the prescribed Concrete Usage Index (CUI) limit for non-residential buildings *(refer to page 91 for CUI limit)* (Up to 4 points)
(b) Conservation of existing building structure Applicable to existing structural elements or building envelope.	Extent of Coverage : Conserve at least 50 % of the existing structural elements or building envelope (by area) 2 points
(c) Use of sustainable materials and products in building construction such as :	
(i) Environmental friendly products that are certified under the Singapore Green Labelling Scheme (SGLS).	1 point for high impact item 0.5 point for low impact item (Cap at 4 points)
(ii) Products with at least 30% by weight or volume (applicable only to non-structural elements).	1 point for high impact item 0.5 point for low impact item (Cap at 4 points)
Note (5) : For products that are certified under SGLS and with at least 30% recycled contents, points can only be scored either from NRB 3-1(c)(i) or (c)(ii).	(Up to 8 points)
NRB 3-2 Greenery Encourage greater use of greenery, restoration of trees to reduce heat island effect.	
(a) Greenery Provision (GnP) is calculated by considering the 3D volume covered by plants using the following Green Area Index (GAI) : Grass GAI = 1 ; Shrubs GAI = 3; Palms Trees GAI = 4; Trees GAI = 6	GnP = 0.5 to < 1.0 – 1 point GnP = 1.0 to < 1.5 – 2 points GnP = 1.5 to < 3.0 – 3 points GnP ≥ 3.0 – 4 points
(b) Restoration of trees on site, conserving or relocating of existing trees on site.	1 point
(c) Use of compost recycled from horticulture waste.	1 point

Part 3 – Environmental Protection	Green Mark Points
NRB 3-3 Environmental Management Practice Encourage the adoption of environmental friendly practices during construction and building operation.	
(a) Implement effective environmental friendly programmes including monitoring and setting targets to minimise energy use, water use and construction waste.	1 point
(b) Building quality assessed under the Construction Quality Assessment System (CONQUAS).	1 point
(c) Developer, main builder, M & E consultant and architect that are ISO 14000 certified.	0.25 point for each firm (Up to 1 point)
(d) Project team comprises one Certified Green Mark Manager (GMM) and/or one Certified Green Mark Professional (GMP).	1 point for GMM / 2 points for GMP (Up to 3 points)
(e) Provision of building users' guide including details of the environmental friendly facilities and features within the building and their uses in achieving the intended environmental performance during building operation.	1 point
(f) Provision of facilities or recycling bins for collection and storage of different recyclable waste such as paper, glass, plastic etc.	1 point
NRB 3-4 Public Transport Accessibility Promote the use of public transport or bicycles to reduce pollution from individual car use with the following provision :	
(a) Good access to nearest MRT/LRT stations or bus stops.	1 point
(b) Adequate bicycle parking lots.	1 point
NRB 3-5 Refrigerants Reduce the potential damage to the ozone layer and the increase in global warming through the release of ozone depleting substances and greenhouse gases.	
(a) Refrigerants with ozone depletion potential (ODP) of zero or with global warming potential (GWP) of less than 100.	1 point
(b) Use of refrigerant leak detection system at critical areas of plant rooms containing chillers and other equipments with refrigerants.	1 point
PART 3 – ENVIRONMENTAL PROTECTION CATEGORY SCORE :	Sum of Green Mark Points obtained from NRB 3-1 to 3-5

Part 4 – Indoor Environmental Quality	Green Mark Points
NRB 4-1 Thermal Comfort Air-conditioning system is designed to allow for cooling load variations due to fluctuations in ambient air temperature to ensure consistent indoor conditions for thermal comfort. Indoor temp between 22.5 to 25.5 °C Relative Humidity < 70%	2 points
NRB 4-2 Noise Level Occupied spaces in buildings are designed with good ambient sound levels as recommended in SS CP 13.	2 points
NRB 4-3 Indoor Air Pollutants Minimise airborne contaminants, mainly from inside sources to promote a healthy indoor environment. (a) Use of low volatile organic compounds (VOC) paints certified under the Singapore Green Labelling Scheme (SGLS). (b) Use of adhesives certified under the Singapore Green Labelling Scheme (SGLS) for composite wood products.	Extent of Coverage : At least 90% of the total internal wall areas 1 point 1 point
NRB 4-4 High Frequency Ballasts *Applicable to offices, classrooms and the like* Improve workplace lighting quality by avoiding low frequency flicker associated with fluorescent lighting with the use of high frequency ballasts in the fluorescent luminaries.	Extent of Coverage : At least 90% of all applicable areas that are served by fluorescent luminaries 2 points
PART 4 – INDOOR ENVIRONMENTAL QUALITY CATEGORY SCORE :	Sum of Green Mark Points obtained from NRB 4-1 to 4-4

Part 5 – Other Green Features	Green Mark Points
NRB 5-1 Green Features and Innovations Encourage the use of other green features which are innovative and have positive environmental impact. Examples : ▪ Pneumatic waste collection system ▪ Rainwater harvesting ▪ Dual chute system ▪ Self cleaning façade system ▪ Infiltration trenches ▪ Integrated storm water retention/treatment into landscaping ▪ etc	2 points for high impact item 1 point for medium impact item 0.5 point for low impact item (Up to 7 points)
PART 5 – OTHER GREEN FEATURES CATEGORY SCORE :	Sum of Green Mark Points obtained from NRB 5-1

Green Mark Score (Non-Residential)

Green Mark Score (Non-Res) = ∑Category Score [(Part 1 – Energy Efficiency) +
(Part 2 – Water Efficiency) +
(Part 3 – Environmental Protection) +
(Part 4 – Indoor Environmental Quality) +
(Part 5 – Other Green Features)]

where Category Score for Part 1 ≥ 30 points and
∑Category Score for Part 2, 3, 4 & 5 ≥ 20 points

6 DOCUMENTATION REQUIREMENTS

6.1 General

All documents submitted for the BCA Green Mark Assessment should be duly verified and signed by the Qualified Person (QP) and appropriate practitioners where applicable (see Table 6.1(a) and (b)). The detailed documentation requirements can be found in Appendix A and B.

The documentation required for ventilation simulation and energy modeling should also be endorsed by the QP and appropriate practitioners as part of the documentary evidences for certification.

Table 6.1 (a) : Summary Checklist and the Corresponding Signatories *for Residential Building Criteria*

Residential Building Criteria	Required Signatories
Part 1 - Energy Efficiency	
RB 1-1 Building Envelope - RETV	QP (BP)[1]
RB 1-2 Dwelling Unit Indoor Comfort	
• Use of energy efficient conditioners	PE (Mechanical)[2]
• Design for Natural Ventilation	QP (BP)
RB 1-3 Natural Ventilation in Common Areas	QP(BP)
RB 1-4 Lighting	
• Artificial Lighting in common areas	PE (Electrical)
• Daylighting	QP(BP)
RB 1-5 Ventilation in Carparks	PE (Mechanical)
RB 1-6 Lifts	PE (Electrical)
RB 1-7 Energy Efficient Features	
• Heat Recovery Devices	PE (Mechanical)
• Motion Sensors /Photo Sensors	PE (Electrical)
• Others	Appropriate Practitioners[3]
RB 1-8 Renewable Energy	PE (Electrical)
Part 2 – Water Efficiency	
RB 2-1 Water Efficient Fittings	QP(BP)
RB 2-2 Water Usage	PE (Mechanical)
RB 2-3 Irrigation System	QP(BP)
Part 3 – Environmental Protection	
RB 3-1 Sustainable Construction	Appropriate Practitioners
RB 3-2 Greenery	QP(BP)
RB 3-3 Environmental Management Practice	QP(BP)
RB 3-4 Public Transport Accessibility	QP(BP)
Part 4 – Indoor Environmental Quality	

[1] QP(BP) refers to Qualified Person who submits building plan.

[2] PE(Mechanical) or PE(Electrical) refers to a professional engineer registered under the Professional Engineers Act (Cap 253) in the branch of mechanical engineering or electrical engineering.

[3] Appropriate Practitioners refer to QP(BP), PE(Mechanical) or PE(Electrical).

Residential Building Criteria	Required Signatories
RB 4-1 Noise Level	QP(BP)
RB 4-2 Indoor Air Pollutants	QP(BP)
RB 4-3 Waste Disposal	QP(BP)
RB 4-4 Indoor Air Quality in Wet Areas	QP(BP)
Part 5 – Other Green Features	
RB 5-1 Green Features and Innovations	Appropriate Practitioners

Note : *Documentary evidences prepared by the domain experts or specialists such as acoustic consultant, landscape architect etc may be used to demonstrate compliance with the criteria where applicable.*

Table 6.1 (b) : Summary Checklist and the Corresponding Signatories *for Non-Residential Building Criteria*

Non-Residential Building Criteria	Required Signatories
Part 1 - Energy Efficiency	
NRB 1-1 Building Envelope - ETTV	QP (BP)
NRB 1-2 Air-Conditioning System	PE (Mechanical)
NRB 1-3 Building Envelope – Design/ Thermal Parameters	QP (BP)
NRB 1-4 Natural Ventilation (exclude carparks)	QP (BP)
NRB 1-5 Artificial Lighting	PE (Electrical)
NRB 1-6 Ventilation in Carparks	PE (Mechanical)
NRB 1.7 Ventilation in Common Areas	PE (Mechanical)
NRB 1-8 Lift and Escalator	PE (Electrical)
NRB 1-9 Energy Efficient Practices / Features • Heat Recovery System • Auto Condenser Tube Cleaning System • Energy Efficiency Index Computation • Motion Sensors /Photo Sensors • Others	 PE (Mechanical) PE (Mechanical) PE (Electrical) PE (Electrical) Appropriate Practitioners
NRB 1-10 Renewable Energy	PE (Electrical)
Part 2 – Water Efficiency	
NRB 2-1 Water Efficient Fittings	QP (BP)
NRB 2-2 Water Usage and Leak Detection	PE (Mechanical)
NRB 2-3 Irrigation System	QP (BP)
NRB 2-4 Water Consumption of Cooling Tower	PE (Mechanical)
Part 3 – Environmental Protection	
NRB 3-1 Sustainable Construction	Appropriate Practitioners
NRB 3-2 Greenery	QP (BP)
NRB 3-3 Environmental Management Practice	QP (BP)
NRB 3-4 Public Transport Accessibility	QP (BP)
NRB 3-5 Refrigerants	PE (Mechanical)

Non-Residential Building Criteria	Required Signatories
Part 4 – Indoor Environmental Quality	
NRB 4-1 Thermal Comfort	PE (Mechanical)
NRB 4-2 Noise Level	QP (BP)
NRB 4-3 Indoor Air Pollutants	QP (BP)
NRB 4-4 High Frequency Ballast	PE (Electrical)
Part 5 – Other Green Features	
NRB 5-1 Green Features and Innovations	Appropriate Practitioners

Note : *Documentary evidences prepared by the domain experts or specialists such as acoustic consultant, landscape architect etc may be used to demonstrate compliance with the criteria where applicable.*

Appendix A

SCORING METHODOLOGY & DOCUMENTATION

Residential Building Criteria

(I) Energy Related Requirements

RB 1-1 BUILDING ENVELOPE - RETV

Objectives	Enhance overall thermal performance of building envelope to minimise heat gain thus reducing the overall cooling load requirement.
Applicability	Applicable to residential buildings with GFA of 2000 m^2.
Baseline Standard	Maximum permissible RETV = 25 W/m^2 RETV stands for Residential Envelope Transmittance Value. The computation of RETV shall be based on the methodology specified in the Code on Envelope Thermal Performance for Buildings issued by BCA.
Requirements	Up to 15 points can be scored for building envelope with better thermal performance than the baseline standard : 3 points for every reduction of 1 W/m^2 in RETV from the baseline. Points scored = 75 – [3 x (RETV)] where RETV ≤ 25 W/m^2 For developments consisting of more than one residential building, the weighted average of the RETVs based on the façade areas of these buildings shall be used as the basis for point allocation. That is $RETV_{\text{Weighted average}} = \sum (RETV_{bldg} \times A_{bldg}) / A_{devt}$ where $RETV_{bldg}$ = RETV for a residential building (W/m^2) A_{bldg} = Summation of all facade areas that enclose all living rooms, dining rooms, study rooms and bedrooms of a residential building (m^2) A_{devt} = Summation of total applicable facade areas of all residential buildings within the development (m^2) (i.e. $\sum A_{bldg}$)
Pre-requisite Requirements	Green Mark Gold^{Plus} – RETV of 22 W/m^2 or lower Green Mark Platinum – RETV of 20 W/m^2 or lower
Documentary Evidences	• Architectural elevation drawings showing the composition of the different façade or wall systems that are relevant for the computation of RETV; • Architectural plan layouts and elevations showing the living rooms, dining rooms, study rooms and bedrooms; • Extracts of the tender specification or material schedules showing the salient data of the material properties that are to be used for the façade or external wall system; and • RETV calculation.
References	Code on Envelope Thermal Performance for Buildings issued by BCA.

RB 1-2 DWELLING UNIT INDOOR COMFORT

<table>
<tr><td>Objectives</td><td>Enhance building design to achieve good natural ventilation for better indoor comfort or through the use of better efficient air-conditioners if needed.</td></tr>
<tr><td>Applicability</td><td>Applicable to all dwelling units within the development.</td></tr>
<tr><td>Baseline Standard</td><td>As specified under the Singapore Energy Labelling Scheme for air-conditioners.</td></tr>
<tr><td>Requirements</td><td>
<u>For development with provision of air-conditioners</u>
1-2 (a)(i) Up to 12 points can be scored for the use of the air-conditioners that are certified under the Singapore Energy Labelling Scheme based on the following rating.
<table>
<tr><th>Rating</th><th>Point Allocation</th></tr>
<tr><td>✓✓</td><td>2</td></tr>
<tr><td>✓✓✓</td><td>6</td></tr>
<tr><td>✓✓✓✓</td><td>12</td></tr>
</table>
Extent of coverage : At least 90% of air-conditioners used in all dwelling units are energy labelled
OR
<u>For developments where air-conditioners are not provided</u>
1-2 (a)(ii) Up to 12 points can be scored for the following design :
• Building layout design that utilises prevailing wind conditions to achieve adequate cross ventilation. (Up to 6 points).
0.6 point for every 10% of units with window openings facing north and south directions
Points scored = 0.6 x (% of units/10)
• Dwelling unit design that allows for true cross ventilation in the living rooms and bedrooms of the dwelling units (Up to 6 points).
0.6 point for every 10 % of living rooms and bedrooms designed with true cross ventilation
Points scored = 0.6 x (% rooms /10)
Note: In Singapore, the prevailing wind comes from two predominant directions; that is the north to north-east during the Northeast monsoon season and south to south-east during the South-west monsoon season. Hence, buildings designed with window openings facing the north and south directions have the advantage of the prevailing wind conditions which would enhance indoor thermal comfort. Meteorological data on the more precise wind direction and velocity of the site location can also be used as the basis for the design.
It is not necessary for the window openings to be located perpendicularly to the prevailing wind direction. An oblique angle is considered acceptable (see illustrations next page).
</td></tr>
</table>

Illustrations on building layout design that facilitate cross ventilation

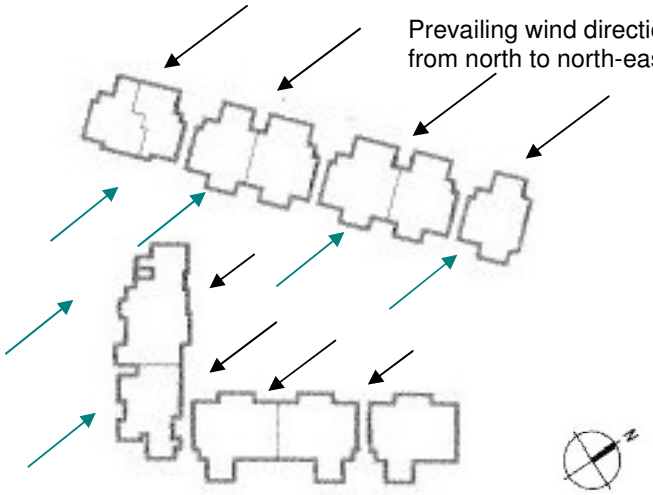


Illustration 1 – Building layout showing all dwelling units with window openings facing the north and south direction. In this instance, all units can be considered meeting the requirement 1-2(a)(ii)

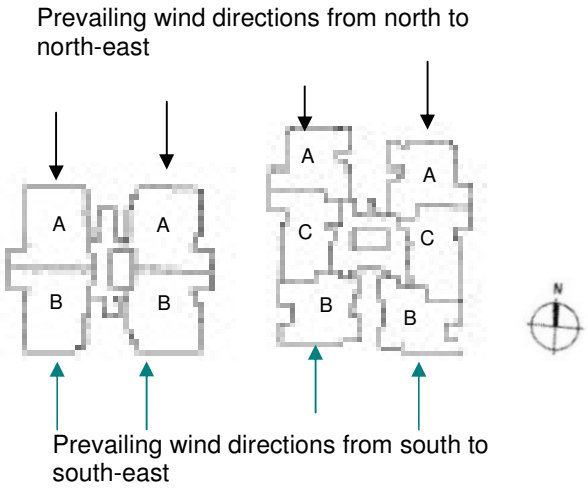
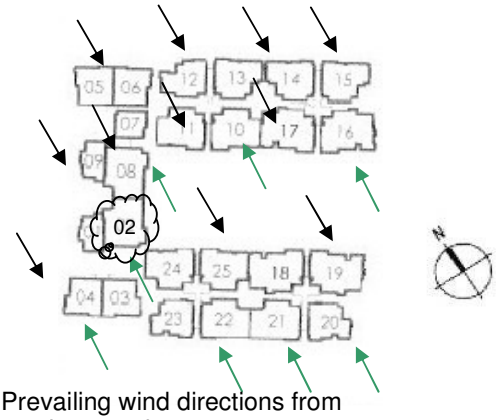


Illustration 2 – Building layout showing all dwelling unit Type A and B with window openings facing either the north or south direction. The dwelling unit Type C has no window openings in the north and south directions. In this instance, no unit can be considered meeting the requirement 1-2(a)(ii)

Prevailing wind directions from north to north-east

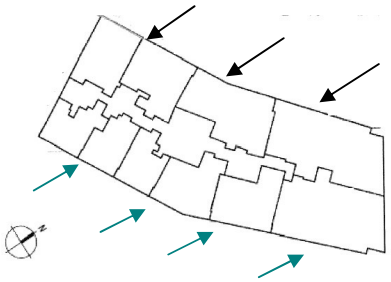


Prevailing wind directions from south to south-east

Illustration 3 – Building layout showing the window openings of all dwelling units facing the north and south direction except dwelling unit 02. Dwelling 02 has window openings facing only the south direction and hence it is not considered meeting the requirement 1-2(a)(ii)

Illustration 4 – Building layout showing the window openings of all dwelling units facing either the north or south direction and hence they are not considered meeting the requirement 1-2(a)(ii)

Prevailing wind directions from north to north-east



Prevailing wind directions from south to south-east

Illustrations on dwelling unit design that facilitates true cross ventilation

Dwelling unit design is considered to have true cross ventilation when there is a reasonably unobstructed air flow path between the windows or vents on opposite sides of the building. For this requirement, the main entrance of the dwelling units is assumed to be closed and all the windows / internal doors are assumed to be open.

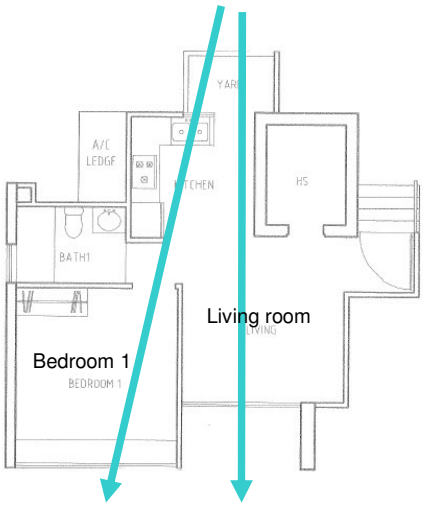


Illustration 5 – Dwelling unit layout showing that both living room and bedroom 1 are considered to have true cross ventilation and meet the requirement 1-2(a)(ii)

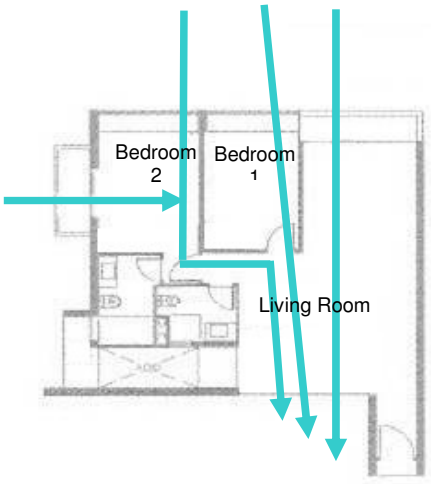


Illustration 6 – Dwelling unit layout showing only living room and bedroom 1 are considered to have true cross ventilation. Bedroom 2 is not considered meeting the requirement 1-2(a)(ii)

	1-2 (b) 4 points for the use of ventilation simulation software to identify the most effective building design and layout in achieving good natural ventilation. The design should provide an average wind velocity within the space of at least 0.6 m/s or more. Points can only be scored if the recommendations from the ventilation simulation are implemented. The ventilation simulation shall be carried out in accordance with the methodology stated in Appendix C.
Pre-requisite Requirements	Ventilation simulation and its recommendation must be carried out using the prescribed methodology stated in Appendix C to be eligible for Green Mark Platinum rating
Documentary Evidences	<u>For 1-2(a)(i) – For dwelling units with provision of air-conditioners</u> • Extracts of the tender specification showing the provision of the types of air-conditioners for the dwelling units of the development; • Schedule of air-conditioners showing the numbers, types and the approved rating from the Singapore Energy Labelling Scheme; and • Technical product information of the air-conditioners and approved rating. <u>For 1-2(a)(ii) – For development where air-conditioners are not provided</u> • Floor plan of all the unit types with highlights of those with window openings facing the north and south directions and/or with true cross ventilation; • Schedules showing the total number of units in the development and those with window openings facing the north and south direction. • Schedules showing the total number of living rooms and bedrooms in the development and those with true cross ventilation. • Calculation showing the percentage of living rooms and bedrooms of dwelling units with true cross ventilation in the tabulated format. <u>For 1-2(b) – Ventilation Simulation</u> • Ventilation simulation reports summarizing the analysis and modelling results for each typical space as well as the recommendations for design as specified in Appendix C.
References	-

RB 1-3 NATURAL VENTILATION IN COMMON AREAS

Objectives	Enhance building design to achieve good natural ventilation in common areas.
Applicability	Applicable to the following common areas of the development. ▪ Lobbies and Corridors ▪ Staircases
Baseline Standard	-
Requirements	1-3(a) 1 point can be scored if all the lift lobbies (including private lift lobbies) and corridors are designed to be naturally ventilated. 1-3(b) 1 point can be scored if all the staircases are designed to be naturally ventilated.
Documentary Evidences	<u>For 1-3(a) and (b)</u> • Plan layouts showing the applicable common areas and confirmation that they are designed to be naturally ventilated.
References	-

RB 1-4 LIGHTING

Objectives	Encourage the use of better efficient lighting and daylighting in common areas to minimise energy consumption from lighting usage while maintaining proper lighting level.
Applicability	Applicable to lighting provisions for the type of usage specified in the SS 530 Clause 7 – Lighting power budget pertaining to common areas and facilities within the residential developments such as staircases, lobbies, corridors, indoor carparks and landscape areas . It is not applicable to lighting provisions for dwelling units.
Baseline Standard	Maximum lighting power budget stated in SS 530 - Code of Practice for Energy Efficiency Standard for Building Services and Equipment.
Requirements	1-4 (a) Up to 12 points can be scored for the improvement in the lighting power budget in common areas : 0.3 point for every percentage improvement in the lighting provisions over the baseline standard. That is Points scored = 0.3 x (% improvement) Display lighting and specialised lighting are to be included in the calculation of lighting power budget. The design service illuminance, lamp efficacies and the light output ratios of luminaries shall be in accordance with SS CP 38 – Code of Practice for Artificial Lighting in Buildings where applicable. 1-4(b)(i) 1 point for provision of daylighting for lift lobbies and corridors. 1-4(b)(ii) 1 point for provision of daylighting for staircases. 1-4(b)(iii) 1 point for provision of daylighting for carparks.
Documentary Evidences	<u>For 1-4(a)</u> • Lighting layout plan; • Lighting schedules showing the numbers, locations and types of luminaries used; • Calculation of the proposed lighting power budget and the percentage; improvement in the tabulated format showing the areas, light fitting type, power consumption per fitting, ballast loss, no. of fittings, individual and total design and reference (based on SS 530) power consumption and power budget according to the fitting type; and • Technical product information of the lighting luminaries used. <u>For 1-4(b)</u> • Extracts of the tender specification or drawings showing the use of daylighting for lift lobbies and corridors, staircases and carparks where applicable.
References	SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment.

RB 1-5 VENTILATION IN CARPARKS

Objectives	Encourage the use of energy efficient design and control of ventilation systems in carparks.
Applicability	Applicable to all carpark spaces in the development.
Baseline Standard	-
Requirements	1-5(a) 8 points can be scored for carpark spaces that are fully naturally ventilated. 1-5(b) For carparks that have to be mechanically ventilated, points can be scored for the use of carbon monoxide (CO) sensors in regulating such demand based on the mode of mechanical ventilation (MV) used; 6 points for carparks using fume extract system and 4 points for those with MV with or without supply. Note : Where there is a combination of different ventilation modes adopted for carpark design, the points scored under this requirement will be prorated accordingly.
Documentary Evidences	For 1-5 (a) and (b) • Plan layouts showing all carpark provisions for the development with highlights of the carpark spaces that are designed to be naturally ventilated and/or mechanical ventilated; • Plan layouts indicating the locations of CO sensors and the mode of ventilation adopted for the design; and • Calculation showing the points allocation if there is a combination of different ventilation mode adopted for the carpark design.
References	SS CP 13 – Code of Practice for Mechanical Ventilation and Air-Conditioning in Buildings.

RB 1-6 LIFTS	
Objectives	Encourage the use of energy efficient lifts.
Applicability	Applicable to all lifts in the development.
Baseline Standard	-
Requirements	1 point can be scored for the use of lifts with energy efficient features such as AC variable voltage and variable frequency (VVVF) motor drive or equivalent 1 point can be scored for the use of lifts with sleep mode features.
Documentary Evidences	Extracts of the tender specification indicating the types of lifts and related features used.
References	-

RB 1-7 ENERGY EFFICIENT FEATURES

Objectives	Encourage the use of energy efficient features which are innovative and have positive environmental impact in terms of energy saving.
Applicability	Applicable to practices and features that are not listed in the requirements under Part 1 – Energy Efficiency.
Baseline Standard	-
Requirements	Up to 7 points can be scored for the use of the following approved energy efficient features based on their potential environmental benefits and the extent of coverage. (i) Use of heat recovery devices • 2 points for more than 50% of all dwelling units • 1 point for at least 25% of all dwelling units • 0.5 point for club house or other common facilities (ii) Use of thermal insulation or cool paints on the east and west facing external walls • 2 points for window to wall ratio (WWR) of less than 0.5 • 1 point for WWR that is between 0.5 to 0.75 • 0.5 point for WWR of more than 0.75 (iii) Use of motion sensors for private lift lobbies, staircases, common toilets • 1 point for at least 50 motion sensors installed • 0.5 point for less than 50 motion sensors installed (iv) 1 point for the use of heat elevator in at least 90% of all dwelling units' water heater systems. (v) 1 point for the use of gas water heaters in at least 90% of all dwelling units. (vi) Use of software analysis and simulation to optimise the capacity and sizing of the air-conditioning system of dwelling units to achieve energy savings (as compared with the SS 530 requirements). • 1 point for at least 30% energy savings • 0.5 point for at least 15% energy savings (vii) 1 point for the provision of clothes drying facilities and open spaces for at least 90% of the dwelling units. (viii) Use of sun pipes for natural lighting. • 1 point for more than 10 sun pipes • 0.5 point for at least 5 sun pipes (ix) 0.5 point for the provision of ductless fans for basement ventilation. (x) 0.5 point for the computation of Energy Efficiency Index (EEI) for common facilities of the development.

Calculation of EEI for Common Facilities :

EEI = (TEC / GFA) x 365 days

where:

(a) TEC : Total electricity consumption for common facilities (kWh/day)
(b) GFA : Gross floor area of development (m^2)

The common facilities and the daily usage hours of these facilities are pre-determined for consistency as shown in Table 1-7. They are to be used in the computation for EEI. Other common facilities that are not listed should be included under 'Others' and the operation hours can be estimated based on the likely usage pattern.

Table 1-7 : Common Facilities and Daily Usage Pattern

	Description	Daily Usage (hr)
A)	**Mechanical Load**	
	MV fan (plant room)	9
	Car park fan	4
	A/C for club house	12
	A/C for lobbies	12
	A/C for guard house	24
	Domestic pump	2
	Ejector pump	2
	Booster pump	3
	Sump pumps	0.5
B)	**Lift Load**	
	Passenger lifts	2
	Service lift	2
C)	**General lighting**	
	Car park lighting - 24 hours operation	24
	Car park lighting - 5 hours operation	5
	Guard house lighting	12
	Facade lighting	5
	Landscape lighting - 12 hours operation	12
	Landscape lighting - 5 hours operation	5
	Lift lobbies, corridors & staircase lighting - 12 hours operation	12
	Lift lobbies, corridors & staircase lighting - 5 hours operation	5
D)	**Club Facilities**	
	Club house interior lighting	12
	Power to Gym equipment, SPA, etc	6
	Swimming pool filtration	12
	Water features	8
E)	**Others**	
	Facilities A	To estimate
	Facilities B	To estimate

Important notes : *For features that are not listed in RB 1-7(i) to (x) above, the QP is required to submit the details showing the positive environmental impacts and potential energy savings of the proposed features to BCA for assessment.*

Documentary Evidences	• Extracts of the tender specification showing the provision of the proposed energy efficient features and the extent of implementation where applicable; • Technical product information on the energy efficient features used; and • Calculation of the potential energy savings that could be reaped from the use of these features. • Calculation of the Energy Efficiency Index (EEI) using the pre-determined daily usage pattern as in Table 1-7 and in the tabulated format showing the daily usage pattern, estimated load (kW) and the load per day (kWh) and the total energy consumption per day (kWh/day).
References	-

RB 1-8 RENEWABLE ENERGY

Objectives	Encourage the use of renewable energy sources in buildings.
Applicability	Includes all renewable energy sources
Baseline Standard	-
Requirements	Up to 20 *Bonus* points can be scored based on the percentage replacement of electricity by the renewable energy source : For solar energy : 1 point for every 3 kWp of solar energy Points scored = (kWp of the solar energy) / 3 For other renewable energy sources : 1 point for every 1% replacement of electricity (based on annual electricity consumption exclude household's usage) by renewable energy
Documentary Evidences	• Extracts of the tender specification and plans showing the location of the renewable energy system and the extent of implementation; • Technical product information on the salient features of the renewable energy system and the expected renewable energy generated; and • Calculation of the percentage replacement of electricity and the total annual electricity consumption of the development.
References	-

(II) Other Green Requirements

RB 2-1 WATER EFFICIENT FITTINGS

<table>
<tr><td>Objectives</td><td>Reduce the use of potable water by using water efficient fittings covered under the Water Efficiency Labelling Scheme (WELS).</td></tr>
<tr><td>Applicability</td><td>Applicable to the water fittings covered by the WELS and used in dwelling units :
▪ Basin taps and mixers
▪ Flushing cistern
▪ Sink/bib taps and mixers
▪ Showerheads, taps and mixers
▪ All other water fittings

Note : No point can be scored for the water fittings used in common facilities such as clubhouse toilets.</td></tr>
<tr><td>Baseline Standard</td><td>As specified under Water Efficiency Labelling Scheme (WELS).</td></tr>
<tr><td>Requirements</td><td>Up to 10 points can be scored based on the number and water efficiency rating of the fitting type used for dwelling units.

<table><tr><th>WELS Rating</th><th>Water Efficiency</th><th>Point Allocation</th></tr><tr><td>✓</td><td>Good</td><td>0.5</td></tr><tr><td>✓✓</td><td>Very Good</td><td>1</td></tr><tr><td>✓✓✓</td><td>Excellent</td><td>2</td></tr></table>
Extent of coverage : At least 90% of each fitting type used.</td></tr>
<tr><td>Documentary Evidences</td><td>• Extracts of the tender specification showing all the water fitting provisions for the development;

• Water fitting schedules showing the numbers, types and the approved rating of the proposed fittings.

• Calculation showing the percentage of proposed water fittings that are approved under WELS.</td></tr>
<tr><td>References</td><td>For more information about WELS, refer to

Inspectorate Branch
Water Demand Management & Inspectorate Division
Water Supply (Network Department)
PUB</td></tr>
</table>

RB 2-2 WATER USAGE

Objectives	Promote the use of sub-metering for better control and monitoring of major water usage.
Applicability	Applicable to sub-metering provisions for major water uses of the building developments.
Baseline Standard	-
Requirements	1 point can be scored if sub-meters are provided for all major water uses i.e. irrigation system, swimming pools and other water features where applicable.
Documentary Evidences	• Extracts from the tender specification stating the locations and provision of sub-metering for all major water uses. • Schematic drawings of cold water distribution system showing the location of the sub-metering provided.
References	-

RB 2-3 IRRIGATION SYSTEM

Objectives	Reduce potable water consumption by provision of suitable systems that utilise rainwater or recycled water for landscape irrigation.
Applicability	Applicable to residential development with landscaping provision.
Baseline Standard	-
Requirements	2-3(a) 1 point can be scored for the use of non-potable water including rainwater for landscape irrigation. 2-3(b) 1 point can be scored if more than 50% of the landscape areas are served by water efficient irrigation system with features such as automatic sub-soil drip irrigation system with rain sensor control.
Documentary Evidences	<u>For 2-3(a)</u> • Extracts of the tender specification showing how the non-potable water source is to be provided; • Relevant drawings showing the location and design of the non-potable water source; and • For rainwater harvesting and storage system, approval letter from PUB is to be provided. <u>For 2-3(b)</u> • Extracts of the tender specification showing the provision and details of water efficient irrigation system; • Relevant layout plans showing the overall landscape areas and the areas that would be served using the system; and • Calculation showing the percentage of the landscape areas that would be served using the system.
References	-

(II) Other Green Requirements

RB 3-1 SUSTAINABLE CONSTRUCTION

<table>
<tr><td>Objectives</td><td>Encourage the adoption of building designs, construction practices and materials that are environmentally friendly and sustainable.</td></tr>
<tr><td>Applicability</td><td>Generally applicable to all building developments.</td></tr>
<tr><td>Baseline Standard</td><td>-</td></tr>
<tr><td>Requirements</td><td>
3-1(a) Up to 4 points are allocated to encourage more efficient concrete usage for building components based on the percentage reduction in the prescribed Concrete Usage Index (CUI) limit.

Note : Concrete Usage Index (CUI) is an indicator of the amount of concrete used to construct the superstructure which includes both the structural and non-structural elements. CUI does not include the concrete used for external works and sub-structural works such as basements and foundations. CUI is defined as the volume of concrete in cubic metres needed to cast a square metre of constructed floor area. It is expressed as:

$$\text{Concrete Usage Index} = \frac{\text{Concrete Volume in m}^3}{\text{Constructed Floor Area in m}^2}$$

Table 3-1(a) CUI Limit for Residential Building
<table>
<tr><th>CATEGORY</th><th>Concrete Usage Index (CUI) limit (m^3/m^2)</th></tr>
<tr><td>Residential (15 storey & below)</td><td>0.55</td></tr>
<tr><td>Residential (above 15 storey)</td><td>0.60</td></tr>
</table>
3-1(b) Up to 2 points can be scored if more than 50% of the existing structural elements or building envelopes (by areas) are conserved during redevelopment. Structural elements refer to slabs, columns, beams and load bearing walls.

3-1(c) Up to 6 points are allocated to encourage the use of sustainable materials and products in building construction such as :

(i) Up to 3 points for the use of environmental friendly products that are certified under the Singapore Green Labelling Scheme (SGLS) where 1 point for each high impact item and 0.5 point for each low impact item.

(ii) Up to 3 points for the use of products (applicable only for non-structural elements) with at least 30% recycled content by weight or volume where 1 point for each high impact item and 0.5 point for each low impact item

Note (1) : The use of environmental friendly products or recycled materials used for all dwelling units of the development are considered as high impact. Items that are used in common areas, external works and communal facilities are considered as low impact.

Note (2) : The point allocated for low volatile organic compound (VOC) paints and adhesives certified under SGLS can be found in RB 4-2 and hence shall not be included in the scoring for RB 3-1(c)(i) and (ii).
</td></tr>
</table>

Documentary Evidences

For 3-1(a)

- Architectural and structural plan layout, elevation and sectional plans showing the type of wall system used, the dimensions and sizes of all the building and structural elements; and
- Calculation showing the quantity of concrete for each floor level in the prescribed tabulated format as shown below. The calculation should include all the building elements listed in the Table 3-1(a) .

Table 3-1 (a) : COMPUTATION OF CONCRETE USAGE INDEX

Project Reference No.: AXXXX-00001-2007 **Total no. of storey for the project: __**

Block No :___

	Structural System	Thickness (mm) or size (mm x mm)	Volume of concrete (m^3)	Remark *
1	**1st storey**			
	1.1 Columns			
	1.2 Beams			
	1.3 Slabs			
	1.4 Staircases			
	1.5 Suspended structures like planter boxes, bay windows, ledges etc			
	1.6 Parapets			
	1.7 External walls - loadbearing walls			
	1.8 External walls – non-loadbearing walls			
	1.9 Internal walls – loadbearing walls			
	1.10 Internal walls – non-loadbearing walls			
	1.11 Others (kerbs, ramps, services risers, etc)			
	Total volume of concrete for this storey (m^3)			
	Total constructed floor area for this storey (m^2)			
2	**Typical floor layout**			
	2.1 Columns			
	2.2 Beams			
	2.3 Slabs			
	2.4 Staircases			
	2.5 Suspended structures like planter boxes, bay windows, ledges etc			
	2.6 Parapets			
	2.7 External walls - loadbearing walls			
	2.8 External walls – non-loadbearing walls			

COMPUTATION OF CONCRETE USAGE INDEX

Project Reference No.: AXXXX-00001-2007 **Total no. of storey for the project: ___**

Block No : __

	Structural System	Thickness (mm) or size (mm x mm)	Volume of concrete (m^3)	Remark *
2	**2nd storey to 30th storey (Typical floor layout)**			
	2.9 Internal walls – loadbearing walls			
	2.10.Internal walls – non-loadbearing walls			
	2.11 Others (kerbs, ramps, services risers etc)			
	Volume of concrete for one storey (m^3)			
	Constructed floor area for one storey			
	Total volume of concrete (including roof level)			
	Total constructed floor area (including roof level)			
	Total volume of concrete for this project (m^3)			
	Total constructed floor area for this project (m^2)			
	Concrete Usage Index (CUI in m^3/m^2)			

*To indicate if the structural elements is of precast concrete, post-tensioned concrete, high strength concrete (> Grade 60) or reinforced concrete (RC) under the 'Remarks' column

For 3-1(b)

- Architectural and structural plan layout, elevation and sectional plans of the proposed building showing the areas of the existing building envelope or structural elements that are to be conserved;
- A summary sheet listing each area of the existing building envelope or structural elements that are to be conserved;
- Calculation showing that the percentage of building envelope or structural elements being conserved; and
- Extracts from the tender specification and documents indicating the portion of existing building envelope or structural elements to be conserved.

For 3-1(c)

- Extracts from the tender specification showing the requirements to incorporate the environmental friendly products that are certified with SGLS.
- Extracts from the tender specification showing the requirements to incorporate the use of recycled products
- Technical product information on the recycled products and their recycled contents by weight or volume.

References -

RB 3-2 GREENERY

<table>
<tr><td>Objectives</td><td>Encourage greater use of greenery and restoration of existing trees to reduce heat island effect.</td></tr>
<tr><td>Applicability</td><td>Applicable to building developments with landscaping areas.</td></tr>
<tr><td>Baseline Standard</td><td>-</td></tr>
<tr><td>Requirements</td><td>3-2(a) Up to 4 points can be scored for the provision of greenery within the developments including roof top/ sky garden and green roof.

Greenery Provision (GnP) is calculated by considering the 3D volume covered by plants using the following Green Area Index (GAI) :
Grass GAI = 1 ; Shrubs GAI = 3; Palms Trees GAI = 4; Trees GAI = 6

Greenery Provision (GnP) = total green area / site area

GnP = 2.0 to < 3.0 – 1 point
GnP = 3.0 to < 3.5 – 2 points
GnP = 3.5 to < 4.0 – 3 points
GnP ≥ 4.0 – 4 points

3-2(b) 1 point for restoration of trees on site, conserving or relocating of existing trees on site.

3-2(c) 1 point for the use of compost recycled from horticulture waste.</td></tr>
<tr><td>Documentary Evidences</td><td><u>For 3-2(a)</u>
• Plan layouts showing the greenery provision and site areas ; and
• Calculation showing the extent of the greenery provision in the prescribed tabulated format as shown below.

<table>
<tr><th>Description</th><th>Qty
(A)</th><th>Canopy area
(B)</th><th>Radius
(C)</th><th>Green Area Index GAI</th><th>Green Area
(A)x(B)x(C^2)xGAI</th></tr>
<tr><td>Trees (Nos)</td><td></td><td>3.14</td><td>3.5</td><td>6</td><td></td></tr>
<tr><td>Palms (Nos)</td><td></td><td>3.14</td><td>1</td><td>4</td><td></td></tr>
<tr><td>Shrubs (m^2)</td><td></td><td>NA</td><td>NA</td><td>3</td><td></td></tr>
<tr><td>Landscape area + roof garden area + vertical greening (m^2)</td><td></td><td>NA</td><td>NA</td><td>1</td><td></td></tr>
<tr><td colspan="5">Total Green Area :

Total Site Area :

Greenery Provision (GnP) = Total (Green Area/Site Area) :</td><td></td></tr>
</table>
</td></tr>
</table>

	For 3-2(b) • Site layouts showing the existing and final locations (where applicable) and number of the trees to be restored or conserved or relocated. For 3-2(c) • Extracts of the tender specification showing the requirements to use compost recycled from horticulture waste.
References	-

RB 3-3 ENVIRONMENTAL MANAGEMENT PRACTICE

Objectives	Encourage the adoption of environmental friendly practices during construction and building operation.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	3-3(a) 1 point can be scored if effective implementation of environmental friendly programmes including monitoring and setting targets to minimise energy use, water use and construction waste are in place. 3-3(b) 1 point can be scored if the building quality is assessed under the Construction Quality Assessment System (CONQUAS) and an additional one (1) point can be scored if the project is assessed under Quality Mark. 3-3(c) Up to 1 point if the developer, main builder, M & E consultant and architect are ISO 14000 certified. 0.25 point is allocated for each firm that is certified. 3-3(d) Up to 3 points where 1 point can be scored if the project team comprises one Certified Green Mark Manager (GMM) and 2 points can be scored if the team has one Certified Green Mark Professional (GMP). 3-3(e) 1 point can be scored for the provision of building users' guide including details of the environmental friendly facilities and features within the building and their uses in achieving the intended environment performance during the building operation. 3-3(f) 1 point can be scored for the provision of facilities or recycling bins for collection and storage of different recyclable waste such as paper, glass, plastic etc.
Documentary Evidences	<u>For 3-3(a)</u> • Extracts of the tender specification showing the requirements for builder to provide and implement environmental friendly programmes to minimise energy use, water use and construction waste; and • Details of the environmental friendly programmes implemented. <u>For 3-3(b)</u> • Extracts of the tender specification showing the requirement to adopt CONQUAS. <u>For 3-3(c)</u> • A certified true copy of the ISO 14000 certificate of developer, main contractor, M & E consultant and architect where applicable. <u>For 3-3(d)</u> • A certified true copy of the certificate of Green Mark manager and Green Mark professional where applicable and a confirmation of their involvement in the project.

Documentary Evidences – Cont'd	<u>For 3-3(e)</u> • A copy of the building users' guide containing the details of the environmental friendly facilities and features within the building and their uses in achieving the intended environment performance during the building operation. <u>For 3-3(f)</u> • Plan layout showing the location of the recycling bins for collection and storage of different recyclable waste.
References	-

RB 3-4 PUBLIC TRANSPORT ACCESSIBILITY

Objectives	Promote the use of public transport or bicycles to reduce pollution from individual car use.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	3-4(a) 1 point can be scored for design that provides good access (< 500m) to public transport networks such as MRT/LRT stations and bus stops. 3-4(b) 1 point can be scored for the provision of adequate bicycles parking lots.
Documentary Evidences	<u>For 3-4(a)</u> • Site layout plan in the context of the surrounding area showing the location of the development site and the location of the MRT/LRT stations and bus stops. <u>For 3-4(b)</u> • Extracts of the tender specification showing the requirement to provide bicycles parking lots for the development.
References	-

(II) Other Green Requirements

Part 4 – Indoor Environmental Quality	**RB4-1**	**Noise Level**
	RB4-2	**Indoor Air Pollutants**
	RB4-3	**Waste Disposal**
	RB4-4	**Indoor Air Quality in Wet Areas**

RB 4-1 NOISE LEVEL

Objectives	Recognise buildings that are designed to consider the potential noise levels within the dwelling units are maintained at an appropriate level.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	1 point can be scored if the building is designed to achieve ambient internal noise level as specified : • 55 dB (6am-10 pm) LeqA • 45 dB (10 pm-6 am) LeqA For developments that are in close proximity to road with heavy traffic, flyover or highway, it is necessary to have a detailed analysis conducted by the acoustic consultant. Points can only be scored if the recommendations from the acoustic consultant are implemented.
Documentary Evidences	• Extracts of the tender specification showing the requirement to design the occupied space with the ambient sound levels; and • A report of the detailed analysis and recommendations from acoustic consultant on how the designed ambient sound levels can be met where applicable.
References	-

RB 4-2 INDOOR AIR POLLUTANTS

Objectives	Minimise airborne contaminants, mainly from inside sources to promote a healthy indoor environment.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	4-2(a) 2 points can be scored for the use of low volatile organic compounds (VOC) paints certified under the Singapore Green Labelling Scheme (SGLS) for at least 90% of the internal wall areas. 4-2(b) 1 point can be scored for the use of adhesives certified under the Singapore Green Labelling Scheme (SGLS) in all composite wood products used for the development.
Documentary Evidences	<u>For 4-2(a)</u> • Extracts of the tender specification showing the requirement to use low VOC paints that are certified under SGLS. <u>For 4-2(b)</u> • Extracts of the tender specification showing the requirement to use adhesive with low emission formaldehyde and are certified under SGLS for all composite wood products used.
References	-

RB 4-3 WASTE DISPOSAL

Objectives	Minimise airborne contaminants from waste.
Applicability	Generally applicable to all developments.
Baseline Standard	-
Requirements	1 point can be scored if the refuse chutes are located at open ventilation areas such as service balconies or common corridors
Documentary Evidences	• Plan layouts showing the location of the refuse chutes for all typical dwelling units.
References	-

RB 4-4 INDOOR AIR QUALITY IN WET AREAS

Objectives	Encourage provision of adequate natural ventilation and daylighting in wet areas.
Applicability	Generally applicable to all wet areas such as kitchens, bathrooms and toilets of the developments.
Baseline Standard	-
Requirements	1 point can be scored if there is provision for adequate natural ventilation and daylighting in wet areas i.e. kitchens, bathrooms and toilets. Extent of coverage : At least 90% of all applicable areas.
Documentary Evidences	• Plan layouts showing the location of the window openings of the kitchens, bathrooms and toilets for all typical dwelling units.
References	-

(II) Other Green Requirements

RB 5-1 OTHER GREEN FEATURES

Objectives	Encourage the use of green features which are innovative and have positive environmental impact on water efficiency, environmental protection and indoor environmental quality of the buildings.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	Up to 7 points can be scored for the use of the following green features depending on their potential environmental benefits and the extent of coverage. <u>Water Efficiency</u> (iii) Use of self cleaning façade system : • 2 points for more than 75% of the external walls • 1 point for more than 50% of the external walls • 0.5 point for at least 25% of the external walls (ii) Use of integrated basin/cistern pedestal system : • 2 points for more than 50% of all dwelling units' flushing cisterns • 1 point for more than 25% of all dwelling units' flushing cisterns • 0.5 point for at least 10% of all dwelling units' flushing cisterns (iii) Use of grey water recycling system : • 2 points for all blocks of the development. • 1 point for at least one block of the development. (iv) 0.5 point for the use of membrane filtration system to recycle water during construction. <u>Environmental Protection</u> (i) Use of precast toilets : • 2 points for more than 75% of all toilets • 1 point for more than 50% of all toilets • 0.5 point for at least 25% of all toilets (ii) Provision of green roof and roof top garden : • 1 point for more than 50% of the roof areas • 0.5 point for at least 25% of the roof areas. (iii) Provision of vertical greening : • 1 point for more than 50% of the external wall areas • 0.5 point for at least 25% of the external wall areas (iv) 1 point for the provision of double refuse chutes for separating recyclable from non-recyclable waste (v) 0.5 point for the use of non-chemical termite treatment system such as termite baiting system, anti-termite mesh.

	(vi) 0.5 point for the provision of at least 5 nos. of compost bins to recycle organic waste. (vii) 0.5 point for the use of non-chemical water treatment system for swimming pools. (viii) Up to 1 point if at least 10% of the fine and/or coarse aggregate used for concrete production of structural application are replaced with recycled products from approved sources. 0.5 point for each recycled product used. Points can only be scored if the extent of implementation covers at least 50% of all concrete structural elements of the superstructures (by volume). <u>Indoor Air Quality</u> (i) Use of Titanium Dioxide solutions to remove odour in toilets : • 2 points for more than 50% of all toilets • 1 point for more than 25% of all toilets • 0.5 point for at least 10% of all toilets (ii) 1 point for the use of pneumatic waste collection system. <u>Others</u> (i) Provision of landscape drainage and infiltration trenches : • 1 point for at least 25% of the landscape areas • 0.5 point for less than 25% of the landscape areas (ii) Provision of system to recycle surface runoff from the vertical green wall and sky garden : • 1 point for at least 25% of the green areas • 0.5 point for less than 25% of the green areas (iii) 0.5 point for the use of siphonic rainwater discharge system at roof. (iv) 0.5 point for the provision of eco-pond. ***Important notes :*** *For features that are not listed above, the QP is required to submit the details showing the positive environmental impacts, possible savings and benefits of the proposed features to BCA for assessment.*
Documentary Evidences	• Extracts of the tender specification showing the provision of the specific green features used and the extent of implementation where applicable; • Technical product information (including drawings and supporting documents) of the green features; • A summary sheet listing the breakdown and the extent of implementation as well as the total requirements for the same intended purpose for the specific green features used; and • Quantified evidences on the potential environmental benefits that the features can bring to the development.
References	-

Appendix B

SCORING METHODOLOGY & DOCUMENTATION
Non-Residential Building Criteria

(I) Energy Related Requirements

Part 1 – Energy Efficiency

NRB 1-1 BUILDING ENVELOPE - ETTV

Objectives	Enhance overall thermal performance of building envelope to minimise heat gain thus reducing the overall cooling load requirement.
Applicability	Applicable to air-conditioned building spaces with aggregate areas > 500 m^2.
Baseline Standard	Maximum permissible ETTV = 50 W/m^2 ETTV stands for Envelope Thermal Transfer Value. The computation of ETTV shall be based on the methodology specified in the Code on Envelope Thermal Performance for Buildings issued by BCA.
Requirements	Up to 15 points can be scored for building envelope with better thermal performance than the baseline standard : 2 points for every reduction of 1 W/m^2 in ETTV from the baseline. Points scored = 100 – [2 x (ETTV)] where ETTV ≤ 50 W/m^2 For developments consisting of more than one building, the weighted average of the ETTVs based on the façade areas of these buildings shall be used as the basis for point allocation. That is $ETTV_{\text{Weighted average}} = \sum (ETTV_{bldg} \times A_{bldg}) / A_{devt}$ where $ETTV_{bldg}$ = ETTV for a building (W/m^2) A_{bldg} = Summation of all facade areas that enclose all the air-conditioning areas (m^2) in a building A_{devt} = Summation of total applicable facade areas of all buildings within the development (m^2) (i.e. $\sum A_{bldg}$)
Pre-requisite Requirements	Green Mark $Gold^{Plus}$ – ETTV of 42 W/m^2 or lower Green Mark Platinum – ETTV of 40 W/m^2 or lower
Documentary Evidences	• Architectural elevation drawings showing the composition of the different façade or wall systems that are relevant for the computation of ETTV; • Architectural plan layouts and elevations showing all the air-conditioning areas; • Extracts of the tender specification or material schedules showing the salient data of the material properties that are to be used for the façade or external wall system; and • ETTV calculation.
References	Code on Envelope Thermal Performance for Buildings issued by BCA

NRB 1-2 AIR-CONDITIONING SYSTEM

Objectives	Encourage the use of better efficient air-conditioned equipments to minimise energy consumption.
Applicability	Applicable to air-conditioned building areas where its aggregate air-conditioned areas > 500 m^2. Scope covers all air-conditioned equipments for the buildings as listed: ▪ Chillers ▪ Chilled water pumps ▪ Condenser water pumps ▪ Cooling Towers ▪ Air Handling Units (AHUs) ▪ Fan Coil Units (FCU) ▪ Unitary Air-Conditioners/ Condensing Units which include single-split units, multi-spilt units and variable refrigerant units (VRV) system
Baseline Standard	Minimum efficiency requirement of the air-conditioning system stated in SS 530 and SS CP 13. <u>1-2(a)(i) Air-Conditioned Plant</u> • Chiller - Refer Table 2 of SS 530. • Chiller and condenser water pump efficiency - Refer to Clause 7.11.6 in CP 13 which states that the water transport factor shall not be less than 30 for chiller water and 40 for the condensing water circuit. Chilled water pump efficiency ≤ 1kW / (30kW/3.5172) tons ≤ 1kW / 8.53 tons ≤ 0.117 kW/ tons Condenser water pump efficiency ≤ 1kW / (40kW/3.5172) tons ≤ 1kW / 11.37 tons ≤ 0.088 kW/ tons • Cooling tower performance at the <u>rating condition</u> stated in Table 3 of SS530. Rating condition is as follows : 35℃ Entering water 29℃ Leaving water 24℃ wb Outdoor air <u>Propeller and axial fan cooling tower :</u> With heat rejected from every 3.23 L/s of condenser water per 1 kW of fan power rating : Cooling tower performance ≤ 1kW / 3.23 L/s ≤ 0.310 kW/ L/s <u>Centrifugal fan cooling tower :</u> With heat rejected from every 1.7 L/s of condenser water per 1 kW of fan power rating : Cooling tower performance ≤ 1kW/1.7 L/s ≤ 0.588 kW/ L/s <u>1-2(a)(ii) Air Distribution System</u> – Refer to Clause 7.11.5 in CP 13. <u>1-2(b) Unitary Air-Conditioners/ Condensing Units</u> - Refer Table 1 of SS 530.

Requirements	1-2 (a)(i) Air-Conditioned Plant (Up to 20 points) 1.45 points for every percentage improvement in the efficiency of chiller, chilled-water pump and condenser water pump. Points scored = 1.45 x (% improvement) 0.05 point for every percentage improvement in the performance of cooling tower at rating condition. Points scored = 0.05 x (% improvement) 1-2 (a)(ii) Air Distribution System (Up to 5 points) 0.5 points for every percentage improvement in the air distribution system efficiency above the baseline. Points scored = 0.5 x (% improvement) Note (1) : For buildings using district cooling system, there is no need to compute the plant efficiency under item (a)(i). The points obtained will be pro-rated based on the air distribution system efficiency under NRB 1-2(a)(ii). OR 1-2 (b) Unitary Air-Conditioners/Condensing Units (Up to 25 points) 1.5 points for every average percentage improvement in the efficiency of unitary air-conditioners/ condensing units above the baseline. Points scored = 1.5 x (% improvement) Note (2) : Where there is a combination of centralised air-con system with unitary air-conditioned system, the computation for the points scored will only be based on the air-conditioning system with a larger aggregate capacity. 1-2 (c) Sensors or similar automatic control devices (2 points) 2 points can be scored if sensors or similar automatic control devices are used to regulate outdoor air flow rate to maintain the concentration of carbon dioxide (CO_2) below 1000ppm.
Documentary Evidences	For 1-2 (a) and 1-2(b) • Detailed calculations of the overall improvement in equipment/system efficiency of the air-conditioning plants/ units and air distribution system in the tabulated formats showing the design cooling system capacity and the system efficiency (including individual equipment efficiency). • Calculation and technical data of the designed system efficiency of chillers at part load condition ; and • Technical product information of all air-conditioning units and system. For 1-2 (c) • Extracts of the tender specification showing the requirements to incorporate these control devices; and • Plan layouts showing the locations and the types of control devices used to regulate fresh air intake.
References	(a) SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment. (a) SS CP 13 – Code of Practice for Mechanical Ventilation and Air-Conditioning in Buildings.

NRB 1-3 BUILDING ENVELOPE – DESIGN / THERMAL PARAMETERS

Objectives

Enhance the overall thermal performance of building envelope to minimise heat gain which would improve indoor thermal comfort and encourage natural ventilation.

Applicability

Applicable to non air-conditioned building spaces with aggregate areas > 10% of the total floor areas excluding carparks.

Baseline Standard

Baseline standard for 1-3(d) - U value for roof :

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

Requirements

1-3(a) Up to 10 points can be scored if the building envelope is designed with minimum direct west facing façade by having better building orientation. Where there is no west facing façade, the points scored will be 24 points and the requirements under 1-3(b)(i), b(ii) and (c) will not be applicable for scoring.

Points scored = 10 – [0.2 x (% of west facing facade areas over total façade areas)]

Note : 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 façade (see illustrations below). Core walls for lifts or staircases and toilets that are located within this range are exempted in computation.

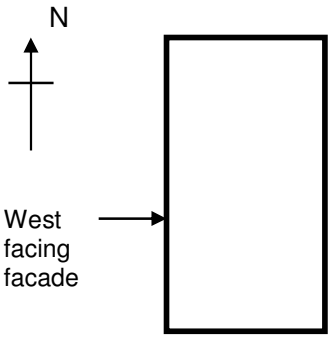


Illustration 1
An example of direct west facing facade

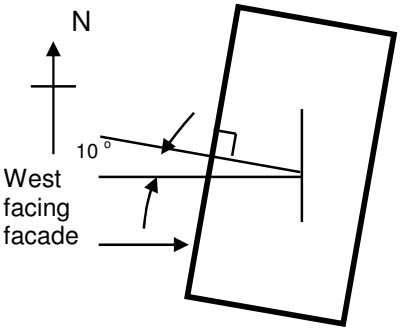


Illustration 2
The block is orientated 10°N of W which is less than of 22.5° N of W. In this instance, the façade is defined as 'west facing façade'.

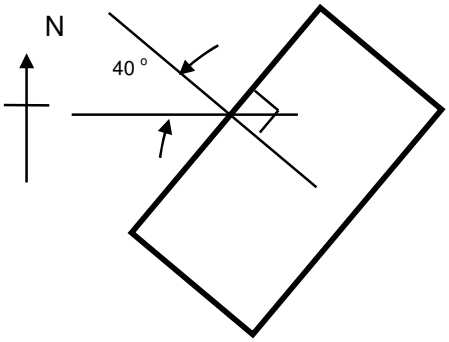


Illustration 3
The block is orientated 40°N of W which exceeds 22.5°N of W and hence the façade is not considered as 'west facing façade' in the computation.

Exception : For existing buildings, the requirement NRB 1-3(a) may be excluded in the computation. The total score obtained from NRB 1-3 and NRB 1-4 under Part 1 – Energy Efficiency will be prorated accordingly.

1-3(b) Up to 10 points can be scored for design with (i) minimum west facing window openings and/or (ii) having effective sunshading provision for windows with minimum shading of 30% on the west façade.

For 1-3 (b)(i) Points scored = 10 – [0.1 x (% of west facing window areas over total west facing façade areas)]

For 1-3 (b)(ii) Points scored = 0.1 x (% of west facing window areas with sunshading devices over total west facing façade areas)

Important notes *: For 1-3 (b)(ii) Points can only be scored if the sunshading devices meet at least a shading of 30% as tabulated in Table 1-3(b) below :*

Table 1-3(b) : Minimum Requirement on Shading Devices for West Facade

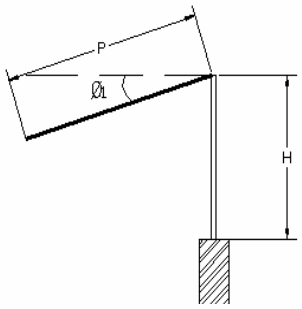
Types of Sunshading Devices	Angle of Inclination	Desired Shading			
		30%	40%	50%	60%
Horizontal Shading (R_1)	**0°**	0.6	0.9	1.5	
	20°	0.4	0.6	0.9	1.8
	40°	0.4	0.5	0.7	1.1
Vertical Shading (R_2)	**0°**	2.1			
	20°	1.1	1.7	2.5	
	40°	0.7	1	1.4	
	50°	0.6	0.9	1.1	2.8

where

Horizontal Shading/Projections (R_1)

$$R_1 = \frac{P}{H}$$

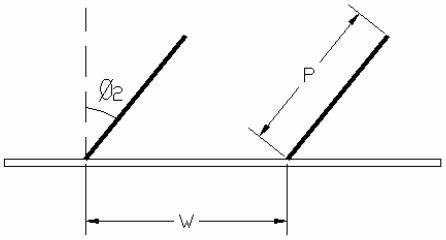
ϕ_1 = Angle of inclination



Vertical Shading/Projections (R_2)

$$R_2 = \frac{P}{W}$$

ϕ_2 = Angle of inclination



1.3(c) Up to 4 points can be scored for external west facing wall that are designed with better thermal transmittance that is a U-value of wall equal or less than 2 W/m^{2}K.

Points scored = 0.04 x (% of the external west facing walls areas with U-value of 2 W/m^{2}K or less over the total west facing façade areas)

	1.3(d) Up to 5 points can be scored for roof design with better thermal transmittance that is a lower U value of roof than the baseline standard. Points scored = 2 points for every 0.1 W/m^2K reduction from the baseline.
Pre-requisite Requirements	Ventilation simulation and its recommendation must be carried out using the prescribed methodology stated in Appendix C to be eligible for Green Mark Platinum rating
Documentary Evidences	<u>For 1-3(a)</u> • Architectural plan layouts and elevation drawings of the façades of all blocks. Highlight those areas that are considered as west facing façade ; and • Calculation showing the percentage of west facing façade areas in the prescribed tabulated format as shown in Table 1-3(a).

Table 1-3(a) Minimum direct west facing external facade

	Area of west facing external façade (m^2) (a)	**Total area of external facade (b)**	**% of west facing external facade**
Block 1			∑ (a)/ ∑ (b) x100
Block 2			
Block 3			
Total			

Points scored for 1-3(a) = 10 – [0.2 x (∑ (a)/ ∑ (b)) x100)]

<u>For 1-3(b)(i) and (ii)</u>

- Architectural plan layouts and elevation drawings of west facing façade and window openings;
- Sectional drawings showing the details of the sunshading devices. Highlight those sunshading devices that meet the 30% shading requirement ;
- Window schedules or drawings showing the areas of the west facing windows; and
- Calculation showing the percentage of west facing window areas in the prescribed tabulated format as shown in Table 1-3(b)(i) and (ii).

Table 1-3(b)(i) : Minimum west facing windows openings

Description	**Area of west facing window area (m^2) (a)**	**Total area of west facing external façade (m^2) (b)**	**% of west facing window areas over total west facing external façade areas**
Block 1			∑ (a)/ ∑ (b) x100
Block 2			
Block 3			
Total			

Points scored for 1-3(b)(i) = 10 – [0.1 x ((∑ (a)/ ∑ (b)) x 100)]

Table 1-3(b)(ii) : Effective sunshading provisions for west facing window with minimum 30% shading

Description	Area of west facing window with effective sunshading provision (m^2) (a)	Total area of west facing external façade (m^2) (b)	% of west facing window areas over total west facing external façade areas
Block 1			$\sum$ (a)/ $\sum$ (b) x100
Block 2			
Block 3			
Total			

Points scored for 1-3(b)(ii) = 0.1 x [($\sum$ (a)/ $\sum$ (b)) x100]

For 1-3(c)

- Architectural drawings highlighting the material types and wall areas which are of better thermal transmittance (U-value);
- Detailed sectional drawings showing the wall composition and the respective U-values;
- Extracts of the tender specification which states the thermal transmittance properties to be adopted for west facing walls; and
- Technical product information and relevant calculation on the U-value of the wall materials used.
- Calculation showing the percentage of west facing window areas in the prescribed tabulated format as shown in Table 1-3(c).

Table 1-3(c): Better thermal transmittance of external west facing walls

Description	Area of external west facing walls with U-value of 2W/m^2K or less (m^2) (a)	Total area of west facing external façade (m^2) (b)	% of external west facing wall areas with prescribed U values over total west facing external façade areas
Block 1			$\sum$ (a)/ $\sum$ (b) x100%
Block 2			
Block 3			
Total			

Points scored = 0.04 x [($\sum$ (a)/ $\sum$ (b)) x100)]

For 1-3(d)

- Plan layout and sectional details of the different roof types of the development;
- Extracts of the tender specification which states the thermal transmittance properties of roof and calculation showing the average reduction as shown in Table 1-3(d);
-

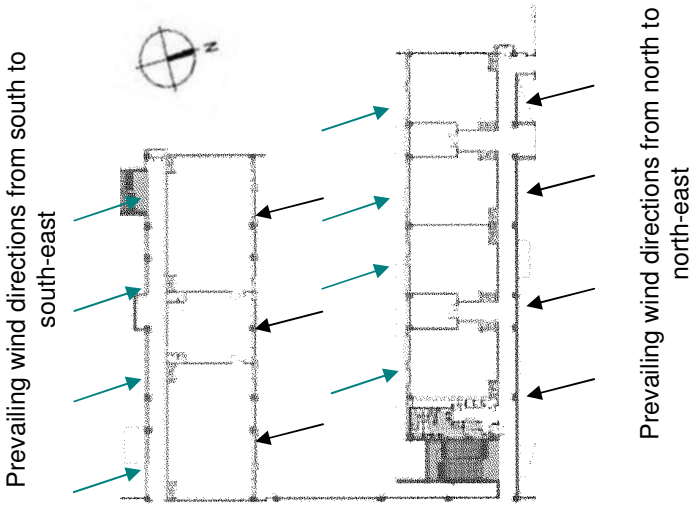
Table 1-3(d): Better thermal transmittance of roof

Roof Type	Weight Group	Weight range (kg/m^2)	Maximum Thermal Transmittance (W/m^2K)	Designed U-value (W/m^2K)	Reduction (W/m^2K)
Roof 1	Light	Under 50	0.8		
Roof 2	Medium	50 to 230	1.1		
Roof 3	Heavy	Over 230	1.5		

- Detailed sectional drawings showing the roof composition and the respective U-values; and
- Technical product information and relevant calculation of the U-value of the roof.

References -

NRB 1-4 NATURAL VENTILATION (EXCLUDE CARPARKS)

Objectives	Enhance building design to achieve good natural ventilation.
Applicability	Applicable to non air-conditioned building spaces with aggregate areas > 10% of the total floor areas excluding carparks.
Baseline Standard	-
Requirements	1-4 (a) Up to 8 points can be scored for building design that utilises prevailing wind conditions to achieve adequate cross ventilation. 0.8 point for every 10% of units/rooms with window openings facing north and south directions Points scored = 0.8 x (% of units / 10) Note: In Singapore, the prevailing wind comes from two predominant directions; that is the north to north-east during the Northeast monsoon season and south to south-east during the South-west monsoon season. Hence, buildings designed with window openings facing the north and south directions have the advantage of the prevailing wind conditions which would enhance indoor thermal comfort. Meteorological data on the more precise wind direction and velocity of the site location can also be used as the basis for the design. It is not necessary for the window openings to be located perpendicularly to the prevailing wind direction. An oblique angle is considered acceptable (see illustrations below).  Illustration 1 - Building layout shows all rooms with window openings facing the north and south directions.

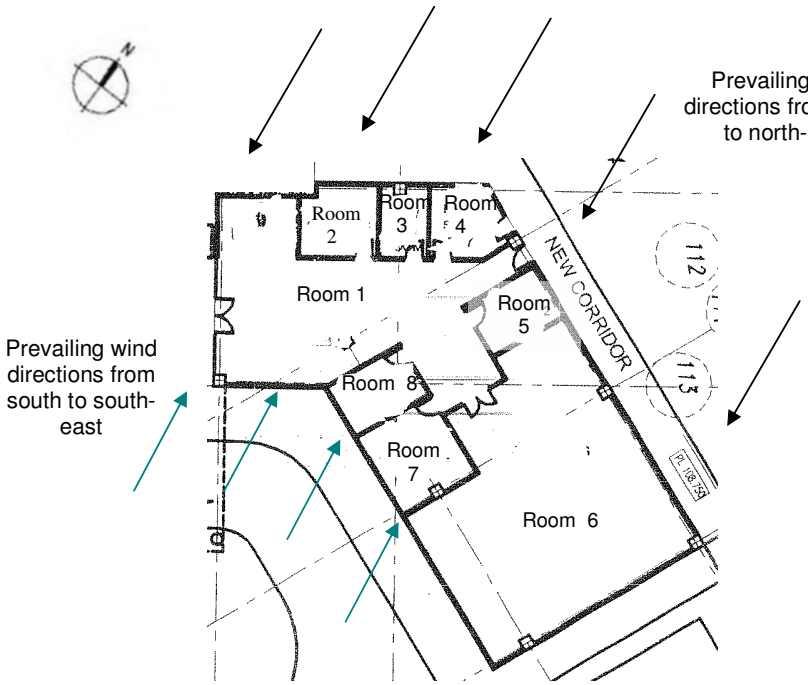


Illustration 2 - Building layout shows not all rooms with window openings facing the north and south directions. Room 2 to Room 5 would only have prevailing wind in one direction. Only Room 1 and 6 can be considered meeting the requirement 1-4 (a)

Alternative compliance : The application of ventilation simulation can be used to prove that the building layout utilises prevailing wind conditions and could achieve adequate cross ventilation within the indoor units through sufficient window openings. The ventilation simulation should be carried out in the same conditions outlined in para 1-4(b) below. Points should only be scored if the recommendations from the simulation are implemented.

1-4 (b) 5 points for the use of ventilation simulation software to identify the most effective building design and layout in achieving good natural ventilation. The design should provide an average wind velocity within the space of at least 0.6 m/s or more. Points can only be scored if the recommendations from the ventilation simulation are implemented. The ventilation simulation shall be carried out in accordance with the methodology stated in Appendix C.

Documentary Evidences

For 1-4(a)

- Architectural plan layouts showing the units / rooms of all blocks with highlights of those with window openings in the N-S direction and/or with air-conditioned systems;
- Calculation showing the percentage of units or rooms with window openings facing north and south directions in the prescribed tabulated format as shown in the Table 1-4(a).

Table 1-4(a) – Percentage of units with window openings in N-S direction

Ref	Description	Units/Rooms with window openings in the N-S direction (a)	Total no. of naturally ventilated units/room (b)	% of units/rooms with window openings in N-S direction
1	Classroom Blk A & A1			$\sum$ (a)/ $\sum$ (b) x100
2	Classroom Blk B			
3	Offices, meeting rooms and computer rooms with air-conditioning			
	Total :			

Points scored = 0.8x (% of units / 10)

= 0.8 x [($\sum$ (a)/ $\sum$ (b) x100) /10]

For 1-4(b)

- Ventilation simulation reports summarising the analysis and simulation results for each typical space as well as the recommendations for design as specified in Appendix C.

References -

NRB 1-5 ARTIFICIAL LIGHTING

Objectives	Encourage the use of better efficient lighting to minimise energy consumption from lighting usage while maintaining proper lighting level.
Applicability	Applicable to lighting provisions for the type of usage specified in the SS 530 Clause 7 – Lighting power budget.
Baseline Standard	Maximum lighting power budget stated in SS 530 - Code of Practice for Energy Efficiency Standard for Building Services and Equipment.
Requirements	Up to 12 points if tenants' light is provided OR Up to 5 points if tenants' light is excluded for the improvement in the lighting power consumption. 0.5 point for every percentage improvement in the lighting provisions over the baseline standard. That is Points scored = 0.5 x (% improvement) Display lighting and specialised lighting are to be included in the calculation of lighting power budget. The design service illuminance, lamp efficacies and the light output ratios of luminaries shall be in accordance with SS 531 : Part 1 – Code of Practice for Lighting of Work Places - Indoor
Documentary Evidences	• Lighting layout plan; • Lighting schedules showing the numbers, locations and types of lighting luminaries used; • Calculation of the proposed lighting power budget and the percentage; improvement in the tabulated format showing the areas, light fitting type, power consumption per fitting, ballast loss, no. of fittings, individual and total design and reference (based on SS 530) power consumption and power budget according to the fitting type ; and • Technical product information of the lighting luminaries used.
References	SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment. SS 531 : Part 1 – Code of Practice for Lighting of Work Places - Indoor

NRB 1-6 VENTILATION IN CARPARKS

Objectives	Encourage the use of energy efficient design and control of ventilation systems in carparks.
Applicability	Applicable to all carpark spaces in the development.
Baseline Standard	-
Requirements	1-6(a) 5 points can be scored if the carparks spaces that are fully naturally ventilated. 1-6(b) For carparks that have to be mechanically ventilated, points can be scored for the use of carbon monoxide (CO) sensors in regulating such demand based on the mode of mechanical ventilation (MV) used; 4 points for carparks using fume extract system and 3 points for those with MV with or without supply. Note : Where there is a combination of different ventilation mode adopted for carpark design, the points scored under this requirement will be prorated accordingly.
Documentary Evidences	<u>For 1-6 (a) and (b)</u> • Plan layouts showing all carpark provisions for the development with highlights of the carpark spaces that are designed to be naturally ventilated and/or mechanical ventilated; • Plan layouts indicating the locations of CO sensors and the mode of ventilation adopted for the design; and • Calculation showing the points allocation if there is a combination of different ventilation modes adopted for the carpark design.
References	SS CP 13 – Code of Practice for Mechanical Ventilation and Air-Conditioning in Buildings.

NRB 1-7 VENTILATION IN COMMON AREAS

Objectives	Encourage the use of energy efficient design and control of ventilation systems in common areas.
Applicability	Applicable to the following common areas of the development. ▪ Toilets ▪ Staircases ▪ Corridors ▪ Lift Lobbies ▪ Atriums
Baseline Standard	-
Requirements	Up to 5 points can be scored for the use of natural ventilation as an effective passive cooling design strategy to reduce the energy used by air-conditioning systems in these common areas. Extent of coverage : At least 90% of each applicable area (by numbers). Points are scored based on the mode of ventilation provided in these applicable areas. Natural ventilation – 1.5 points for each area Mechanical ventilation – 0.5 point for each area
Documentary Evidences	• Plan layouts showing the applicable areas and the respective modes of ventilation; and • Schedules showing the numbers, locations of the applicable areas and the modes of ventilation used.
References	SS CP 13 – Code of Practice for Mechanical Ventilation and Air-Conditioning in Buildings.

NRB 1-8 LIFTS AND ESCALATORS

Objectives	Encourage the use of energy efficient lifts and escalators.
Applicability	Applicable to all lifts and/or escalators in the development.
Baseline Standard	-
Requirements	1 point can be scored for the use of lifts with energy efficient features such as AC variable voltage and variable frequency (VVVF) motor drive or equivalent. 1 point can be scored for the use of lifts with sleep mode features. 1 point can be scored for the use of escalators with motion sensors to regulate usage.
Documentary Evidences	Extracts of the tender specification indicating the types of lifts, escalators and related features.
References	-

NRB 1-9 ENERGY EFFICIENT PRACTICES & FEATURES

Objectives	Encourage the use of energy efficient practices and features which are innovative and have positive environmental impact in terms of energy saving.
Applicability	Applicable to practices and features that are not listed in the requirements under Part 1 – Energy Efficiency.
Baseline Standard	-
Requirements	1-9 (a) 1 point can be scored for the practice of using Energy Efficiency Index (EEI) as a building performance indicator to measure the building's unit area energy consumption for future monitoring and improvements. Calculation of EEI : EEI = [(TBEC - DCEC) / (GFA – DCA)] x (NF/OH) *where:* (a) TBEC : Total building energy consumption (kWh/year) (b) DCEC : Data centre energy consumption (kWh/year) (d) GFA : Gross floor area (exclude car park area) (m^2) (e) DCA : Data centre area (m^2) (f) NF : Normalising factor based on a typical weekly operating hours that is 55 hrs/week (g) OH : Weighted weekly operating hours (hrs/week) Note : (1) EEI is based on 100% occupancy rate for consistency. (2) All major energy consumption equipments are to be included in the estimation of total building energy consumption. (3) For industrial buildings, process load should be excluded. 1-9(b) Up to 11 points can be scored for the use of the following approved energy efficient features depending on the potential energy saving. ▪ Thermal storage system ▪ Heat recovery devices ▪ Light shelves ▪ Motion sensors for staircases half landing and toilets ▪ Sun pipes for natural lighting ▪ Ductless fans for basement ventilation ▪ Auto-condenser tube cleaning system ▪ Photo sensors to maximize the use of daylighting ***Important notes :*** *For features that are not listed NRB 1-9(b) above, the QP is required to submit the details showing the positive environmental impacts and potential energy savings of the proposed features to BCA for assessment.*

Documentary Evidences	For 1-9(a) • Calculation of the Energy Efficiency Index (EEI) using the pre-determined daily usage pattern as in Table 1-9 and in the tabulated format showing the daily usage pattern, estimated load (kW) and the load per day (kWh) and the total energy consumption per day (kWh/day). For 1-9(b) • Extracts of the tender specification showing the provision of the proposed energy efficient features and the extent of implementation where applicable; • Technical product information on the energy efficient features used; and • Calculation of the potential energy savings that could be reaped from the use of these features.
References	NUS Centre for Total Building Performance: http://www.bdg.nus.edu.sg/buildingenergy/e_energy/audit_results.html

NRB 1-10 RENEWABLE ENERGY

Objectives	Encourage the use of renewable energy sources in buildings.
Applicability	Includes all renewable energy sources
Baseline Standard	-
Requirements	Up to 20 *Bonus* points can be scored based on the percentage replacement of electricity by the renewable energy source : 5 points for every 1% replacement of electricity (based on total electricity consumption) by renewable energy OR 3 points for every 1% replacement of electricity (exclude tenant's usage) by renewable energy
Documentary Evidences	• Extracts of the tender specification and plans showing the location of the renewable energy system and the extent of implementation; • Technical product information on the salient features of the renewable energy system and the expected renewable energy generated; and • Calculation of the percentage replacement of electricity and the total annual electricity consumption of the development.
References	-

(II) Other Green Requirements

Part 2 – Water Efficiency

NRB 2-1 WATER EFFICIENT FITTINGS

Objectives

Reduce the use of potable water by using water efficient fittings covered under the Water Efficiency Labelling Scheme (WELS).

Applicability

Applicable to all water fittings covered by the WELS as follows:

- Basin taps and mixers
- Sink/bib taps and mixers
- Shower taps and mixers
- Showerheads
- Dual-Flush Low Capacity Flushing Cisterns
- Urinals and Urinal Flush Valves

Baseline Standard

As specified under Water Efficiency Labelling Scheme (WELS).

Requirements

Up to 8 points can be scored based on the number and water efficiency rating of the fitting type used.

WELS Rating	Water Efficiency	Weightage for Point Allocation
✓	Good	4
✓✓	Very Good	6
✓✓✓	Excellent	8

Documentary Evidences

- Extracts of the tender specification showing all the water fitting provisions for the development;
- Water fitting schedules showing the numbers, types and the approved rating of the proposed fittings
- Calculation showing the percentage of proposed water fittings that are approved under WELS as shown in Table 2-1.

Table 2-1 –Computation of the percentage of water fittings under WELS

Ref.	Water Fitting Type	WELS rating			No approved rating	Total no. based on fitting type
		Excellent	Very Good	Good		
1	Shower taps and mixers					
2	Showerheads					
3	Basin taps and mixers					
4	etc..					
Total no. based on rating (A)						∑A
Weightage (B)		8	6	4	0	0
Total (AXB)						∑(AxB)

Points scored = ∑(AxB) / ∑A

References	For more information about WELS, refer to Inspectorate Branch Water Demand Management & Inspectorate Division Water Supply (Network Department) PUB

NRB 2-2 WATER USAGE AND LEAK DETECTION

Objectives	Promote the use of sub-metering and leak detection system for better control and monitoring of water usage.
Applicability	Applicable to sub-metering provisions for major water uses of the building developments.
Baseline Standard	-
Requirements	2-2(a) 1 point can be scored if sub-meters are provided for <u>all</u> major water uses i.e. irrigation system, cooling towers and tenant's usage where applicable. 2-2(b) 1 point can be scored if all sub-meters are linked to the Building Management System (BMS) for monitoring and leak detection. The BMS should have specific alert features that can be set and triggered to detect the possibility of water leakage during operation.
Documentary Evidences	<u>For 2-2(a)</u> • Extracts from the tender specification stating the provision of sub-metering for all major water uses. • Schematic drawings of cold water distribution system showing the location of the sub-metering provided. <u>For 2-2(b)</u> • Extracts from the tender specification and schematic drawings showing the location of sub-metering and its linkage to the BMS.
References	-

NRB 2-3 IRRIGATION SYSTEM

Objectives	Reduce potable water consumption by provision of suitable systems that utilise rainwater or recycled water for landscape irrigation.
Applicability	Applicable to development with landscaping provision.
Baseline Standard	-
Requirements	2-3(a) 1 point can be scored for the use of non-potable water including rainwater for landscape irrigation. 2-3(b) 1 point can be scored if more than 50% of the landscape areas are served by water efficient irrigation system with features such as automatic sub-soil drip irrigation system with rain sensor control.
Documentary Evidences	<u>For 2-3(a)</u> • Extracts of the tender specification showing how the non-potable water source is to be provided; • Relevant drawings showing the location and design of the non-potable water source; and • For rainwater harvesting and storage system, approval letter from PUB is to be provided. <u>For 2-3(b)</u> • Extracts of the tender specification showing the provision and details of water efficient irrigation system; • Relevant layout plans showing the overall landscape areas and the areas that would be served using the system; and • Calculation showing the percentage of the landscape areas that would be served using the system.
References	-

NRB 2-4 WATER CONSUMPTION OF COOLING TOWER

Objectives	Reduce potable water consumption for cooling purpose.
Applicability	Applicable to building developments with water-cooled central chillers systems and water cooled package units.
Baseline Standard	-
Requirements	2-4(a) 1 point can be scored for the use of cooling tower water treatment system which can achieve 6 or better cycles of concentration at acceptable water quality. 2-4(b) 1 point can be scored for the use of NEwater or on-site and recycled water from approved sources to meet the water demand for cooling purpose.
Documentary Evidences	<u>For 2-4(a)</u> • Extracts of the tender specification showing the requirements to incorporate with the cooling tower designs to achieve six cycles of concentration; • Details showing how the cooling towers have been designed to achieve at least six cycles of concentration; and • Relevant drawings showing the location of the cooling towers and other supporting systems that are required to achieve the designed concentration. <u>For 2-4(b)</u> • Extracts of the tender specification showing how the Newater or other recycled water source is to be provided.
References	-

(II) Other Green Requirements

NRB 3-1 SUSTAINABLE CONSTRUCTION

<table>
<tr><td>Objectives</td><td>Encourage the adoption of building designs, construction practices and materials that are environmentally friendly and sustainable.</td></tr>
<tr><td>Applicability</td><td>Generally applicable to all building developments.</td></tr>
<tr><td>Baseline Standard</td><td>-</td></tr>
<tr><td>Requirements</td><td>
3-1(a) Up to 4 points are allocated to encourage more efficient concrete usage for building components based on the percentage reduction in the prescribed Concrete Usage Index (CUI) limit.

Note : Concrete Usage Index (CUI) is an indicator of the amount of concrete used to construct the superstructure which includes both the structural and non-structural elements. CUI does not include the concrete used for external works and sub-structural works such as basements and foundations. CUI is defined as the volume of concrete in cubic metres needed to cast a square metre of constructed floor area. It is expressed as:

$$\text{Concrete Usage Index} = \frac{\text{Concrete Volume in m}^3}{\text{Constructed Floor Area in m}^2}$$
Table 3-1(a) CUI Limit for Non-Residential Building
<table>
<tr><th>CATEGORY</th><th>Concrete Usage Index (CUI) limit (m^3/m^2)</th></tr>
<tr><td>Non-Residential (15 storey & below)</td><td>0.50</td></tr>
<tr><td>Non-Residential (above 15 storey)</td><td>0.55</td></tr>
</table>
3-1(b) Up to 2 points can be scored if more than 50% of the existing structural elements or building envelopes (by areas) are conserved during redevelopment. Structural elements refer to slabs, columns, beams and load bearing walls.

3-1(c) Up to 8 points are allocated to encourage the use of sustainable materials and products in building construction such as :

(i) Up to 4 points for the use of environmental friendly products that are certified under the Singapore Green Labelling Scheme (SGLS) where 1 point for each high impact item and 0.5 point for each low impact item.

(i) Up to 4 points for the use of products (applicable only for non-structural elements) with at least 30% recycled content by weight or volume where 1 point for each high impact item and 0.5 point for each low impact item

Note (1) : The use of environmental friendly products or recycled products used for the main building elements or functional spaces will be considered as high impact if the quantities used by percentage is more than 50% as compared to the total amount of materials used for same intended purpose.

Note (2) : The point allocated for low volatile organic compound (VOC) paints and adhesives certified under SGLS can be found in NRB 4-3 and hence shall not be included in the scoring for NRB 3-1(c)(i) and (ii).
</td></tr>
</table>

Documentary Evidences

For 3-1(a)

- Architectural and structural plan layout, elevation and sectional plans showing the type of wall system used, the dimensions and sizes of all the building and structural elements; and
- Calculation showing the quantity of concrete for each floor level in the prescribed tabulated format as shown below. The calculation should include all the building elements listed in the Table 3-1(a).

Table 3-1 (a) : COMPUTATION OF CONCRETE USAGE INDEX

Project Reference No.: AXXXX-00001-2007 **Total no. of storey for the project: __**

Block No :___

	Structural System	Thickness (mm) or size (mm x mm)	Volume of concrete (m^3)	Remark *
1	**1st storey**			
	1.1 Columns			
	1.2 Beams			
	1.3 Slabs			
	1.4 Staircases			
	1.5 Suspended structures like planter boxes, bay windows, ledges etc			
	1.6 Parapets			
	1.7 External walls - loadbearing walls			
	1.8 External walls – non-loadbearing walls			
	1.9 Internal walls – loadbearing walls			
	1.10 Internal walls – non-loadbearing walls			
	1.11 Others (kerbs, ramps, services risers, etc)			
	Total volume of concrete for this storey (m^3)			
	Total constructed floor area for this storey (m^2)			
2	**Typical floor layout**			
	2.1 Columns			
	2.2 Beams			
	2.3 Slabs			
	2.4 Staircases			
	2.5 Suspended structures like planter boxes, bay windows, ledges etc			
	2.6 Parapets			
	2.7 External walls - loadbearing walls			
	2.8 External walls – non-loadbearing walls			

COMPUTATION OF CONCRETE USAGE INDEX

Project Reference No.: AXXXX-00001-2007 Total no. of storey for the project: ___

Block No : __

	Structural System	Thickness (mm) or size (mm x mm)	Volume of concrete (m^3)	Remark *
2	**2nd storey to 30th storey (Typical floor layout)**			
	2.9 Internal walls – loadbearing walls			
	2.10.Internal walls – non-loadbearing walls			
	2.11 Others (kerbs, ramps, services risers etc)			
	Volume of concrete for one storey (m^3)			
	Constructed floor area for one storey			
	Total volume of concrete (including roof level)			
	Total constructed floor area (including roof level)			
	Total volume of concrete for this project (m^3)			
	Total constructed floor area for this project (m^2)			
	Concrete Usage Index (CUI in m^3/m^2)			

*To indicate if the structural elements is of precast concrete, post-tensioned concrete, high strength concrete (> Grade 60) or reinforced concrete (RC) under the 'Remarks' column

For 3-1(b)

- Architectural and structural plan layout, elevation and sectional plans of the proposed building showing the areas of the existing building envelope or structural elements that are to be conserved;
- Calculation showing that the percentage of building envelope or structural elements being conserved; and
- Extracts from the tender specification and documents indicating the portion of existing building envelope or structural elements to be conserved.

For 3-1(c)

- Extracts from the tender specification showing the requirements to incorporate the environmental friendly products that are certified with SGLS.
- Extracts from the tender specification showing the requirements to incorporate the use of recycled products
- Technical product information on the recycled products and their recycled contents by weight or volume.

References -

NRB 3-2 GREENERY

Objectives	Encourage greater use of greenery and restoration of existing trees to reduce heat island effect.
Applicability	Applicable to building developments with landscaping areas.
Baseline Standard	-
Requirements	3-2(a) Up to 4 points can be scored for the provision of greenery within the developments including roof top/ sky garden and green roof. Greenery Provision (GnP) is calculated by considering the 3D volume covered by plants using the following Green Area Index (GAI) : Grass GAI = 1 ; Shrubs GAI = 3; Palms Trees GAI = 4; Trees GAI = 6 Greenery Provision (GnP) = total green area / site area GnP = 0.5 to < 1.0 – 1 point GnP = 1.0 to < 1.5 – 2 points GnP = 1.5 to < 3.0 – 3 points GnP ≥ 3.0 – 4 points 3-2(b) 1 point for restoration of trees on site, conserving or relocating of existing trees on site. 3-2(c) 1 point for the use of compost recycled from horticulture waste.
Documentary Evidences	<u>For 3-2(a)</u> • Plan layouts showing the greenery provision and site areas ; and • Calculation showing the extent of the greenery provision in the prescribed tabulated format as shown below.

Description	**Qty (A)**	**Canopy area (B)**	**Radius (C)**	**Green Area Index GAI**	**Green Area (A)x(B)x(C^2)xGAI**
Trees (Nos)		3.14	3.5	6	
Palms (Nos)		3.14	1	4	
Shrubs (m^2)		NA	NA	3	
Landscape area + roof garden area + vertical greening (m^2)		NA	NA	1	
				Total Green Area :	
				Total Site Area :	
				Greenery Provision (GnP) = Total (Green Area/Site Area) :	

	For 3-2(b) • Site layouts showing the existing and final locations (where applicable) and number of the trees to be restored or conserved or relocated. For 3-2(c) • Extracts of the tender specification showing the requirements to use compost recycled from horticulture waste.
References	-

NRB 3-3 ENVIRONMENTAL MANAGEMENT PRACTICE

Objectives	Encourage the adoption of environmental friendly practices during construction and building operation.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	3-3(a) 1 point can be scored if effective implementation of environmental friendly programmes including monitoring and setting targets to minimise energy use, water use and construction waste are in place. 3-3(b) 1 point can be scored if the building quality is assessed under the Construction Quality Assessment System (CONQUAS). 3-3(c) Up to 1 point if the developer, main builder, M & E consultant and architect are ISO 14000 certified. 0.25 point is allocated for each firm that is certified. 3-3(d) Up to 3 points where 1 point can be scored if the project team comprises one Certified Green Mark Manager (GMM) and 2 points can be scored if the team has one Certified Green Mark Professional (GMP). 3-3(e) 1 point can be scored for the provision of building users' guide including details of the environmental friendly facilities and features within the building and their uses in achieving the intended environment performance during the building operation. 3-3(f) 1 point can be scored for the provision of facilities or recycling bins for collection and storage of different recyclable waste such as paper, glass, plastic etc.
Documentary Evidences	<u>For 3-3(a)</u> • Extracts of the tender specification showing the requirements for builder to provide and implement environmental friendly programmes to minimise energy use, water use and construction waste; and • Details of the environmental friendly programmes implemented. <u>For 3-3(b)</u> • Extracts of the tender specification showing the requirement to adopt CONQUAS. <u>For 3-3(c)</u> • A certified true copy of the ISO 14000 certificate of developer, main contractor, M & E consultant and architect where applicable. <u>For 3-3(d)</u> • A certified true copy of the certificate of Green Mark manager and Green Mark professional where applicable and a confirmation of their involvement in the project.

Documentary Evidences – Cont'd	<u>For 3-3(e)</u> • A copy of the building users' guide containing the details of the environmental friendly facilities and features within the building and their uses in achieving the intended environment performance during the building operation. <u>For 3-3(f)</u> • Plan layout showing the location of the recycling bins for collection and storage of different recyclable waste.
References	-

NRB 3-4 PUBLIC TRANSPORT ACCESSIBILITY

Objectives	Promote the use of public transport or bicycles to reduce pollution from individual car use.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	3-4(a) 1 point can be scored for design that provides good access (< 500m) to public transport networks such as MRT/LRT stations and bus stops. 3-4(b) 1 point can be scored for the provision of adequate bicycles parking lots.
Documentary Evidences	<u>For 3-4(a)</u> • Site layout plan in the context of the surrounding area showing the location of the development site and the location of the MRT/LRT stations and bus stops. <u>For 3-4(b)</u> • Extracts of the tender specification showing the requirement to provide bicycles parking lots for the development.
References	-

NRB 3-5 REFRIGERANTS

Objectives	Reduce the potential damage to the ozone layer and the increase in global warming through the release of ozone depleting substances and greenhouse gases.
Applicability	Generally applicable to all building developments with air-conditioning systems.
Baseline Standard	-
Requirements	3-5(a) 1 point can be scored for the use of refrigerants with ozone depleting potential(ODP) of zero or with global warming potential (GWP) of less than 100. 3-5(b) 1 point can be scored for the use of refrigerant leak detection system at critical areas of plant rooms containing chillers and other equipments with refrigerants.
Documentary Evidences	<u>For 3-5(a)</u> • Extracts from the tender specification showing the requirement for all refrigerants to have an ODP of zero or GWP of less than 100. <u>For 3-5(b)</u> • Extracts from tender specification showing the requirement to incorporate a refrigerant leak detection system.
References	-

(II) Other Green Requirements

Part 4 –	**Indoor Environmental Quality**	**NRB 4-1**	**Thermal Comfort**
		NRB 4-2	**Noise Level**
		NRB 4-3	**Indoor Air Pollutants**
		NRB 4-4	**High Frequency Ballasts**

NRB 4-1 THERMAL COMFORT

Objectives	Recognise buildings that are designed with good thermal comfort.
Applicability	Generally applicable to all building developments with air-conditioning systems.
Baseline Standard	-
Requirements	2 points can be scored if the air-conditioning systems are designed to allow for cooling load variations due to fluctuations in ambient air temperature to ensure consistent indoor conditions for thermal comfort. Indoor temp between 22.5 to 25.5 °C Relative Humidity < 70%
Documentary Evidences	Extracts of the tender specification showing the requirement to design the air-conditioning systems which would provide consistent indoor conditions for thermal comfort as stated in the above requirement.
References	-

NRB 4-2 NOISE LEVEL

Objectives	Recognise buildings that are designed to control and keep the background noise in occupied spaces at levels appropriate to the intended use of the spaces.
Applicability	Generally applicable to all building developments.
Baseline Standard	SS CP 13 – Code of Practice for Mechanical Ventilation and Air-Conditioning in Buildings.
Requirements	2 points can be scored if the occupied spaces in buildings are designed with the recommended ambient sound levels stated in SS CP 13.
Documentary Evidences	• Extracts of the tender specification showing the requirement to design the occupied space with the ambient sound levels to the recommendation stated in SS CP 13 ; and • Detailed analysis, calculations and/or measurements to ensure that the designed ambient sound levels are met.
References	-

NRB 4-3 INDOOR AIR POLLUTANTS

Objectives	Minimise airborne contaminants, mainly from inside sources to promote a healthy indoor environment.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	4-3(a) 1 point can be scored for the use of low volatile organic compounds (VOC) paints certified under the Singapore Green Labelling Scheme (SGLS) for at least 90% of the internal wall areas. 4-3(b) 1 point can be scored for the use of adhesives certified under the Singapore Green Labelling Scheme (SGLS) in all composite wood products used for the development.
Documentary Evidences	<u>For 4-3(a)</u> • Extracts of the tender specification showing the requirement to use low VOC paints that are certified under SGLS. <u>For 4-3(b)</u> • Extracts of the tender specification showing the requirement to use adhesive with low emission formaldehyde and are certified under SGLS for all composite wood products used.
References	-

NRB 4-4 HIGH FREQUENCY BALLASTS

Objectives	Encourage the use of high frequency ballasts in fluorescent luminaries to improve the workplace lighting quality.
Applicability	Generally applicable to workplace such as offices, classrooms and training rooms and the like.
Baseline Standard	-
Requirements	2 points can be scored for the use of high frequency ballasts in the fluorescent luminaries if it is adopted in at least 90% of the applicable areas that are served by fluorescent luminaries.
Documentary Evidences	• A summary sheet listing all fluorescent luminaries used for the developments and those with high frequency ballasts; and • Extracts of the tender specification showing the requirement to have high frequency ballasts are to be used in all fluorescent luminaries listed.
References	-

(II) Other Green Requirements

Part 5 – Other Green Features

NRB 5-1 Green Features and Innovations

NRB 5-1 OTHER GREEN FEATURES

Objectives	Encourage the use of green features which are innovative and have positive environmental impact on water efficiency, environmental protection and indoor environmental quality of the buildings.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	Up to 7 points are awarded for the use of the following green features depending on their potential environmental benefits or reduced environmental impacts. <u>Water Efficiency</u> (i) Use of self cleaning façade system • 2 points for more than 75% of the external walls. • 1 point for more than 50% of the external walls. • 0.5 point for at least 25% of the external walls. (ii) Use of grey water recycling system • 2 points for all blocks of the development. • 1 point for at least one block of the development. (iii) Recycling of AHU condensate • 1 point for more than 75% of the AHU condensate. • 0.5 point for at least 50% of the AHU condensate. (iv) 0.5 point for the use of membrane filtration system to recycle water during construction. (v) 0.5 point for the use of non-chemical water treatment for cooling tower. <u>Environmental Protection</u> (i) Provision of green roof and roof top garden • 1 point for more than 50% of the roof areas • 0.5 point for at least 25% of the roof areas (ii) Provision of vertical greening • 1 point for more than 50% of the external wall areas • 0.5 point for at least 25% of the external wall areas (iii) 1 point for the provision of double refuse chutes for separating recyclable from non-recyclable waste (iv) 0.5 point for the use of non-chemical termite treatment system such as termite baiting system, anti-termite mesh. (v) 0.5 point for the provision of at least 5 nos. of compost bins to recycle organic waste.

	(vi) 0.5 point for the use of non-chemical water treatment system for swimming pools. (vii) Up to 1 point if at least 10% of the fine and/or coarse aggregate used for concrete production of structural application are replaced with recycled products from approved sources. 0.5 point for each recycled product used. Points can only be scored if the extent of implementation covers at least 50% of all concrete structural elements of the superstructures (by volume). <u>Indoor Air Quality</u> (i) Use of Titanium Dioxide solutions to remove odour in toilets : • 1 point for more than 50% of all toilets • 0.5 point for at least 25% of all toilets (ii) 1 point for the use of pneumatic waste collection system. (iii) 0.5 point for the use of Ultraviolet light-C band (UV) emitters in <u>all</u> air handling units (AHUs) to improve indoor air quality. <u>Others</u> (i) Provision of landscape drainage and infiltration trenches : • 1 point for at least 25% of the landscape areas • 0.5 point for less than 25% of the landscape areas (ii) Provision of system to recycle surface runoff from the vertical green wall and sky garden : • 1 point for at least 25% of the green areas • 0.5 point for less than 25% of the green areas (iii) 0.5 point for the use of siphonic rainwater discharge system at roof. (iv) 0.5 point for the provision of eco-pond. (v) 0.5 point for the provision of carpark guidance system. ***Important notes :*** *For features that are not listed above, the QP is required to submit the details showing the positive environmental impacts, possible savings and benefits of the proposed features to BCA for assessment.*
Documentary Evidences	• Extracts of the tender specification showing the provision of the specific green features used and the extent of implementation where applicable; • Technical product information (including drawings and supporting documents) of the green features; • A summary sheet listing the breakdown and the extent of implementation as well as the total requirements for the same intended purpose for the specific green features used; and • Quantified evidences on the potential environmental benefits that the features can bring to the development.
References	-

Appendix C

VENTILATION SIMULATION METHODOLOGY AND REQUIREMENTS

C1 General

The natural ventilation simulation shall be carried out using computational fluid dynamics (CFD) modeling to identify the most effective building design and layout for the development. The simulation results and recommendations derived are to be adopted to meet the intent of the criteria.

C2 Simulation Software

The CFD modeling shall be carried out using a well validated software such as *AVL-Swift, CFX, Fluent, Star-CD*) which is acceptable to BCA. The CFD solver shall have the minimum capability of solving the Navier-Stokes fluid flow equations for a three-dimensional incompressible flow at steady state on a body conforming computational grid. Turbulence modelling shall also be included with the minimum requirement of using the standard k-ε turbulence model, coupled with standard wall function.

C3 Ventilation Simulation Methodology

C3.1 All simulations shall be carried out under isothermal condition of 33.0℃ air temperature at steady state condition.

C3.2 The computational domain of all simulations shall be extended, approximately 3 times in radius the length of the longest distance measured across the boundary of the development which should include the development of interest, the characteristics of the immediate surroundings and buildings at a large scale level.

C3.3 The computational grid generated for all simulations should resolve the salient flow features in the apartment units and around the development. As a guide, the dimension of the computational element should be set at 0.1 to 0.2m in the apartment unit, 0.5 to 1.0 m near the buildings & ground level and 10 m at the far field boundary.

C3.4 Depending on local climatic wind condition, meteorological data on the precise wind direction and velocity of the proposed site location for the month of December, March, June and September should be used for the simulation. The prevailing wind condition such as the mean speed and direction for Singapore shall be taken from Table C3.4 below. The inbound vertical wind profile shall assume to be given by the Logarithmic Law with reference height at 15.0m.

Table C3.4: Tabulation of Prevailing Wind Direction & Speed obtained from NEA over a Period of 18 Years.

Wind Direction	Mean Speed (m/s)
North	2.0
North-East	2.9
South	2.8
South-East	3.2

C3.5 There should have two large scale simulation models using the specified computational domain and grid stated in paragraph C3.2 and C3.3, to assess the wind flow conditions and air-flow pattern within the development and units.

(a) Simulation model for development : To assess the wind flow conditions and pattern around the building development and adjacent buildings and to determine and select up to three (3) units type (with best, average and worst air-flow conditions) for the subsequent simulation model for units (see paragraph C3.5(b) for details). The simulation is carried out based on the average wind pressure, taken at 0.5m away from the all the openings

into a unit, for all the units at mid height level. The maximum allowable margin should not be more 20% difference from the total average wind pressure.

(b) Simulation model for units : To assess the air-flow patterns within the units and the average wind velocity in the selected units, all habitable spaces in the dwelling units or functional spaces are to be included in the modelling except for enclosed space, such as storeroom or CD shelter. All windows & doors are assumed to be fully opened except for the main door, which is assumed to be closed at all time.

C3.6 For residential buildings, the area-weighted average wind velocity for the living room, open kitchen (which is connected to the living room) and all bedrooms are to be computed, on horizontal-plane 1.2m above the floor level and should meet at least 0.6m/s. The same applies to naturally ventilated functional spaces for non-residential buildings.

C4 Documentation Requirements

C4.1 The Qualified Person (QP) and the other appropriate practitioners shall ensure that the following report is available as evidences to demonstrate compliance with the ventilation simulation framework. The report should comprise the following items:

(i) Cover page with a proper title, photo of development, developer's information (including developer's name and address and person-in-charge), Consultant's detail (including the principal's name and authorized signature, firm's address and person-in-charge)

(ii) Table of Contents

(iii) Executive Summary
- Background of the development
- Main findings
- Concluding remarks

(iv) Background/ Introduction

(v) Methodology
- Describe methodology used in the study
- Provide the rationale for the units selection as well as salient information such as the total no. of units and different design units layout and location

(vi) Geometrical Model should include
- Isometric view of the development from various angles
- Domain size used
- Plan and 3D isometric model of units from various angles

(vii) Simulation settings
- Boundary conditions
- CFD software/ models used/ numerical scheme
- Mesh / cell sizing
- Solution control- convergence criteria

(viii) Result and discussions
- Simulation results for development for all 4 directions showing the main graphical plots of the plan pressure and velocity vector and salient findings

- Simulation results for units by way of tabulation of the velocity of the selected units as well as the calculation showing the average wind velocity.

(ix) Conclusion

(x) The following plots are to be placed in the appendixes

- Simulation results for the development (done for each direction)
  - Static pressure (plan view-ground & mid elevation, isometric views on building façade)
  - Velocity vector and contour showing the plan view at ground & mid elevation and a few isometric sectional cut plans to show air-flow patterns across the development

- Simulation results for the units (done for each direction)
  - Static pressure (plan view-ground & mid elevation)
  - Velocity vector and contour showing the plan view at ground & mid elevation

Appendix D

ENERGY MODELING METHODOLOGY AND REQUIREMENTS

D1 General

The energy modeling for evaluating the energy performance of a building should be carried out in a prescribed manner to quantify the potential savings over the Reference Model.

D2 Simulation Software

The simulation software used for energy modeling should meet the following criteria :

(a) It must have the capability to model the thermal performance of buildings in a mult-zone format and calculate the building's total energy consumption over a continuous 12-months period.

(b) It must be tested by a recognised institution in accordance to the Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs – **ANSI/ASHRAD STD 140** or other equivalent standard.

D3 Reference Model

The simulation model for calculating the baseline building performance (known as Reference Model) shall be developed in accordance with the requirements in the following Table D3.

Table D3 – Baseline Standard

<table>
<tr><th>S/No.</th><th>Component</th><th>Baseline Standard</th><th>Minimum Requirement</th></tr>
<tr><td>1</td><td>Building Envelope Design</td><td>BCA Approved Document

Code on Envelope Thermal Performance for buildings</td><td>(a) ETTV shall not exceed 50 W/m^2

(b) For roof with skylight, RTTV shall not exceed 50 W/m^2

(c) For roof without skylight, the average U value of the gross area of the roof shall not exceed the limit below :

Maximum Thermal Transmittance for Roof of air-conditioned buildings
<table>
<tr><th>Weight Group</th><th>Weight range (kg/m^2)</th><th>Maximum Thermal Transmittance (W/m^{2}k)</th></tr>
<tr><td>Light</td><td>Under 50</td><td>0.5</td></tr>
<tr><td>Medium</td><td>50 to 230</td><td>0.8</td></tr>
<tr><td>Heavy</td><td>Over 230</td><td>1.2</td></tr>
</table>
(d) All windows on the building envelope shall not exceed the air leakage rates specified in SS 212 – Specification for Aluminium Alloy Windows.

(e) Where the door opening of any commercial unit is located along the perimeter of the building envelope, that unit shall : -

(i) be completely separated from the other parts of the building; and

(ii) has its air-conditioning system separated from and independent of the central system.</td></tr>
<tr><td>2</td><td>Chiller Efficiency</td><td>SS 530: 2006</td><td>Minimum energy efficiency standard stated</td></tr>
</table>

S/No.	Component	Baseline Standard	Minimum Requirement
3	Pump Efficiency (for chilled water and condenser water)	CP 13: 1999 – Code of Practice for mechanical ventilation and air-conditioning in buildings (Cl 7.11.6 – Pump system design criteria)	Chiller Water Pump energy consumption shall not exceed 0.033 kW/kW Condenser Water Pump energy consumption shall not exceed 0.025 kW/kW 7.11.6 Pumping system design criteria (a) Piping systems should be designed at a friction pressure loss rate of no more than 4.0m of water per 100 equivalent metre of pipe. (b) The water transport factor shall not be less than 30 for chilled water and 40 for the condensing water circuit, whether open or closed. (c) Water Transport factor – Heat Transfer to circulating water/ (Pump power input)
4	Cooling Tower	SS 530 : 2006 – Energy Efficiency Standard for building services and equipment	Performance requirement for heat rejection equipment. *Propeller or axial fan cooling towers* Cooling Tower performance shall not be less than 3.24 L/s/kW. *Centrifugal fan cooling towers* Cooling Tower performance shall not be less than 1.7 L/s/kW
5	Mechanical Fans	CP 13: 1999 – Code of Practice for mechanical ventilation and air-conditioning in buildings (cl 7.11.5 – Fan system design criteria)	Fan power shall not exceed 0.47 W per m^3/h and 0.74 W per m^3/h for CAV and VAV system respectively. 7.11.5 Fan system design criteria (a) For fan systems which provide a constant air volume whenever the fans are running, the power required by the motor for the combined fan system at design conditions shall not exceed 0.47 W per m^3/h of supply air. (b) For fan systems which are able to vary system air volume automatically as a function of load, the power required by the motors for the combined fan system at design conditions shall not exceed 0.74 W per m^3/h of supply air.
6	Lighting	SS530: 2006 – Energy Efficiency Standard for building services and equipment CP 38-1999 – Code of Practice for artificial lighting of buildings	Lighting power budget Stipulated luminance level

Important notes :

1. Where no Baseline Standard is available, eg. building with air-conditioned atrium space, receptacle loads, lift & escalator, Sanitary & plumbing, a. the same input parameters for good design practice should apply to both the Reference and Proposed Models.
b. Detail calculations to be provided to justify the savings in energy consumption by salient energy efficient features/equipment, eg if sensors or VVVF motors are used in the Proposed Models.

2. For receptacle loads, Table A below is for reference.

Table A: Receptacle Loads	Standard	Nominal Values
a. Computer intensive Offices	Source:-	22.0 W/m2
b. General Office Areas	ASHRAE STD	16.0 W/m2
c. Large Conference areas	90.1:1989	11.0 W/m2
d. Server/Computer rooms		540.0 W/m2

D4 Energy Modeling Methodology

D4.1 The simulation model of the proposed design (known as Proposed Model) shall be developed in accordance with the design parameters of the building. This includes :

(i) Building design layout in terms of shape, size and orientation.
(ii) Materials for walls, windows, roofs, floors, doors and permanent shading devices, internal partitions between conditioned and non-conditioned spaces.
(iii) Internal loads such as levels and schedules for occupancy, lighting systems, equipment, appliances and machinery within the building
(iv) ACMV equipments, controls and other associated components selected for use in the building.

D4.2 The Reference Model shall be developed using similar data as stated in paragraph D4.1.

D4.3 The simulations for the Proposed Model and Reference Model shall be calculated using

(i) the same software
(ii) the same weather data[1]
(iii) the same operating schedules
(iv) the same occupancy rates
(v) the same building design in terms of shape, size and orientation
(vi) the same receptacle loads
(vii) the same indoor environmental conditions in terms of thermal comfort level[2], and
(viii) the same internal illuminance levels (lux) for space lightings

D4.4 The overall energy consumption of the Reference Model is to be computed over a period of one (1) year using the building envelope and all energy consuming equipment that are selected during the design stage. This includes energy consumed by chillers, air handling systems, plant equipment (eg. water pumps, cooling towers, tube cleaning devices, chillers, etc.), and non-ACMV systems such as lightings, lifts,escalators, ceiling fans and receptacle loads from equipment (eg. photo-copiers, printers, fax machines, computers, laptops, fridges, projectors, audio-cum video systems, water heaters, dryers, washers, etc). Similiarly, the overall energy consumption of the Proposed Model can be computed over a period of one (1) year.

[1] Appropriate up-to-date weather set should be used for energy modeling such as ASHRAE's International Weather for Energy Calculation data for Singapore.

[2] If a different condition such as higher space temperature is used in the Proposed Model, there must be evidence to demonstrate that the overall thermal comfort level is not lower than that of the Reference Model.

D4.5 The improved performance of the proposed building design can then be obtained by making comparison of the overall energy consumption of the Reference Model against the Proposed Model.

D4.6 The Energy Efficiency Index for both the Proposed and Reference Models shall also be computed. The details are as follows :

Calculation of EEI :

EEI = [(TBEC - DCEC) / (GFA $_{\text{excluding carpark}}$ – DCA – GLV x VCR)] x (NF/OH)

where:

(a) TBEC : Total building energy consumption (kWh/year)
(b) DCEC : Data centre energy consumption (kWh/year)
(c) GFA : Gross floor area (exclude car park area) (m^2)
(d) DCA : Data centre area (m^2)
(e) GLA : Gross lettable area (m^2)
(f) VCR : Weighted floor vacancy rate of gross lettable area (%)
(g) NF : Normalising factor based on a typical weekly operating hours that is 55 hrs/week
(h) OH : Weighted weekly operating hours (hrs/week)

Reference : [1] NUS Centre for Total Building Performance:
http://www.bdg.nus.edu.sg/buildingenergy/e_energy/audit_results.html

D5 Documentation Requirements

D5.1 The Qualified Person (QP) and the appropriate practitioners shall certify that the energy modeling for the building has been carried out in accordance with the requirements using the Energy Modeling methodology. The appropriate practitioner shall ensure that the assumptions and inputs used for energy modeling are bona fide. Whilst the energy modeling specialist shall certify and be responsible for the correctness of the modeling included proper usage of the relevant software.

D5.2 The QP and the appropriate practitioners shall ensure the following documents and records are available as evidences to demonstrate compliance with the energy modeling framework and validation of the potential energy savings during assessment. They are :

(a) Certification showing that the simulation software is tested and meet the criteria in accordance with the ASHRAE Standard 140
(b) Detailed drawings and other necessary information of proposed design
(c) Detailed system design calculation
(d) Summary of Space and ETTV of the Building Envelope as in Table D5.2-1(a) and Table D5.2-2(a)
(e) List of data such as
    (i) Space input data for all zones comprising detail information on construction materials and their properties designed for each individual zone. For example, room area, walls, windows, doors, floors, partitions, sensible and latent loads (lightings, occupancy rates, receptacles loads, Outdoor ventilation rates, misc. loads etc).
    (ii) Schedules for each individual operating zone (eg. lighting, occupants, mechanical fans, AHUs, other mechanical and electrical equipment, etc.)
    (iii) Executable input data files used in the generation of the energy estimates for the Proposed and Reference Models
    (iv) Output data on the monthly energy consumption by mechanical and electrical system components (eg. Air-conditioned systems, Lighting Systems, Receptacle Equipment, Lifts, Escalators etc)

(f) Detailed computation of the ETTV for both Reference and Proposed Models
(g) Comparison of Reference Model versus Proposed Model as in Table D5.2-1(b)
(h) Summary of Energy of End Use including Efficiency Indicators for both Reference and Proposed Models as in Table D5.2-1(c) and Table D5.2-2(b).
(i) Summary printouts of energy modeling software for the Reference Model including summary of weather data results
(j) Monthly energy consumption of mechanical and electrical system components such as air-conditioned system, lighting systems, receptacle equipments, lift and escalator etc.

D5.3 Similar documentation requirements as above will also be required to reflect the as-built condition upon project completion for validation.

Table D5.2-1(a) Summary of Space and ETTV of the Building Envelope

(A) Space Summary			
Building Use	Air-Conditioned Area (m^2)	Non Air-Conditioned Area (m^2)	Total Area (m^2)
1. Office			
2. Toilets			
3. Storage			
4. Corridor			
5. Atrium			
6. Foodcourt			
7. Mechanical / Electrical			
8. Staircase			
9. Conference			
10.Retail Outlets			
11.Carpark			
12. Others			
Total			
Note: The building use floor areas for both the Reference and Proposed Models must be the same.			

(B) Building Envelope Summary – ETTV			
Orientation of Façade	Gross Area of External Walls (m^2)	Reference Model ETTV (W/m^2)	Proposed Model ETTV (W/m^2)
North			
North-East			
East			
South-East			
South			
South-West			
West			
North-West			
Average ETTV of the Building Envelope (W/m^2)		50 W/m^2	

Table D5.2-1(b) Comparison of Reference Model versus Proposed Model

BUILDING ELEMENT	REFERENCE MODEL	PROPOSED MODEL
BUILDING ENVELOPE		
Wall Construction		
Opaque Doors		
Windows		
Floor		
Roof		
Window to Wall Ratio (WWR)		
Others		
ELECTRICAL SYSTEMS		
Lighting Power Density (W/m^2)		
Lighting Occupant Sensor Controls		
Lighting Daylighting Controls		
Receptacle Power (W/m^2)		
Lifts & Escalators		
Others		
Note: The Receptacle Loads for both the Reference and Proposed Models must be the same.		
RENEWABLE ENERGY SYSTEMS		
Photovoltaics		
Note: Always include a description of renewable energy systems used to reduce Proposed Model energy consumption.		

BUILDING ELEMENT	REFERENCE MODEL	PROPOSED MODEL
SCHEDULES		
Occupancy, Lighting & Equipment		
HVAC		
Note: The Occupancy Rates and Operating Schedules for both the Reference and Proposed Models must be the same.		
MECHANICAL & PLUMBING SYSTEMS		
HVAC System Type		
AHU Fan Properties		
Boiler Efficiency		
Central Plant Efficiency		
Note: Central plant efficiencies and capacities for chillers and cooling towers should be listed whenever the central plant is included as part of the energy model.		
HVAC Circulation Loop Properties		
Domestic Water System		
Mechanical Ventilation Fans		
OTHERS		

Description of differences between the Reference Model and Proposed Model not documented on other forms:

□ Not Applicable □ Attached

Table D5.2-1(c) : Summary of Energy by End Use including Efficiency Indicators

End Use	Reference Model Energy Consumption (kWh)	Proposed Building Energy Consumption (kWh)	Tolerance (%)
Lighting – (Air-Conditioned Space)			
Lighting- (Non Air-Conditioned Space)			
[3]Air-Conditioned Plant			
[4]Air System Fans			
Mechanical Ventilation Fans			
Lifts			
Escalators			
Receptacle Equipment			
Domestic Water Systems			
Others			
Total Building Energy Consumption			

Renewable Energy Sources

End Use	Energy Produced (kWh)	Reference Model Energy Consumption (kWh)	Proposed Building Energy Consumption (kWh)	Tolerance (%)
Photovoltaics				
Others				
Total Building Energy Consumption including Renewable Energy Sources				

Efficiency Indicators

Efficiency Indicators	Reference Model	Proposed Model
Energy Efficiency Index, EEI (kWh/m^2/yr)		
System Efficiency of Air-Conditioned Plant (ikW/kW)		

[3] Chilled Water System (chillers, water pumps and cooling towers)
[4] Chilled water Air Handling and Fan Coil units

Table D5.2-2(a) : Summary of Space and ETTV of the Building Envelope

(required if there is a change)

(A) Space Summary			
Building Use	Air-Conditioned Area (m^2)	Non Air-Conditioned Area (m^2)	Total Area (m^2)
1. Office			
2. Toilets			
3. Storage			
4. Corridor			
5. Atrium			
6. Foodcourt			
7. Mechanical / Electrical			
8. Staircase			
9. Conference			
10.Retail Outlets			
11.Carpark			
12. Others			
Total			
Note: The building use floor areas for both the Reference and Actual Models must be the same.			

(B) Building Envelope Summary – ETTV			
Orientation of Façade	Gross Area of External Walls (m^2)	Reference Model ETTV (W/m^2)	Actual Model ETTV (W/m^2)
North			
North-East			
East			
South-East			
South			
South-West			
West			
North-West			
Average ETTV of the Building Envelope (W/m^2)		50 W/m^2	

Table D5.2-2(b) : Summary of Actual Energy by End Use including Efficiency Indicators

End Use	Reference Model Energy Consumption (kWh)	Actual Building Energy Consumption (kWh)	Tolerance (%)
Lighting – (Air-Conditioned Space)			
Lighting- (Non Air-Conditioned Space)			
[5]Air-Conditioned Plant			
[6]Air System Fans			
Mechanical Ventilation Fans			
Lifts			
Escalators			
Receptacle Equipment			
Domestic Water Systems			
Others			
Total Building Energy Consumption			

Renewable Energy Sources

End Use	Energy Produced (kWh)	Reference Model Energy Consumption (kWh)	Actual Building Energy Consumption (kWh)	Tolerance (%)
Photovoltaics				
Others				
Total Building Energy Consumption including Renewable Energy Sources				

Efficiency Indicators

Efficiency Indicators	Reference Model	Actual Building Model
Energy Efficiency Index, EEI (kWh/m^2/yr)		
System Efficiency of Air-Conditioned Plant (ikW/kW)		

[5] Chilled Water System (chillers, water pumps and cooling towers)
[6] Chilled water Air Handling and Fan Coil units