DESIGN REFERENCE GUIDE

NON-RESIDENTIAL BUILDING

Version 3.3, February 2026

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1. About GreenRE

GreenRE Sdn Bhd is a wholly owned subsidiary of the Real Estate and Housing Development Association (REHDA). The GreenRE rating tool has been developed for the purposes as mentioned herein and may be subject to updating and/or modification in the future.

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2. Introduction

The GreenRE assessment scheme was established in 2013 and is a recognised green building rating system tailored for the tropical climate. GreenRE sets parameters and establishes indicators to guide the design, construction and operation of buildings towards increased energy effectiveness and enhanced environmental performance.

The intent of this Design Reference Guide for Non-Residential Buildings (referred to as "this Guideline") is to establish environmentally friendly practices for the planning, design, construction and operation of buildings, which would help to mitigate the environmental impact of built structures.

This Guideline 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 Guideline and such other regulations affecting the design, construction and operation of the project, the building regulations shall take precedence.

3. Revision Log

Revision	Description	Date Effective
1.1	Issued for Implementation	1st June 2013
1.2	Revised version of Implementation	1st June 2014
2.0	Revised version of Implementation	1st June 2015
3.0	Revised version of Implementation	1st October 2015
3.1	Revised version of Implementation	15th March 2018
3.2	Revised version of Implementation	15th February 2021
3.2	Revised version of Implementation	3rd September 2021
3.2	Revised version of Implementation	January 2024
3.3	Revised version of Implementation	February 2026

4. GreenRE Assessment Stages

The GreenRE Non-Residential Building certification process is as follows:

Application

- Submittal of application with relevant supporting documents for certification upon strategic inception of infrastructure project.

Pre-Assessment

- A pre-assessment can be conducted (optional) to give the project team a better understanding of the criteria and evaluation of the certification level sought. This should be performed upon selection of suitable design option to allow teams to identify and maximize opportunities at the earliest stages of the project.

Actual Assessment

- Actual assessment to be conducted once the design and documentary evidences (e.g. approved plan) are ready. After the actual assessment, our assessors will review the documents submitted.
- Assessment process includes design and documentary reviews to verify if the project meets:
  i. The intents of the criteria
  ii. The pre-requisite requirement for GreenRE Bronze, Silver, Gold and Platinum rating where applicable.
- Provisional Certificate will be issued upon completion of this stage.

Site Verification

- Site verification to be conducted upon project completion.
- A Final Certificate will be issued upon completion of this stage.

5. GreenRE Non-Residential Building Rating System

OVERVIEW:

The GreenRE non-residential building rating system is divided into six (6) sections as follows:

1. **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.
2. **Part 2** – Water Efficiency: This category focuses on the selection of fittings and strategies enabling water use efficiency during construction and building operation.
3. **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.
4. **Part 4** – Indoor Environmental Quality: This category focuses on the design strategies that would enhance the indoor environmental quality which include air quality, thermal comfort, acoustic control and daylighting.
5. **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.
6. **Part 6** – Carbon Emission of Development: This category focuses on the use of carbon calculator to calculate the carbon emission of the development.

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

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

[1] Commercial terraces typically refer to rows of connected commercial units or shop lots, purposed for retail, office, or mixed commercial activities

Other Green Requirements consist of Part 2 - Water Efficiency; Part 3 - Environmental Protection; Part 4 - Indoor Environmental Quality; Part 5 - Other Green Features and Part 6 - Carbon Emission of Development. Credits are allocated for the water efficient features, environmentally friendly design practices, innovative green features used and carbon emission of development. A minimum of 20 credits must be obtained from this group to be eligible for certification. The number of credits achievable for this group is also capped at 50 credits.

The maximum GreenRE score achievable for a project is capped at 100 credits and this does not include 20 bonus credits that are obtainable under Energy Related Requirements if a project uses renewable energy sources. The credit scored for renewable energy provision shall not result in a double grade jump in GreenRE rating (i.e from GreenRE Bronze or Silver to Gold or Platinum)

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 credits allocated are to be prorated in accordance with the respective floor areas. For simplicity, credits applicable to air-conditioned areas are accounted only if the aggregate air-conditioned areas exceed 1000 m^2. Similarly, credits 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 and common areas.

Points scoring and fulfilment of pre-requisite for mixed mode ventilated spaces are as follows:

- If more than ≥ 90% of space (NLA excluding common areas) utilizes one mode of ventilation, pre-requisite for that form of ventilation only applies.
- Points scoring to be pro-rated based on modes of ventilation provided. (e.g if ≥ 90% NV and ≥ 10% air-conditioned – points for NV scoring to be 90% of available points (NRB 1-3 & NRB 1-4) and 10% from NRB 1-1 & NRB 1-2).
- OTTV <50 w/m2 will be applicable for all air-conditioned spaces exceeding 1000m2.
- Roof u-value requirements mandatory for all building types.

Framework:

To achieve GreenRE Award

Pre-requisite & Mandatory Requirements
All relevant prerequisite and mandatory requirements for the specific GreenRE Rating are to be compiled with

Energy Related Requirements
Minimum 30 credits
Commercial Terraces no minimum Credit

Other Green Requirements
Minimum 20 credits

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

PART 1 - ENERGY EFFICIENCY

- NRB 1-1 Thermal Performance of Building Envelope -OTTV
- NRB 1-2 Air-Conditioning System
- NRB 1-3 Building Envelope – Design/ Thermal Parameters
- NRB 1-4 Natural Ventilation/Mechanical Ventilation
- NRB 1-5 Daylighting
- NRB 1-6 Artificial Lighting
- NRB 1-7 Ventilation in Carparks
- NRB 1-8 Ventilation in Common Areas
- NRB 1-9 Lift and Escalators
- NRB 1-10 Energy Efficient Practices & Features
- NRB 1-11 Renewable Energy

Elective Requirement for Other Areas (Combination of the following items to meet 20 credits)

PART 2 - WATER EFFICIENCY

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

PART 3 – ENVIRONMENTAL PROTECTION

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

PART 4 - INDOOR ENVIRONMENTAL QUALITY

- NRB 4-1 Thermal Comfort
- NRB 4-2 Noise Level
- NRB 4-3 Indoor Air Pollutants
- NRB 4-4 Indoor Air Quality (IAQ) Management
- NRB 4-5 High Frequency Ballasts
- NRB 4-6 Access to View from Work Area

PART 5 – OTHER GREEN FEATURES

- NRB 5-1 Green Features & Innovations

PART 6 – CARBON EMISSION DEVELOPMENT

- NRB 6-1 Carbon Emission of Development

CREDIT ALLOCATION:

	Category		Credits Allocations
	(I) Energy Related Requirements		
Minimum 30 credits	**Part 1: Energy Efficiency**		
	NRB 1-1 Thermal Performance of Building Envelope – OTTV NRB 1-2 Air – Conditioning System	Section (A) Applicable to air-cond. areas	15 33
	Sub -Total (A) – NRB 1-1 to 1-2		**48**
	NRB 1-3 Building Envelope – Design/Thermal Parameters NRB 1-4 Natural Ventilation/Mechanical Ventilation	Section (B) Applicable to non-air-cond. areas	30 20
	Sub – Total (B) – NRB 1-3 to 1-4		**50**
	NRB 1-5 Daylighting NRB 1-6 Artificial Lighting NRB 1-7 Ventilation in Carparks NRB 1-8 Ventilation in Common Areas NRB 1-9 Lifts and Escalators NRB 1-10 Energy Efficient Practices & Features NRB 1-11 Renewable Energy	Section (C) Applicable to all areas	6 12 4 5 2 13 20
	Sub – Total (C) – NRB 1-5 to 1-11		**62**
	Category Score for Part 1 – Energy Efficiency [Prorate Subtotal (A) + Prorate Subtotal (B)] + Subtotal (C)		**112 (MAX)**
	(II) Other Green Requirements		
Minimum 20 credits	**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 and Landscaping		3
	NRB 2-4 Water Consumption of Cooling Tower		2
	Category Score for Part 2 – Water Efficiency		**15**
	Part 3: Environmental Protection		
	NRB 3-1 Sustainable Construction		10
	NRB 3-2 Sustainable Products		10
	NRB 3-3 Greenery Provision		8
	NRB 3-4 Environmental Management Practice		10
	NRB 3-5 Green Transport		5
	NRB 3-6 Stormwater Management		3
	NRB 3-7 Refrigerants		2
	Category Score for Part 3 – Environmental Protection		**48**
	Part 4: Indoor Environmental Quality		
	NRB 4-1 Thermal Comfort		2
	NRB 4-2 Noise Level		1
	NRB 4-3 Indoor Air pollutants		2
	NRB 4-4 Indoor Air Quality (IAQ) Management		2
	NRB 4-5 High Frequency Ballasts		1
	NRB 4-6 Access to View from Work Area		1
	Category Score for Part 4: Indoor Environmental Quality		**9**
	Part 5: Other Green Features		
	NRB 5-1 Green Features & Innovations		7
	Category Score for Part 5: Other Green Features		**7**
	Part 6: Carbon Emission of Development		
	NRB 6-1 Carbon Emission of Development		3
	Category Score for Part 6 – Carbon Emission of Development		**3**
	GreenRE Non-Residential Building Score:		**192 (MAX)**

6. GreenRE Non-Residential Building Rating System Scoring

			
Score: >90	Score: 86 to < 90	Score: 76 to < 85	Score: 50 to < 75
GreenRE Platinum	**GreenRE Gold**	**GreenRE Silver**	**GreenRE Bronze**

7. GreenRE Non-Residential Building Rating System Criteria

PRE-REQUISITES:

Air-Conditioned Buildings

GENERAL

- Building envelope design with Overall Thermal Transfer Value (OTTV) computed based on the methodology and guidelines stipulated in the MS1525:2019.

GreenRE Gold	OTTV of 42 W/m^2 or lower
GreenRE Platinum	OTTV of 40 W/m^2 or lower

- To demonstrate the 6% energy saving over its reference model using static calculation for GreenRE Bronze and Silver.
- Minimum score under NRB1-6 Artificial Lighting

GreenRE Gold	≥ 5 credits
GreenRE Platinum	≥ 5 credits

- Building Energy Intensity (BEI) calculation, proper submetering is essential. Projects must ensure that energy consumption is accurately tracked through dedicated submeters.
- NRB 2-1 Water Efficient Fittings - To demonstrate reduction of potable water usage by 10% from baseline.
- Minimum score under NRB 3-1 Sustainable Construction

GreenRE Gold	≥ 3 credits
GreenRE Platinum	≥ 5 credits

- Minimum score under NRB 3-2 Sustainable Products

GreenRE Gold	≥ 3 credits
GreenRE Platinum	≥ 4 credits

- NRB 3-3 (a) Green Plot Ratio site inventory analysis and carbon sequestration calculation.
- NRB 3-4 (a) Environmental Management Plan (EMP) during construction.
- NRB 3-4 (g) Provision of Building User Guide and Sustainable Operation Management Guide.
- NRB 3-4 (i) Provision of facilities or recycling bins for collection and storage of different recyclable waste such as paper, glass, plastic etc and establish the Waste Management Route and Provide recycler details.
- NRB 4-1 (a) To meet the minimum requirement of ASHRAE 62.1. Ventilation for Acceptable Indoor Air Quality for building with centralized handling unit (AHU) system
- NRB 6-1(a) & (b) & (c) calculation of operational and embodied carbon

MINIMUM SYSTEMS EFFICIENCY

- Minimum Design System Efficiency/Operating System Efficiency (DSE/OSE)
- For buildings using Water Cooled Chilled-Water Plant:

GreenRE Rating	Building Cooling Load (RT)	
	< 500	≥ 500
	Efficiency (kW/RT)	
Bronze	0.85	0.75
Silver	0.80	0.70
Gold	0.75	0.68
Platinum	0.70	0.65

- For buildings using Air Cooled Chilled-Water Plant or Unitary Air-Conditioners:

GreenRE Rating	Building Cooling Load (RT)	
	< 500	≥ 500
	Efficiency (kW/RT)	
Bronze	1.1	1.0
Silver	1.0	1.0
Gold	0.85	Case by case(i)
Platinum	0.78	

- For building with building cooling load of more than 500RT, the use of air cooled central chilled water plant or other unitary air-conditioners are not encouraged for Gold and Platinum ratings. In general, the system efficiency of the air cooled central chilled-water plant and other unitary air-conditioners are to be comparable with the stipulated efficiency for water-cooled central chilled-water plant. Buildings that are designed with air cooled systems (e.g stratified and/or multi-block developments) and seeking Gold / Platinum GreenRE rating will be assessed on a case-by-case basis.
- Points scoring and fulfilment of pre-requisite for air-conditioning will be allowed if the air conditioning provided by developer for NLA.
- Fulfilment of pre-requisite for air-conditioning without point scoring:
  - » Included in building user guide.
  - » For gold and platinum projects, savings in energy model to reflect efficiency of air-conditioners proposed in building user guide.

Note: The performance of the overall air-conditioning system for the building is based on the Operating System Efficiency (OSE) of the system during normal building operating hours as defined below:

Office Building
Monday to Friday: 9am to 6pm

Hotel and Hospital:
24-hour

Retail Mall:
Monday to Sunday: 10am to 9pm

Industrial and Other Building Types:
To be determined based on the operating hours

Institutional:
Monday to Friday: 9am to 5pm

ENERGY EFFICIENCY COMPLIANCE

Projects shall demonstrate the stipulated performance through either option listed below (Gold and Platinum projects with air-conditioning system only):

Option 1: Energy Saving

- 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 A Energy Modelling Guideline.

Type of AC System	Energy Saving Required (%)	
	Gold	Platinum
Centralized Air Conditioning system / Unitary system	25	30
District Cooling System	10	15

Option 2 – Building Energy Intensity (BEI) Benchmarking

- To demonstrate the stipulated Building Energy Intensity (BEI) using an energy modelling framework set out. Details and submission requirements on energy modelling can be found in Appendix A Energy Modelling Guideline. (Baseline – MS1525:2007)

BEI is derived using the following equation:
BEI = [(TBEC – CPEC) / (GFA excluding carpark - GLA x FVR) x (NF/OH)

Where:

TBEC = Total building energy consumption (kWh/year) excluding renewable energy replacement
CPEC = Car Park Energy Consumption in (kWh/year)
GFA = Gross Floor Area (exclude car park area) (m^2)
GLA = Gross Lettable Area (m^2)
FVR = Floor Vacancy Rate (NLA) (m^2)
NF = Normalizing factor based on a typical weekly operating hour that is 52 Hrs/week [only for office category]
OH = Weighted weekly operating hours (hrs/week) [only for office category]

Note:

- Design BEI is based on 100% occupancy rate for consistency.
- All major active equipment to be included in the estimation of TBEC.
- During verification stage, if the occupancy rate is low, e.g., only 20% occupancy rate, it needs to be projected to 80% to get the BEI which reflects the actual operation situation

Building Type	Bronze ($kWh/m^2/year$)	Silver ($kWh/m^2/year$)	Gold ($kWh/m^2/year$)	Platinum ($kWh/m^2/year$)
Office Buildings (Small) (GFA < 15,000sqm)	205	180	135	120
Office Buildings (Large) (GFA > 15,000sqm)	210	190	155	140
Retail Mall	360	315	230	210
School, University and College	170	145	110	200
School, University and College (MOE)	60	50	40	35
Community Centres	210	190	150	125
Civic Buildings	120	105	80	70
Cultural Institutions	240	210	180	140
Sport and Recreations Centres	135	120	110	80

Table 1: Building Energy Intensity (BEI) Benchmarking

Building Type	Bronze (kWh/m^2/year)	Silver (kWh/m^2/year)	Gold (kWh/m^2/year)	Platinum (kWh/m^2/year)
Office Buildings (Small) (GFA < 15,000sqm)	150	125	100	90
Office Buildings (Large) (GFA > 15,000sqm)	130	120	90	80
Retail Mall	230	200	160	140
Community Centres	150	130	100	90
Civic Buildings	70	60	50	45
Cultural Institutions	160	135	115	100
Sport and Recreations Centres	100	85	70	65

Table 2: Building Energy Intensity (BEI) Benchmarking with DCS System

CHILLER PLANT M&V INSTRUMENTATION

- Provision of permanent measuring instruments for monitoring of water-cooled chilled-water system and air-cooled chilled water system operating system efficiency. The installed instrumentation shall have the capability to calculate resultant plant operating system efficiency (i.e. kW/RT) within 5% of its true value and in accordance with ASHRAE Guide 22 and AHRI 550/590. Heat balance test for water-cooled chilled water system is required for verification of the accuracy of the Measurement and Verification (M&V) instrumentation.

Non-Air-conditioned Buildings

- To be eligible for GreenRE 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 B of this Guideline. Assistance from ceiling fans is allowable to improve the thermal comfort of a space whereby ventilation simulation shall prove that unassisted ventilation (NV) complies with the minimum requirement of 0.14 m/s wind velocity.

- Minimum score under NRB1-6 Artificial Lighting

GreenRE Gold	≥ 5 credits
GreenRE Platinum	≥ 5 credits

- Building Energy Intensity (BEI) calculation, proper submetering is essential. Projects must ensure that energy consumption is accurately tracked through dedicated submeters.
- NRB 2-1 Water Efficient Fittings - To demonstrate reduction of potable water usage by 10% from baseline.
- Minimum score under NRB 3-1 Sustainable Construction

GreenRE Gold	≥ 3 credits
GreenRE Platinum	≥ 5 credits

- Minimum score under NRB 3-2 Sustainable Products

GreenRE Gold	≥ 3 credits
GreenRE Platinum	≥ 4 credits

- NRB 3-3 (a) Green Plot Ratio site inventory analysis and carbon sequestration calculation.
- NRB 3-4 (a) Environmental Management Plan (EMP) during construction.
- NRB 3-4 (g) Provision of Building User Guide and Sustainable Operation Management Guide.
- NRB 3-4 (i) Provision of facilities or recycling bins for collection and storage of different recyclable waste such as paper, glass, plastic etc and establish the Waste Management Route and Provide recycler details.
- NRB 6-1(a) & (b) & (c) calculation of operational and embodied carbon

MANDATORY REQUIREMENTS:

BUILDING ENVELOPE - OTTV

- The OTTV of the building envelope for a building, having a **total air-conditioned area exceeding 1000 m^2 and above should not exceed 50 W/m^2.**

ROOF

- In the **case of an air-conditioned building**, the concept of Roof Thermal Transfer Value (RTTV) is applied if the roof is provided with skylight and the entire enclosure below is fully air-conditioned.
- For roofs with skylight, the maximum recommended RTTV is 25 W/m^2.

ROOF – U-VALUE

- **The roof of the building** shall not have a thermal transmittance (U-Value) greater than that tabulated in Table 2-1.

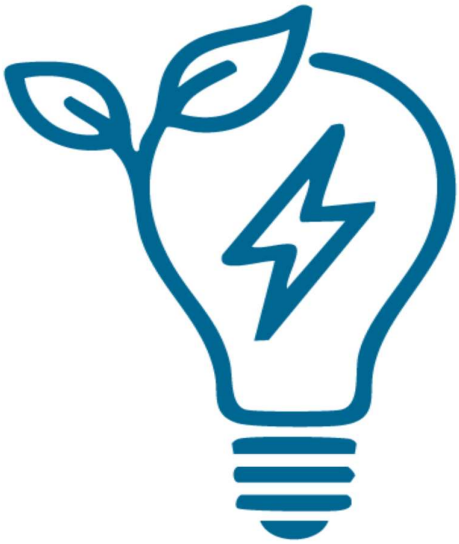
Roof Weight Group	Maximum U-Value (W/m^2K)
Light (Under 50 kg/m^2)	0.4
Heavy (Above 50 kg/m^2)	0.6

Table 2-1 Maximum U-Value for Roof (W/m^2K)

ENERGY MANAGEMENT SYSTEM

- To Install Energy Management System where air-conditioned space is greater than 4000m^2

Provision of differently-able amenities based on recommended or best practices as UBBL, MS1183 Part-8, MS1184, MS1331 and etc.



Part 1

Energy Efficiency

Part 1 – Energy Efficiency

(A) Applicable to Air-Conditioned Building Area (with an aggregate air-conditioned area ≥ 1000m²)

NRB 1-1 THERMAL PERFORMANCE OF BUILDING ENVELOPE - OTTV	GREENRE CREDITS
Enhance overall thermal performance of building envelope to minimise heat gain thus reducing the overall cooling load requirement. Baseline: Maximum permissible OTTV = 50 W/m² *Prerequisite Requirement:* *GreenRE Gold - OTTV of 42 W/m² or lower* *GreenRE Platinum - OTTV of 40 W/m² or lower*	2 credits for every reduction of 1 W/m² in OTTV from the baseline. Credits scored = 100 - [2 x (OTTV)] where OTTV ≤ 50 W/m² (Up to 15 credits)
NRB 1-2 AIR-CONDITIONING SYSTEM	**GREENRE CREDITS**
Applicable to Air-conditioned Building Areas (with an aggregate air-conditioned area > 1000m²) Encourage the use of better efficiency air-conditioned equipment to minimize the energy consumption. (System efficiency in kW/ton)	
a. Water-Cooled Chilled-Water Plant: • Water-Cooled Chiller • Chilled water pump • Condenser water pump • Cooling tower	a. Water-Cooled Chilled-Water Plant: Building cooling load < 500 RT 14 credits for achieving plant efficiency of 0.85 kW/ton 0.3 credit for every percentage improvement in the chiller plant efficiency better than 0.85 kW/ton Credit scored = 0.3 x (% improvement)

Baseline	Building Cooling Load	
	<500 RT	≥500RT
Prerequisite Requirements Minimum Design System Efficiency (DSE) for central chilled-water plant	0.85 kW/RT	0.75 kW/RT

Building cooling load ≥ 500 RT

14 credits for achieving plant efficiency of 0.75 kW/ton

0.35 credit for every percentage improvement in the chiller plant efficiency better than 0.75 kW/ton

Credit scored = 0.35 x (% improvement)

(up to 20 credits)

OR

OR

b. Air Cooled Chilled-Water Plant / Unitary Air-Conditioners:

Air cooled Chilled-Water Plant:
- Air-Cooled Chiller
- Chilled Water Pump

Unitary Air-Conditioners:
- Variable Refrigerant Flow (VRF) System
- Water-Cooled Package Unit
- Single-Split Unit
- Multi-Split Unit

b. Air Cooled Chilled-Water Plant / Unitary Air-Conditioners:

Building cooling load < 500 RT

14 credits for achieving plant efficiency of 1.1 kW/ton

0.2 credit for every percentage improvement in the chiller plant efficiency better than 1.1 kW/ton

Credit scored = 0.2 x (% improvement)

Baseline	Building Cooling Load	
	< 500 RT	≥ 500 RT
Prerequisite Requirements Minimum system efficiency of air-cooled chilled water plant or unitary conditioners	1.1 kW/RT	1.0 kW/RT

Building cooling load ≥ 500 RT

14 credits for achieving plant efficiency of 1.0 kW/ton

0.25 credit for every percentage improvement in the chiller plant efficiency better than 1.0 kW/tom

Credit scored = 0.25 x (% improvement)

(up to 20 credits)

Note (1): Where there is a combination of centralised air-conditioned system with unitary air-conditioned system, the computation for the credits scored will be pro-rated based on the air-conditioning system aggregate capacity.

c. Air Distribution system:

- Air Handling units (AHUs)
- Fan Coil Units (FCUs)

Fan System Input Power

Baseline: ASHRAE 90.1:2010 Clause 6.5.3.1 and as prescribed below;

c. Air Distribution system:

0.15 credits for every percentage improvement in the air distribution system efficiency over the baseline

Credit scored = 0.15 x (% improvement)

(up to 8 credits)

Baseline Air Distribution System Type	Allowable Fan System Input Power	
	(kW/m³/s)	(W/CMH)
AHUs / FCUs ≥ 4kW (Constant Volume)	1.5	0.42
AHUs ≥ 4kW (Variable Volume)	2.1	0.58
Fan systems with nameplate motor power < 4kW	0.6	0.17

Note (2): For buildings using district cooling system, there is no need to compute the plant efficiency under Part 1-2 (a) and (b). The credits obtained will be pro-rated based on the air distribution system efficiency under Part 1-2(c).

d. Prerequisite requirements: Provision of permanent measuring instruments for monitoring of water-cooled chilled water plant and air-cooled chilled water plant efficiency. The installed instrumentation shall have the capability to calculate resultant plant efficiency (i.e. kW/RT) within 5% of its true value and in accordance with ASHRAE Guide 22 and AHRI 550/590. The following instrumentation and installation are also required to be complied:

- Location and installation of the measuring devices to meet the manufacturer's and engineer's recommendation.
- Data acquisition system to have a minimum resolution of 16 bit.
- All data logging with capability to trend at 1 minute sampling time interval for 24 hours a day, 7 days a week.
- Dedicated digital power meters shall be provided for the each of equipment: chiller(s), chilled water pump(s), condenser water pump(s) and cooling tower(s).

Applicable only to buildings with provision of water-cooled chilled water plants

2 credits

• Flow meters to be provided for chilled-water and condenser water loop (return and supply) and shall be of ultrasonic / full bore magnetic type or equivalent. • Temperature sensors are to be provided for chilled water and condenser water loop (return and supply) and shall have an end-to-end measurement uncertainty not exceeding ± 0.05°C over entire measurement or calibration range. All thermo-wells shall be installed in a manner that ensures that the sensors can be in direct contact with fluid flow. Provisions shall be made for each temperature measurement location to have two spare thermo-wells located at both side of the temperature sensor for verification of measurement accuracy.	
e. *Prerequisite requirements:* Verification of central water cooled chilled-water plant instrumentation: Heat Balance – substantiating test for water cooled chilled-water plant to be computed in accordance with AHRI 550/590. The operating system efficiency and heat balance to be submitted to GreenRE upon commissioning.	1 credit
f. Provision of variable speed controls for chiller plant equipment such as chilled-water pumps and cooling tower fans to ensure better part-load plant efficiency.	1 credit
g. Sensors or similar automatic control devices are used to regulate outdoor air flow rate to maintain the concentration of carbon dioxide. Indoor carbon dioxide acceptable range ≤700 ppm above outdoor concentration.	1 credit
Sub-Total (A):	Sum of GreenRE credits obtained from NRB 1-1 to 1-2

(B) Applicable to Non-Air-Conditioned Building Areas (with an aggregate non-air-conditioned areas ≥ 10% of total floor area excluding carparks and common areas)

NRB 1-3 BUILDING ENVELOPE – DESIGN/THERMAL PARAMETERS	GREENRE CREDITS
Enhance the overall thermal performance of building envelope to minimise heat gain which would improve indoor thermal comfort and encourage natural ventilation or mechanical ventilation.	
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 façade. Core walls for lift or staircases and toilets that are located within this range are exempted in computation.	Credits scored = 10 – [0.2 x (% of west facing façade areas over total façade areas)] (Up to 10 credits) Where there is no west facing façade, the total credits scored for this item will be 25 credits; the NRB 1-3 b (i), b (ii) and (c) as listed below will not be applicable.
b. (i) Minimum west facing window opening.	Credits scored = 10 – [0.1 x (% of west facing window areas over total west facing façade areas)]
(ii) Effective sun shading provision for windows on the west façade with minimum shading of 30%.	Credits scored = 0.1 x (% of west facing window areas with sun shading devices over total west facing façade areas) (Up to 10 credits for NRB 1-3(b)(i) & (b)(ii))
c. Better thermal transmittance (U-value) of external west facing walls. The U-value of external west facing wall should be equal or less than 2 W/m^{2}K	Credits scored = 0.05 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) (Up to 5 credits)
d. Better thermal transmittance (U-value) of roof Baseline: U-value for roof as stated below, which depends on the weight range of roof structure.	2 credits for every 0.1 W/m^{2}K reduction (Up to 5 credits)

Roof Weight Group (kg/m^2)	Maximum U-value (W/m^{2}K)
Light (Under 50)	0.4
Heavy (Over 50)	0.6

NRB 1-4 NATURAL VENTILATION / MECHANICAL VENTILATION	GREENRE CREDITS
a. Ventilation System	
• Ventilation Design: Encourage building that facilitates good natural ventilation. Proper design of building layout that utilises prevailing wind conditions to achieve adequate cross ventilation. Note (3): credit can be attempted if window openings facing **predominant wind directions** and cross ventilation. Local wind rose to be submitted to justify predominant wind directions. **OR**	1 credit for every 10% of NV areas with window openings facing north and south directions and cross ventilation Credits scored = 1 x (% units/10) (Up to 10 credits) **OR**
• Encourage energy efficient mechanical ventilation system and analysis Baseline: Fan power limitation in mechanical ventilation systems: **Allowable nameplate motor power** Nameplate motor power > 4kW: 0.32 W/CMH Nameplate motor power < 4kW: 0.17 W/CMH Note (4): Where there is a combination of naturally ventilated and mechanical ventilated spaces, the credits scored will only be based on the predominant ventilation modes of normally occupied spaces.	0.4 credit for every subsequent 1% improvement from the baseline Credits scored = 0.4 x (% improvement) (Up to 10 credits)
b. Ventilation Simulation Modelling and Analysis • Ventilation simulation modelling and 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 and demonstrate that 40% of the typical units achieve area weighted average wind velocity of 0.4m/s or alternatively, to conduct thermal comfort modelling to achieve a PMV of +/- 1. Note: Assistance from ceiling fan is allowable to improve the thermal comfort of a space whereby ventilation simulation shall prove that unassisted ventilation (NV) complies with the minimum requirement of 0.14 m/s wind velocity.	5 credits (Additional 5 credits if the recommendations are implemented and meet air-flow requirements – up to 10 credits)

Note: Assistance from ceiling fan is allowable to improve the thermal comfort of a space whereby ventilation simulation shall prove that unassisted ventilation (NV) complies with the minimum requirement of 0.14 m/s wind velocity. Prerequisite requirement: GreenRE Platinum: Ventilation simulation modelling and analysis are to be carried out to ensure good natural ventilation with minimum weighted average wind velocity of 0.6m/s within the functional spaces or units.	
Sub-Total (B):	Sum of GreenRE credits obtained from NRB 1-3 to 1-4

(C) General

<table>
<tr><th>NRB 1-5 DAYLIGHTING</th><th>GREENRE CREDITS</th></tr>
<tr><td>Encourage design that optimises the use of effective day lighting to reduce energy use for artificial lighting.</td><td></td></tr>
<tr><td>a. Use of daylight simulation analysis or any relevant calculation to verify that 50% or more of all normally occupied areas achieve adequate daylight illuminance levels as specified in MS 1525:2019. Areas with illuminance levels below or above the range do not comply.</td><td><table><tr><th>Percentage of Habitable Spaces with Adequate Ambient Lighting Level</th><th>Credits Allocation</th></tr><tr><td>50% - 75%</td><td>1</td></tr><tr><td>76% - 90%</td><td>2</td></tr><tr><td>>90%</td><td>3</td></tr></table>(Up to 3 credits)</td></tr>
<tr><td>b. Daylighting in the following common areas:</td><td>Extent of Coverage: At least 90% of the common area</td></tr>
<tr><td>• Lift lobbies and corridors</td><td>1 credit</td></tr>
<tr><td>• Staircases (All staircase)</td><td>1 credit</td></tr>
<tr><td>• Carparks</td><td>1 credit</td></tr>
<tr><td>Note:
a. Simulation or suitable daylight calculation is necessary for occupied space and common area to achieve the minimum daylight factors required
b. For common areas, artificial lighting circuits schematic area necessary as documentary to proof design allows controllability to maximise harvested daylight</td><td></td></tr>
</table>

NRB 1-6 ARTIFICIAL LIGHTING

Encourage the use of better efficient lighting to minimise energy consumption from lighting usage while maintaining proper lighting level.

Baseline: Luminance level stated in MS 1525:2019.

Note: The following lighting power budget baselines shall be used:

Retail type	Baseline
General	≤ 15.0 W/m^2
Jewellery	≤ 35.0 W/m^2
Furniture, clothing & accessories, cosmetic & art	≤ 25.0 W/m^2
Supermarket, vehicle, sporting goods, stationary, & hardware	≤ 20.0 W/m^2
Carpark	<2 W/m^2

GREENRE CREDITS

0.25 credit for every percentage improvement in the lighting power budget

Credits scored = 0.25 x (% improvement)
(Including tenant lighting provision)
(Up to 12 credits)

(Excluding tenant lighting provision)
(Up to 5 credits)

NRB 1-7 VENTILATION IN CARPARKS

Encourage the use energy efficient design and control of ventilation systems on 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 mode adopted for car park design, the credits scored under this requirement will be prorated accordingly.

GREENRE CREDITS

Naturally ventilated carparks – 4 credits

Credits scored based on the mode of mechanical ventilation provided

Fume extract- 2.5 credit

MV with or without supply – 2 credits

(Up to 4 credits)

NRB 1-8 VENTILATION IN COMMON AREAS	GREENRE CREDITS
Encourage the use of energy efficient design and control of ventilation systems in the following common areas: • Toilets • Staircases (Including BOMBA Staircase) • Lift Lobbies • Corridors • Atriums	Credits scored based on the mode of ventilation provided in the applicable areas. Natural vent. – 1.5 credits for each area Mechanical vent. – 0.5 credit for each area (Up to 5 credits)

NRB 1-9 LIFTS AND ESCALATORS	GREENRE CREDITS
a. Encourage the use of lift with energy efficient features such as sleep mode or regenerative features and motorless lift.	Extent of Coverage: All lifts and/or escalators 1 credit
b. Escalators with energy efficient features such as motion sensors.	1 credit

NRB 1-10 ENERGY EFFICIENT PRACTICES & FEATURES	GREENRE CREDITS
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 Building Energy Intensity (BEI)	1 credit
b. Use of vertical greenery system on east and west facade to reduce heat gain through building envelope.	1 credit for high impact 0.5 credit for low impact
c. Use of energy efficient features: Examples: • Heat recovery system • Ductless fan for basement ventilation • Motion sensors for staircases half landing • Sun pipes • Etc	3 credits for every 1% energy saving over the total building energy consumption per features (Up to 11 credits)

NRB 1-11 RENEWABLE ENERGY	GREENRE CREDITS
Encourage the use of renewable energy sources in buildings	5 credits for every 1% replacement of electricity (based on total electricity consumption) by renewable energy OR 3 credits for every 1% replacement of electricity (based on the total electricity consumption excluding tenant's usage) by renewable energy OR 3 credits for every 10% of roof area used for solar panels. OR
For buildings where solar panels are not installed, provide solar panel installation ready roof. Appropriate roof pitch, static loads, mounting system, and roof access to be considered.	1 credit Note: The credit scored for renewable energy provision shall not result in a double grade jump in GreenRE rating (i.e. from GreenRE Bronze or Silver to Gold or Platinum) (Up to 20 credits)
Sub-Total (C):	Sum of GreenRE credits obtained from NRB 1-5 to 1-11

PART 1 – ENERGY EFFICIENCY CATEGORY SCORE:	$\text{Sub-Total (A)} \times \frac{\text{Air-Conditioned Building Floor Area}}{\text{Total Floor Area}} + \text{Sub-Total (B)} \times \frac{\text{Non-Air-Conditioned Building Floor Area}}{\text{Total Floor Area}} + \text{Sub-Total (C)}$ Where: Sub-Total (A) = Sum of GreenRE Credits obtained Under Section (A) that is NRB 1-1 to 1-2 Sub-Total (B) = Sum of GreenRE Credits obtained Under Section (B) that is NRB 1-3 to 1-4 Sub-Total (C) = Sum of GreenRE Credits obtained Under Section (C) that is NRB 1-5 to 1-11 If either Section (A) or Section (B) is not applicable, no pro-rating of areas is required for the score computation. Total floor area includes air-conditioned area and non-air-conditioned area but excluding car park and common area.

Part 2

Water Efficiency

Part 2 – Water Efficiency

NRB 2-1 WATER EFFICIENCY FITTINGS	GREENRE CREDITS
Encourage the use of water efficient fittings that are certified under the Water Efficiency Products Labelling Scheme (WEPLS). a. Basin taps and mixers b. Flushing cistern c. Shower taps and mixers or showerheads d. Sink/bib taps and mixers e. Urinals and urinal flush valve Note : Pre-requisite requirement - To demonstrate reduction of potable water usage by 10% from baseline.	**Weightage Based on Water Efficiency Products Labelling Scheme (WEPLS)** Efficient* | Highly Efficient** | Most Efficient*** **4 credits** | **6 credits** | **8 credits** Credits can be scored based on the number and water efficiency rating of the fitting type used. (Up to 8 credits)

NRB 2-2 WATER USAGE AND LEAK DETECTION	GREENRE CREDITS
Promote the use of sub-metering and leak detection system for better control and monitoring	
a. Provision of private meters to monitor the major water usage such as irrigation, cooling tower and tenants' usage.	1 credit
b. Linking all private meters to the Building Management System (BMS) for leak detection.	1 credit

NRB 2-3 IRRIGATION SYSTEM AND LANDSCAPING	GREENRE CREDITS
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 with provision of submetering for monitoring during the operation.	1 credit
b. Use of water efficient irrigation system with rain sensor.	Extent of Coverage: At least 50% of the landscape areas are served by the system 1 credit
c. Use of drought tolerant plants that require minimal irrigation.	Extent of Coverage: At least 50% of the landscape areas 1 credit
NRB 2-4 WATER CONSUMPTION OF COOLING TOWER	**GREENRE CREDITS**
Reduce potable water consumption for cooling purpose.	
a. Use of cooling tower water treatment system which can achieve 6 or better cycles of concentration at acceptable water quality	1 credit
b. Use of recycled water from approved sources for cooling purpose	1 credit
PART 2 – WATER EFFICIENCY CATEGORY SCORE:	Sum of GreenRE credits obtained from NRB 2-1 to 2-4

Part 3

Environmental Protection

Part 3 – Environmental Protection

NRB 3-1 SUSTAINABLE CONSTRUCTION	GREENRE CREDITS
Encourage recycling and the adoption of building designs, construction practices and materials that are environmentally friendly and sustainable.	
a. Use of sustainable and recycled materials; Green Cements with approved industrial by-product (such as Ground Granulated Blast furnace Slag (GGBS), silica fume, fly ash) to replace Ordinary Portland Cement (OPC) for super-structural works.	
b. Concrete Usage Index (CUI) Encourage more efficient concrete usage for building components.	
Prerequisite Requirement: *Minimum score under NRB 3-1:* *GreenRE Gold ≥ 3 credits* *GreenRE Platinum ≥ 5 credits*	

% Replacement of OPC by approved industrial by-products	Credits Allocation
10	1
20	2
30	3
40	4
≥50	5

(Up to 5 credits)

Project CUI ($m3/m^2$)	Credits Allocation
≤ 0.70	1
≤ 0.60	2
≤0.50	3
≤0.40	4
≤0.35	5

(Up to 5 credits)

<table>
<tr><th>NRB 3-2 SUSTAINABLE PRODUCTS</th><th>GREENRE CREDITS</th></tr>
<tr><td>a. Promote use of environmentally friendly products that are certified by approved local or international certification bodies and are applicable to non-structural and architectural related building components.
• Eco Label products
• Wood products certified by the Forest Stewardship council (FSC) or the Malaysia Certification Council (MTCC)
• Agreement of the manufacturer or suppliers for the buyback programmes within the life cycle or at the end of materials life for recycling reuse purpose</td><td><table><tr><th>Extent of use of environmentally friendly product</th><th>Weightage for Credit Allocation</th></tr><tr><td>Low Impact</td><td>0.5</td></tr><tr><td>Medium impact</td><td>1</td></tr><tr><td>High Impact</td><td>2</td></tr></table>Credits scored will be based on the extent of coverage and impact
(Up to 8 credits)</td></tr>
<tr><td>b. Reuse Salvaged Materials
Salvage or reuse construction materials for 2% of building materials based on the total material cost (extracted from the bill of quantities).</td><td>1 credit</td></tr>
<tr><td>c. Recycled Content
Encourage the utilisation and use of recycled content material so that the total of post-consumer recycled content plus half of the pre-consumer content constitutes at least 10% based on the total material cost.</td><td>1 credit</td></tr>
<tr><td><u>Prerequisite Requirement:</u>
Minimum score under NRB 3-1:
GreenRE Gold ≥ 3 credits
GreenRE Platinum ≥ 4 credits</td><td></td></tr>
</table>

NRB 3-3 GREENERY PROVISION	GREENRE CREDITS
Encourage greater use of greenery and restoration of existing trees to reduce heat island effect.	
a. Green Plot Ratio (GnPR) is calculated by considering the 3D volume covered by plants using the Leaf Area Index (LAI). Note: • To include site inventory analysis on greenery pre-development and calculation of carbon sequestration of greenery post development.	<table><tr><th>GnPR</th><th>Credits Allocation</th></tr><tr><td>1.0 to < 2.0</td><td>1</td></tr><tr><td>2.0 to < 3.0</td><td>2</td></tr><tr><td>3.0 to < 4.0</td><td>3</td></tr><tr><td>4.0 to < 5.0</td><td>4</td></tr><tr><td>5.0 to < 6.0</td><td>5</td></tr><tr><td>≥ 6.0</td><td>6</td></tr></table>
b. Restoration of trees on site, conservation, or relocation of existing trees on site. (at least 20%)	1 credit
c. Provision of compost bins to recycle organic waste to meet at least 30% of landscape fertilizer needs.	1 credit

NRB 3-4 ENVIRONMENTAL MANAGEMENT PRACTICE	GREENRE CREDITS
Encourage the adoption of environmentally friendly practices during construction and building operation.	
a. Implement effective environmentally friendly programmes including monitoring and setting targets to minimise energy use, water use and construction waste during construction stage and include the following practices: • To record the electrical consumption during the construction stage and hence, minimise energy usage by on-site utilities. • Appointment of safety, health and environment officer.	

• To prepare an Environmental Management Plan and conduct a complete Erosion Sedimentation Control Plan (ESCP). • To prepare a Construction Waste Management Plan. • To include commitment to recycle and/or salvage 50% of the volume of non-hazardous construction debris. • Provide at least the minimum level of sanitation/safety facilities for construction workers. • Use a low-flow flushing system and efficient fitting tap in the construction site office/ showroom. • Provision of the Rainwater Harvesting System and the strategies of rainwater. • Develop and implement and IAQ Management plan for Construction.	1 credit
b. Main builder that has good track records in the adoption of sustainable, environmentally friendly, and considerate practices during construction.	1 credit
c. Building quality is assessed and passed under the Quality Assessment System (QLASSIC) or Construction Quality Assessment System (QONQUAS) or Building Quality Assessment System (BuildQUAS).	1 credit
d. To perform IBS content scoring based on CIDB IBS scoring scheme.	1 credit for IBS score ≥ 50% 2 credits for IBS score ≥ 70%
e. Developer, main builder, M&E consultant and architect are ISO 14000 certified.	0.25 credit each (Up to 1 credit)
f. Project team comprises one Certified GreenRE Accredited Professional & Green Mark Manager (GMM).	1 credit
g. Provision of building users' guide with details of the environmentally friendly facilities and features within the building and their uses in achieving the intended environment performance during building operation.	1 credit

h. Provision of Sustainable Operation and Management Guideline and briefing to the building management team.	1 credit
i. Provision of facilities or recycling bins at each block of development for collection and storage of different recyclable waste such as paper, glass, plastic etc.	1 credit
NRB 3-5 GREEN TRANSPORT	**GREENRE CREDITS**
Promote environmentally friendly transport options and facilities to reduce pollution from individual car use.	
a. Good access (<800m walking distance) to public transport networks such as MRT/LRT stations or bus stops.	1 credit
b. Provision of covered walkway to facilitate connectivity and the use of public transport.	1 credit
c. Provision of infrastructure for electric charging stations to at least 10% of available parking spaces.	1 credit
d. Provision of hybrid / electric vehicle charging stations and priority parking lots within the development.	Extent of coverage: Minimum 1 number priority carparking bay for every 100 carparking bays. EV chargers – 1 for every 200 carparking bays. (Cap at 3) (1 credit)
e. Provision of covered / sheltered bicycles parking lots (i.e with rack / bar) and adequate shower and changing facilities.	Extent of Coverage: Bicycles parking lot: Minimum 10 number and maximum 50 numbers of bicycle parking lot. Shower Facilities: Minimum 1 number for every 100 regular occupant and additional 1 for every 150 occupants. (Cap at 7) (1 credit)

f. Community connectivity. Locate the building within 800mof 5 basic service, not limited to: • Place of worship • Bank • Pharmacy • Convenience grocery • Post office • Laundry • Hardware store • Supermarket • School • Library • Daycare centre • Senior care facility • Beauty salon • Hospital/ clinics • Community centre • Park • Night market	1 credit
NRB 3-6 STORMWATER MANAGEMENT	**GREENRE CREDITS**
Encourage the treatment of stormwater runoff through provision of infiltration or design features before discharge to public drains. Provision of infiltration features or design features for new development and redevelopment in accordance with MSMA.	Reduce post development stormwater peak discharge rate and quantity from exceeding pre-development peak discharge rate and quantity: 5 - 15% - 1 credit 16 - 25% - 2 credits > 25% - 3 credits (Up to 3 credits)
NRB 3-7 REFRIGERANTS	**GREENRE CREDITS**
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 depleting potential (ODP) of zero **OR** with global warming potential (GWP) of less than 100.	1 credit
b. Use of refrigerant leak detection system at critical areas of plant rooms containing chillers and other equipment with refrigerants.	1 credit
PART 3–ENVIRONMENTAL PROTECTION CATEGORY SCORE:	Sum of GreenRE credits obtained from NRB 3-1 to 3-7

Part 4

Indoor Environmental Quality

Part 4 – Indoor Environmental Quality

NRB 4-1 THERMAL COMFORT	GREENRE CREDITS
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.	
a. Meet the minimum requirements of Section 4 through 7 of ASHRAE Standard 62.1, Ventilation for Acceptable Indoor Air Quality or any applicable local code, whichever is more stringent and requirement as follow: • Indoor temperature between 23°C to 26°C • Relative Humidity between 50% to 70%	1 credit
b. Additional 1 credit will be awarded for room temperature and humidity displays in all applicable areas.	1 credit

NRB 4-2 NOISE LEVEL	GREENRE CREDITS
Building is designed to achieve ambient internal noise level as specified: • 55 dB (6am – 10pm) LAeq • 45 dB (10pm – 6am) LAeq	1 credit

NRB 4-3 INDOOR AIR POLLUTANTS	GREENRE CREDITS
Minimise airborne contaminants, mainly from inside sources to promote a healthy indoor environment.	Extent of Coverage: A at least 90% of the internal wall areas
a. Use of low volatile organic compounds (VOC) paints certified under local/international certification body.	1 credit
b. Use adhesives certified under local/international certification body for composite wood products.	1 credit

NRB 4-4 INDOOR AIR QUALITY (IAQ) MANAGEMENT	GREENRE CREDITS
Ensure that building ventilation systems are designed and installed to provide acceptable IAQ under normal operating hours.	
a. Provision of filtration media and differential pressure monitoring equipment in Air Handling Units (AHUs) with minimum (MERV 8)	1 credit
b. Implement effective IAQ management plan to ensure that building ventilation systems are clean and free from residuals left over from construction activities.	1 credit

NRB 4-5 HIGH FREQUENCY BALLASTS/ LED DRIVERS	GREENRE CREDITS
Improve workplace lighting quality by avoiding low frequency flicker associated with fluorescent lighting with the use of high frequency ballasts in the fluorescent luminaries. *OR* Use of driver with output frequency < 200Hz and < 30% flicker for LED lighting.	Extent of Coverage: At least 90% of all applicable areas that are served by fluorescent luminaries 1 credit

NRB 4-6 ACCESS TO VIEW FROM WORK AREA	GREENRE CREDITS
Design ≥ 60% of the occupied building spaces to have a direct line of sight through vision glazing and measured between 0.8 m and 2.3 m above the finished floor plan levels.	1 credit

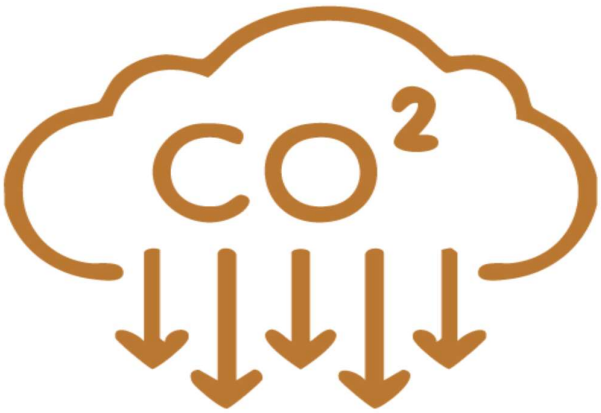
PART 4 – INDOOR ENVIRONMENTAL QUALITY CATEGORY SCORE:	Sum of GreenRE credits obtained from NRB 4-1 to 4-6

Part 5

Other Green Features

Part 5 – Other Green Features

NRB 5-1 GREEN FEATURES & INNOVATIONS	GREENRE CREDITS
Encourage the use of green features that are innovative and have positive environment impact.	
Examples: • Pneumatic waste collection system • Dual chute system • Self-cleaning façade system • Infiltration trenches • Integrated storm water retention/treatment into landscaping • Etc	2 credits for high impact item 1 credit for medium impact item 0.5 credit for low impact item (Up to 7 credits)
PART 5 – OTHER GREEN FEATURES CATEGORY SCORE:	Sum of GreenRE credits obtained from NRB 5-1



Part 6

Carbon Emission of Development

Part 6 – Carbon Emission of Development

NRB 6-1 CARBON EMISSION OF DEVELOPMENT	GREENRE CREDITS
a. Recognise the carbon emission based on operational carbon footprint computation of the building comprising energy [B6] and water consumption [B7].	1 credit
b. Calculation of product stage embodied carbon based on following building materials [A1-A3]: • concrete • steel • bricks • cement • Metal / Aluminium	0.5 credit
c. Calculation of construction stage embodied carbon [A4-A5]	0.5 credit
d. Reduction from reference embodied carbon (for Ready Mix Concrete, Cement, Steel Reinforcement, Bricks, Metal /Aluminium)	>10% 0.5 credit >30% 1 credit
Part 6 – CARBON EMISSION OF DEVELOPMENT CATEGORY SCORE:	Sum of GreenRE credits obtained from NRB 6-1

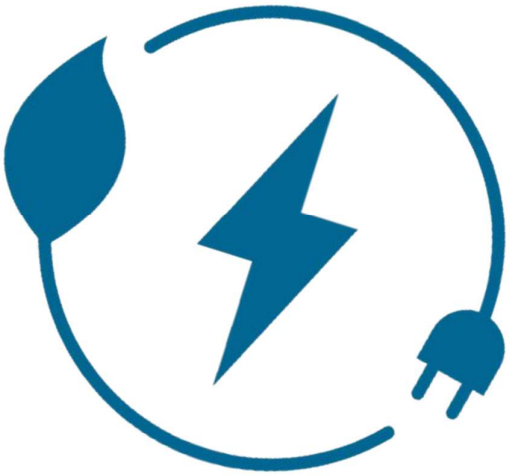
GreenRE Score (Non-Residential)

GreenRE Score (NRB) = ∑Category score [(Part 1-Energy Efficiency) +
(Part 2-Water Efficiency) +
(Part 3-Environmental Protection) +
(Part 4-Indoor Environmental Quality) +
(Part 5-Other Green Features) +
(Part 6-Carbon Emission Development)]

Where:

Category Score for Part 1≥ 30 credits and
Σ Category score for Part 2 to Part 6 ≥ 20 credits

Energy Related Requirements



Part 1 – Energy Efficiency

NRB 1-1 Thermal Performance of Building Envelope-OTTV

NRB 1-2 Air-Conditioning System

NRB 1-3 Building Envelope-Design/ Thermal Parameters

NRB 1-4 Natural Ventilation / Mechanical Ventilation

NRB 1-5 Daylighting

NRB 1-6 Artificial Lighting

NRB 1-7 Ventilation in Carparks

NRB 1-8 Ventilation in Common Areas

NRB 1-9 Lift and Escalators

NRB 1-10 Energy Efficient Practices & Features

NRB 1-11 Renewable Energy

NRB 1-1 THERMAL PERFORMANCE OF BUILDING ENVELOPE - OTTV

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 ≥ 1000m^2.

BASELINE STANDARD

Maximum permissible OTTV = 50 W/m^2

OTTV stands for Overall Thermal Transfer Value.

Maximum permissible RTTV = 25 W/m^2

RTTV stands for Roof Thermal Transfer Value.

In the case of an air-conditioned building, the concept of Roof Thermal Transfer Value (RTTV) is applied if the roof is provided with skylight and the entire enclosure below is fully air-conditioned.

The computation of OTTV & RTTV shall be based on the methodology specified in the MS 1525:2019.

REQUIREMENTS

Up to 15 credits can be scored for building envelope with better thermal performance than the baseline standard:

2 credits for every reduction of 1 W/m^2 in OTTV from the baseline.

Credits scored = 100 – [2 x (OTTV)] where OTTV ≤ 50 W/m^2

For developments consisting of more than one building, the weighted average of the OTTVs based on the façade areas of these buildings shall be used as the basis for credits allocation.

That is:

$OTTV_{\text{weighted average}} = \sum (OTTV_{\text{bldg}} \times A_{\text{bldg}}) / A_{\text{devt}}$

where $OTTV_{\text{bldg}}$ = OTTV for building (W/m^2)
A_{bldg} = Summation of all façade areas (m^2) in a building
A_{devt} = Summation of total applicable façade areas of all buildings within the development (m^2) (i.e. $\sum A_{\text{bldg}}$)

PREREQUISITE REQUIREMENTS

GreenRE Gold	OTTV of 42 W/m^2 or lower
GreenRE Platinum	OTTV of 40 W/m^2 or lower

DOCUMENTARY EVIDENCES

- Site plan with clearly demarcated the orientation of the building.
- Architectural elevation drawings showing the composition of the different façade or wall systems that are relevant for the computation of OTTV.
- Glazing specification showing the U Value and SC Value.
- Window and door schedule.
- Detailed area (m2) tabulation of fenestration and wall for every façade showing the window to wall ratio (WWR).
- Calculation of U Value for all type of external walls.
- Calculation of the Shading Coefficient for external shading device.
- OTTV calculation for each facing wall.
- A drawing showing the cross-sections of typical parts of the roof construction, giving details of the type and thickness of basic construction materials, insulation and air space.
- The U-value of the roof assembly and technical specification of the roof insulation (if any).

In the case of an air-conditioned building, the concept of Roof Thermal Transfer Value (RTTV) is applied if the roof is provided with skylight and the entire enclosure below is fully air-conditioned.

- RTTV Calculation (if applicable)
- Skylight specification showing the U Value and SC Value.

REFERENCES

MS1525:2019- Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings - Code of Practice

NRB 1-2 AIR-CONDITIONING SYSTEM

OBJECTIVES

Encourage the use of better efficient air-conditioned equipment to minimise energy consumption.

APPLICABILITY

Applicable to air-conditioned building areas where its aggregate air-conditioned areas ≥ 1000m^2.

Scope covers all air-conditioned equipment for the buildings as listed:

- Chillers
- Chilled water pumps
- Condenser water pumps
- Cooling Towers
- Air Handling Units (AHU)
- Fan Coil Units (FCU)
- Unitary Air-Conditioners/ Condensing Units which include single-split units, multi-spilt units and variable refrigerant flow (VRF) system

BASELINE STANDARD

Minimum efficiency requirement of the air-conditioning system stated in MS 1525:2019 or SS 530 & SS CP 13.

Points scoring and fulfilment of pre-requisite for air-conditioning will be allowed in the following scenarios:

Points scoring and fulfilment of pre-requisite for air-conditioning will be allowed if the air conditioning provided by developer for NLA.

Fulfilment of pre-requisite for air-conditioning without point scoring:

- Included in building user guide.
- For gold and platinum projects, savings in energy model to reflect efficiency of air-conditioners proposed in building user guide.

1-2(a) Water-Cooled Chilled Water Plant

Baseline	Building Cooling Load	
	< 500 RT	≥ 500 RT
Prerequisite Requirements Minimum system efficiency of central chilled-water plant	0.85 kW/RT	0.75 kW/RT

i. Water-Cooled Chiller – Refer Table 25 of MS 1525:2019 to calculate Its Coefficient of Performance (COP)

ii. Chilled-water pump and condenser water pump efficiency – Refer to Clause 8.2.5.1 in MS 1525:2019 which states that for chilled water or condenser water pumping system operating for more than 750 hours a year, the pump efficiency shall be:

Type of pumping system	Maximum Power consumption [W/(m3/h)]
Condenser water pump	84
Chilled water pump	97

Table 21. Maximum power consumption for pumping system

Cooling tower performance at the rating condition states in Table 3 SS 530.

Rating condition is as follows: 35°C Entering water
29°C Leaving water
24°C Wet Bulb Outdoor air

Propeller and axial fan cooling tower:
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

Centrifugal fan cooling tower:
With heat rejected from every 1.7L/s of condenser water per 1kW of fan power rating:

Cooling tower performance ≤ 1kW / 1.7 L/s
≤ 0.588 kW / L/s

OR

1-2(b) Air-Cooled Chilled-Water Plant / Unitary Air-Conditioners

Baseline	Building Cooling Load	
	< 500 RT	≥ 500 RT
Prerequisite Requirements Minimum system efficiency of air cooled chilled water plant or unitary conditioners	1.1 kW/RT	1.0 kW/RT

- Air-cooled chilled water plant - Refer Table 25 of MS 1525:2019 to calculate its Coefficient of Performance (COP).
- Unitary Air-Conditioners / Condensing Units – Refer Table 23 of MS 1525:2014

Note: If the specific type of air conditioned is not found in MS 1525:2019, please refer to SS 530 to make the calculation on COP. Priority given to MS 1525:2019.

1-2(c) Air Distribution System – Refer ASHRAE 90.1:2010 Clause 6.5.3.1 as prescribed below:

Baseline Air Distribution System Type	Allowable Fan System Input Power	
	($kW/m^3/s$)	(W/CMH)
AHUs / FCUs ≥ 4kW (Constant Volume)	1.5	0.42
AHUs ≥ 4kW (Variable Volume)	2.1	0.58
Fan systems with nameplate motor power < 4kW	0.6	0.17

1-2(d) Provision of permanent measuring instruments to monitor water-cooled and air-cooled chilled water plant

- The instrumentation installed in the system shall have capability to calculate resultant plant efficiency within ± 5% of its true value – Refer ASHRAE Guide 22 and AHRI 550/590.
- To ensure the monitoring of central water-cooled chilled plant efficiency remains within a ± 5% margin of error, the following instrumentation accuracy is recommended;

Description	Measurement error
Temperature sensors • 10K/30K Thermistor • Platinum Resistance Thermometers	± 0.03 – 0.05 °C at 0°C
Flow Meter • Ultrasonic • Full bore magnetic	± 0.5 – 1.0 % over entire measurement range
Power meter	ANSI C12.1-2008, Class 1 ±1%

Note:

1-2(e) Verification of central chilled water plant instrumentation – Heat Balance substantiating test

- Substantiating test shall be conducted as accordance to AHRI 550/590
- The heat balance shall be conducted over entire normal operating hours with more than 80% of the computed balance within ± 5% over the audit period

Heat balance is denoted by below equation:

$q_{condenser} = q_{evaporator} + W_{input}$

Where;

$q_{condenser}$ = heat rejected (in kW or RT)
$q_{evaporator}$ = cooling load (in kW or RT)
W_{input} = measured electrical power input to compressor

1-2(f)

Provisioning of variable speed controls for chiller plant equipment

1-2(g)

Provisioning of automatic control devices or sensors to regulate outdoor air flow rate to maintain the concentration of Carbon Dioxide at acceptable range ≤700 ppm above outdoor concentration.

REQUIREMENTS

1-2(a) Air-Conditioned Plant (Up to 20 credits)

- **Building cooling load ≥ 500RT:**

  14 credits for achieving plant efficiency of 0.75 kW/ton

  0.35 credit for every percentage improvement in the chiller plant efficiency better than 0.75 kW/ton

  Credit scored = 0.35 x (% improvement)

- **Building cooling load < 500RT:**

  14 credits for achieving plant efficiency of 0.85 kW/ton

  0.3 credit for every percentage improvement in the chiller plant efficiency better than 0.85 kW/ton

  Credit scored = 0.3 x (% improvement)

  (up to 20 credits)

OR

1-2(b) Air-Conditioned Plant (Up to 20 credits)

- **Building cooling load ≥ 500RT:**

  14 credits for achieving plant efficiency of 1.0 kW/ton

  0.25 credit for every percentage improvement in the chiller plant efficiency better than 1.0 kW/ton

  Credit scored = 0.25 x (% improvement)

- **Building cooling load < 500RT:**

  14 credits for achieving plant efficiency of 1.1 kW/ton

  0.2 credit for every percentage improvement in the chiller plant efficiency better than 1.1 kW/ton

  Credit scored = 0.2 x (% improvement)

  (up to 20 credits)

1-2 (c) Air Distribution System (Up to 8 credits)

0.15 credits for every percentage improvement in the air distribution system efficiency above the baseline.

Credits scored = 0.15 x (% improvement)

Note (1): For building using district cooling system, there is no need to compute the plant efficiency under item NRB 1-2(a). The credit obtained will be pro-rated based on the air distribution system efficiency under NRB 1-2(c).

1-2 (d)

2 credit can be scored for the provision of permanent measuring instruments for monitoring of water cooled chilled-water plant and air-cooled chilled water plant efficiency

1-2 (e)

1 credit can be scored for verification of central water cooled chilled-water plant instrumentation: Heat Balance – substantiating test for water cooled chilled-water plant to be computed in accordance with AHRI 550/590. The operating system efficiency and heat balance to be submitted to GreenRE upon commissioning.

1-2(f)

1 credit can be scored if variable speed controls for chiller plant equipment such as chilled-water pumps and cooling tower fans are provided to ensure better part-load plant efficiency.

1-2(g)

1 credit 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) ≤ 700 ppm above outdoor.

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 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.
- Technical product information of all air-conditioning and system which included chillers, chilled water pumps, condenser water pumps, cooling towers.
- Schematic drawings showing the air-conditioning system.
- Schedules of the air-conditioning system.
- Operating System Efficiency report during verification endorse by the competent person.

For 1-2 (c)

- Detailed calculations of the overall improvement for air distribution system.
- Technical product information of all AHUs, FCUs, and etc.
- AHUs and FCUs schedule and schematic drawing.

For 1-2 (d)

- Instrument's calibration certificates from accredited laboratory or batch calibration certificates from manufacturer.
- Schematic drawing showing the location of the digital power meters, flow meters and temperature sensors.
- Summary of instruments, standard and measurement accuracy to be presented in the following format:

Instruments	Instruments calibration standard	Quantity	Measurement Error (% of reading)	Resultant Error (% kW/RT)	Type/Brand/ Model
Temperature/ Sensors					
Flow meter/ Sensors					
Power Meter					

- Technical specification of the digital power meters, flow meters and temperature sensors.

For 1-2 (e)

- Computation of the percent heat balance that is the total heat gain and total heat rejected must be within ± 5% for 80% of the sampled credits over the normal building operations hours accordance with AHRI550/590.
- Detailed calculations of the overall uncertainly of measurement of the resultant chiller plant efficiency in kW/RT to be within ± 5% of the true value based on instrumentation specification.

For 1-2 (f) and 1-2 (g)

- Extracts of the tender specification showing the requirements to incorporate these control devices.
- Plan layouts showing the locations and the types of control devices used to regulate fresh air intake.
- Technical product specification of the control devices.

REFERENCES

a. MS 1525:2019 – Energy efficient and use of renewable energy for non-residential building – Code of Practice

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.

WORKED EXAMPLE

Case: District Cooling Plant (DCP)

For 1-2 (c)

An air-conditioned building equipped only AHU and FCU. Whilst its chiller, cooling tower and pumps are placed outside the building. The AHU performance system is 8 %.

0.15 credit for AHU improvement; 0.15 x 8 % = 1.2 credits

For 1-2(a)

The pro-rate calculation shall be;

$$\frac{1.2 \text{ credits}}{8 \text{ credits}} \times 20 \text{ credits} = 3 \text{ credits}$$

Total credits scored for part 1-2(a) and 1-2(c)= 1.2 +3 = 4.2 credits

NRB 1-3 BUILDING ENVELOPE – DESIGN/THERMAL PARAMETERS

OBJECTIVES

Enhance the overall 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 and common area

BASELINE STANDARD

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

Roof Weight Group	Maximum U-Value (W/m^2K)
Light (Under 50 kg/m^2)	0.4
Heavy (Above 50 kg/m^2)	0.6

Table 1-3.1: Maximum U-value for roof

REQUIREMENTS

1-3(a)

Up to 10 credits 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 credits scored will be 24 credits and the requirements under 1-3 (b)(i), b(ii) and (c) will not be applicable for scoring.

Credits scored = 10 – [0.2 x (% of west facing façade 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 illustration below). Core walls for lift or staircases and toilets that are located within this range are exempted in computation.

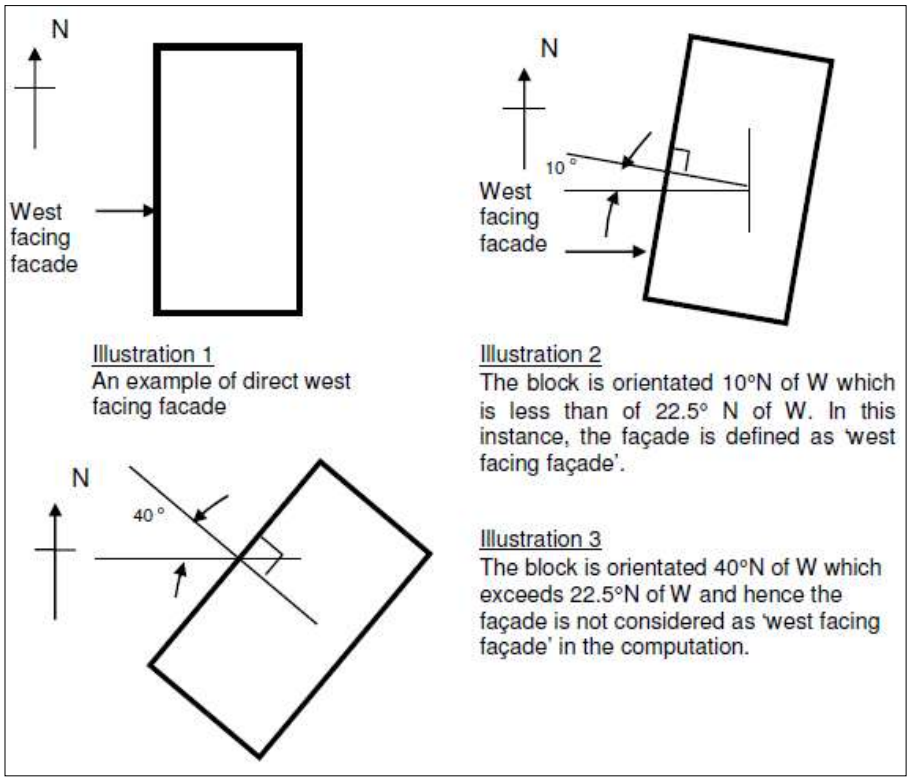


Illustration 1-3.1: Orientation of facade

1-3(b)

Up to 10 credits can be scored for design with (i) minimum west facing window opening and/or (ii) having effective sun shading provision for windows with minimum shading of 30% on the west façade.

For 1-3 (b)(i)

Credits scored = 10 – [0.1 x (% of west facing window areas over total west facing façade areas)]

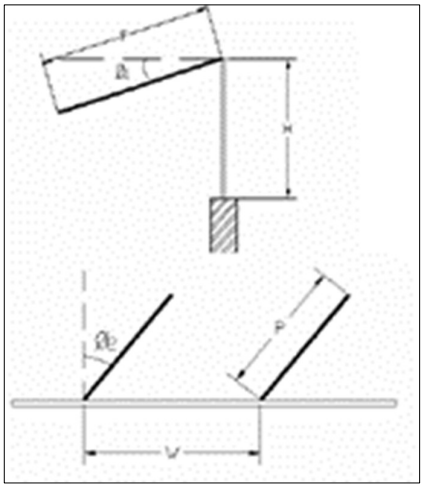
For 1-3 (b)(ii)

Credits scored = 0.1 x (% of west facing window areas with sun shading devices over total west facing façade areas)

Notes: For 1-3 (b)(ii), credits can only be scored if the sun shading devices meet at least a shading of 30% as tabulated in Table 1-3.2 below:

Type of Sun Shading 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

Table 1-3.2 : Minimum Requirement on Shading Devices for West Façade



Where

Horizontal Shading/ Projections (R_1)

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

$Ø_1$ = Angle of inclination

Vertical Shading/ Projections (R_2)

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

$Ø_2$ = Angle of inclination

1-3(c)

Up to 5 credits can be scored for external west facing wall that are designed with better thermal transmittance that is U-value of wall equal or less than 2W/m^{2}K.

Credits 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 credits can be scored for roof design with better thermal transmittance that is U-value of roof than the baseline standard.

Credits scored = 2 credits for every 0.1 W/m^{2}K reduction from the baseline.

DOCUMENTARY EVIDENCES

For 1-3(a)

- Architectural plan layouts and elevation drawings of all façade. Highlight those areas that are considered as west facing façade.
- Calculation showing the percentage of west facing façade areas in the prescribed tabulated format as shown in Table 1-3(a).

	Area of west facing external façade (m^2) (a)	Total area of external façade (b)	% of west facing external facade
Block 1			∑ (a)/ ∑(b) x 100
Block 2			
Block 3			
Total			

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

Credits scored for 1-3(a)= 10 – [0.2 x (∑ (a)/ ∑(b) x 100)]

For 1-3(b)(i) and (ii)

- Architectural plan layouts and elevation drawing of west facing façade and highlight the window openings.
- Sectional drawing showing the details of the sun shading devices. Highlight those sun shading devices that meet the 30% shading requirement.
- Window schedules.
- Calculation showing the percentage of west facing window areas in the prescribed tabulated format.

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) x 100
Block 2			
Block 3			
Total			

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

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

Description	Area of west facing window with effective sun shading 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			∑ (a)/ ∑(b) x 100
Block 2			
Block 3			
Total			

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

Credits scored for 1-3(a) = 0.1 x [(∑ (a)/ ∑(b)) x 100)]

- Calculation showing the percentage of west facing window with the provision of sun shading devices meet at least of 30%.

For 1-3(c)

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

Description	Area of external west facing walls with U-value of 2W/m^{2}K 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			∑ (a)/ ∑(b) x 100
Block 2			
Block 3			
Total			

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

Credits scored = 0.04 x [(∑ (a)/ ∑(b)) x 100)]

For 1-3(d)

- Roof layout and sectional details of the development.
- Extracts of the tender specification which states the thermal transmittance properties of roof.
- Detailed sectional drawings showing the roof composition and the respective U-values and calculation showing the average reduction.
- Technical product information of the insulation materials (if applicable).

Roof Type	Weight Group	Weight range (kg/m^2)	Maximum Thermal Transmittance (w/m^{2}K)	Designed U-value (W/m^{2}K)	Reduction (W/m^{2}K)
Roof 1	Light	Under 50	0.4		
Roof 2	Heavy	Above 50	0.6		

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

NRB 1-4 NATURAL VENTILATION / MECHANICAL VENTILATION

OBJECTIVES

Encourage building that facilitates good natural ventilation. Encourage energy efficient mechanical ventilation system as the preferred ventilation mode to air-conditioning in buildings.

APPLICABILITY

Applicable to Non-Air-Conditioned Building Areas (with an aggregate non-air-conditioned areas > 10% of total floor area excluding carparks and common areas) for Natural Ventilation.

BASELINE STANDARD

Fan power limitation in mechanical ventilation systems:

Allowable nameplate motor power	
Nameplate motor power > 4kW	Nameplate motor power < 4kW
0.32 W/CMH	0.17 W/CMH

REQUIREMENTS

1-4(a) Ventilation System

i. Up to 10 credits can be scored for building design that utilises prevailing wind conditions to achieve adequate cross ventilation.

1 credit for every (10% of units/ rooms with window openings facing north and south directions)

Credits scored = 1 x (% of units / 10)

Note: In Malaysia, 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 advantages 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.

Window openings are not required to be oriented perpendicular to the prevailing wind direction. Window openings oriented within the directional ranges of **north-west to north-east** and **south-west to south-east** shall be deemed to satisfy the prevailing wind orientation requirement.

Only window openings serving **habitable spaces** shall be considered. Window openings serving **toilets, bathrooms, and store rooms** shall be excluded from consideration.

An oblique angle is considered acceptable (see illustrations as shown in the next page).

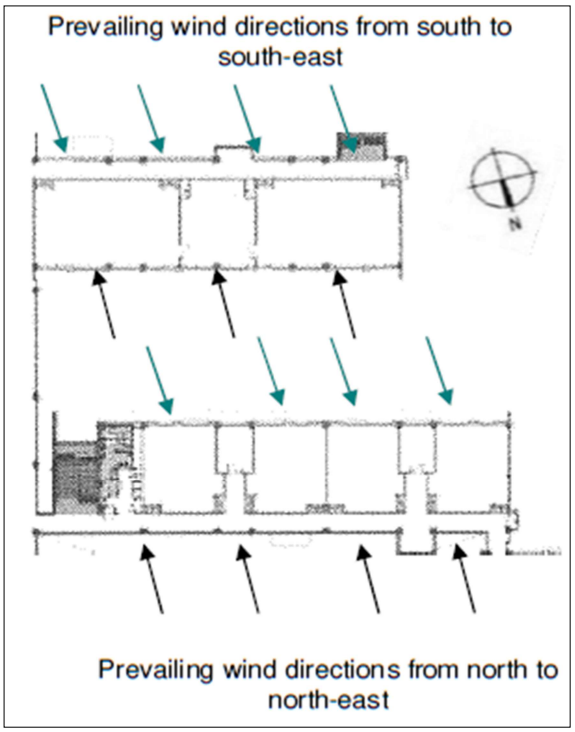


Illustration 1-3.1: Orientation of facade facing North and South

Building layout shows all rooms with window openings facing the North and South directions.

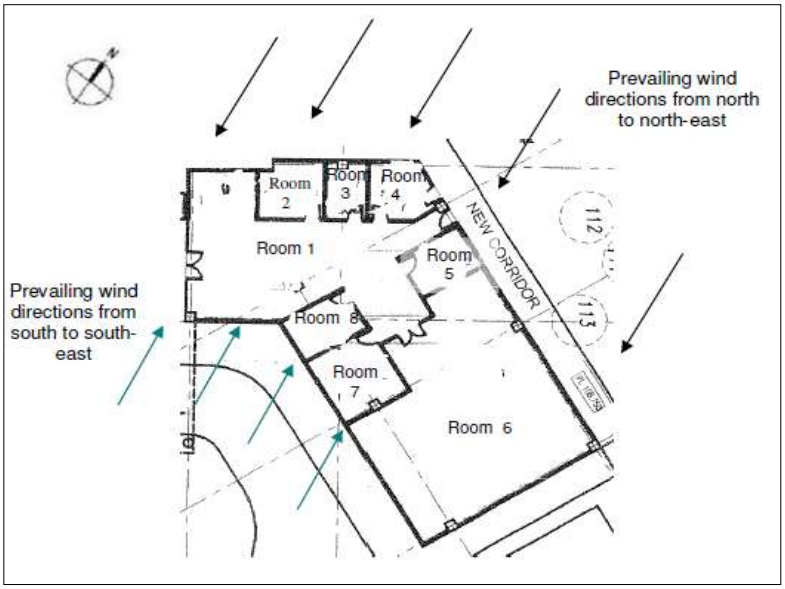


Illustration 1-3.2: Orientation of facade facing North and South

Building layout shows not all rooms with window 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 requirement 1-3(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 in the same conditions outlined in paragraph 1-4(a) below. Credits should only be scored if the recommendations from the simulation are implemented.

OR

ii. Up to 10 credits for the use of mechanical system to promote adequate ventilation between indoor and outdoor air.

0.4 credits for every subsequent 1% improvement in the baseline.

Baseline: Fan power limitation in mechanical ventilation systems:

Allowable nameplate motor power	
Nameplate motor power > 4kW	Nameplate motor power < 4kW
0.32 W/CMH	0.17 W/CMH

1-4(b) Ventilation Simulation Modelling and Analysis

5 credits 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 alternatively, to conduct thermal comfort modelling to achieve a PMV of +/- 1. And additional 5 credits 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 B.

Note: Assistance from the ceiling fan is allowable to improve the thermal comfort of a space whereby ventilation simulation shall prove that unassisted ventilation (NV) complies with the minimum requirement of 0.14 m/s wind velocity.

PREREQUISITE REQUIREMENTS

GreenRE Platinum: Ventilation simulation modelling and analysis are to be carried out to ensure good natural ventilation with minimum weighted average wind velocity of 0.6m/s within the functional spaces or units.

DOCUMENTARY EVIDENCES

1-4(a)(i) Building layout with the cross ventilation

- Architectural plan layouts showing the units / rooms of all blocks with highlights of those with north and south window openings.
- Calculation showing the percentage of units or rooms with window openings facing north and south directions in the prescribed formats as shown in Table 1-4(a).

Ref	Description	Units/Rooms with window opening in the N-S direction (a)	Total no. of naturally ventilated units/room (b)	% of units/ rooms with window opening in N-S direction
1	Classroom Blk A & A1			∑ (a) / ∑(b) x 100
2	Classroom Blk B			
3	Offices, meeting rooms and computer rooms with air-conditioning			
	Total:			

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

Credits scored = 1.0 x (% of units / 10)
= 1.0 x [(∑ (a) / ∑(b) x 100) / 10]

1-4(a)(ii) Mechanical Ventilation

- Plan layout demarcates the area with mechanical ventilation system.
- The overall design and drawings for mechanical ventilation system to make up the required outdoor air quantity into the building at desire fan power limit.
- Detailed calculations showing the fan power improvement.
- Product catalogue of the fan power used.

1-4(b) Good Thermal Comfort

- Ventilation simulation modelling result and analysis or wind tunnel testing to identify the most effective building design and layout which achieve average wind velocity at least 0.6m/s or more.
- A summary of the recommendation from the ventilation simulation report.
- Architectural plan layout highlights the implementation base on the recommendation from the report.

REFERENCES

SS CP 13 – Code of Practice for Mechanical Ventilation and Air-Conditioning Buildings

NRB 1-5 DAYLIGHTING

OBJECTIVES

Encourage design that optimises the use of effective day lighting to reduce energy use for artificial lighting.

APPLICABILITY

1-5(a)

Applicable to all normally occupied areas within the development.

1-5(b)

Applicable to all common areas within the development.

BASELINE STANDARD

1-5(a)

The minimum illuminance level for day lighting shall be in accordance with MS 2680:2017. Daylight factor range to be (1% -3.5%)

1-5(a)

The minimum illuminance level for day lighting shall be in accordance with MS 2680:2017. Daylight factor range to be more than 1%.

REQUIREMENTS

1-5(a)

Up to 3 credits can be scored for the use of daylight simulation analysis or any relevant calculation documents to verify that 50% or more of all habitable spaces achieve adequate daylight illuminance levels as specified in Clause 5.4.2 in MS1525:2019.

The scoring will be based on percentage of habitable spaces with adequate ambient lighting level.

Percentage of Habitable Spaces with Adequate Ambient Lighting Level	Credits Allocated
50% - 75%	1
76% - 90%	2
>90%	3

Table 1-5.1: Credits allocation according to Habitable Spaces

1-5 (b) (i)

1 credit for provision of day lighting for lift lobbies and corridors.

1-5 (b) (ii)

1 credit for provision of day lighting for staircases.

1-5 (b) (iii)

1 credit for provision of day lighting for car parks.

Note:

a. Simulation or suitable daylight calculation is necessary for occupied space and common area to achieve the minimum daylight factors required.
b. For common areas, artificial lighting circuit schematics are necessary as documentary to proof design that allows controllability to maximise harvested daylight.

DOCUMENTARY EVIDENCES

For 1-5(a)

- Schedules showing the total floor area of the habitable spaces in the development.
- Daylight simulation / calculation report summarizing the analysis and modelling results for each habitable space area that meets the requirement.
- Architectural plan layout showing glazing/window area for each habitable space.

For 1-5(b)

- Architectural plan layout showing the window/ glazing at the lift lobby, corridors, staircases and car parks (where applicable).
- Calculation showing the 80% of each common area with the daylight provision.

REFERENCES

MS 1525:2019 –Energy Efficiency and Use of Renewable Energy for Non-Residential Building – Code of Practice

WORKED EXAMPLE 1-5(a)

Tabulate occupied spaces and daylight factor achieved for all areas.

Calculate % of occupied areas achieving daylight factor between 1-3.5%

e.g.: % occupied areas with DF 1-3.5% = 60%

Credits scored for 1-5(a) = 1 credits

WORKED EXAMPLE 1-5(b)

Proposed non-residential development with the following provision:
All lift lobbies (including private lift lobbies), corridors and staircases are designed to have adequate day lighting that would eliminate the need for artificial lighting during daytime. 75% of the car park areas have day lighting provision while the other 25% of the car park areas need to employ the use of artificial lighting to maintain proper lighting level.

No.	Criteria	Credit Allocated	Credit
1-5(b)(i)	Lift lobbies and corridors	1	1
1-5(b)(ii)	Staircases	1	1
1-5(b)(iiii)	Day lighting for carpark	1	0.75
		TOTAL	**2.75**

Table 1-5.3: Credits Allocation

As carpark achieves adequate daylighting in only 75% of applicable areas (<80%) – scoring will be prorated to 0.75.

Therefore, credits scored for 1-5(b) = 2.75 credits

NRB 1-6 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 that designed in accordance to the luminance level as recommended in MS 1525:2019.

BASELINE STANDARD

Luminance level stated in MS 1525:2019 –Energy Efficiency and Use of Renewable Energy for Non-Residential Building – Code of Practice.

Note:
Where the relevant baseline requirement is not specified in MS 1525, reference shall be made to the ASHRAE luminance levels as stated in MS 1525:2019, Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings Code of Practice.

REQUIREMENTS

Up to 12 credits if tenants' light is provided **OR** up to 5 credits if tenants' light is excluded for the improvement in the lighting power consumption.

0.25 credit for every percentage improvement in the lighting provisions over the baseline standard.

Credits scored = 0.25 x (% improvement)

Display lighting and specialised lighting are to be included in the calculation of lighting power budget.

The design service illuminance, lamp efficiencies and the light output ratios of luminaries shall be in accordance with in MS 1525:2019 –Energy Efficiency and Use of Renewable Energy for Non-Residential Building - Code of Practice.

The following lighting power budget baselines shall apply:

Retail Type	Baseline
General	≤ 15.0 W/m^2
Jewellery	≤ 35.0 W/m^2
Furniture, clothing & accessories, cosmetic & art	≤ 25.0 W/m^2
Supermarket, vehicle, sporting goods, stationary, & hardware	≤ 20.0 W/m^2
Carpark	< 2.0 W/m^2

DOCUMENTARY EVIDENCES

- Lighting layout plan.
- Lighting schedules showing the numbers, locations and types of luminaries used.
- Calculation of the proposed lighting power budget and the percentage of improvement in the prescribed tabulated format shown in Table 1-6-1 and 2.
- Extract tender specification of lighting fittings used.
- Technical product information of the lighting luminaries used.
- Lux simulation result for all the spaces showing compliance with illuminance level in table 10, MS1525:2019.

REFERENCES

MS 1525:2019 –Energy Efficiency and Use of Renewable Energy for Non-Residential Building – Code of Practice

WORKED EXAMPLE 1-6

a. Determine the total power consumption based on the lighting layout design for each areas and light fitting types used

b. Calculate the total power consumption based on the maximum lighting power budget stated in MS 1525:2019.

c. Calculate the percentage improvement in the total power consumption.

Description	Areas (m^2) (A)	Light Fitting Type (B)	Power Consumption per fitting (W) (C)	Ballast Loss (W) (D)	No. of Fitting (E)	Total power consumption based on fitting type [(C+D)] x E
Office Space 1	1500	T5	2x28	3	245	14455
Office Space 2	1250	T5	2x28	3	210	12390
Meeting Room	75	75	1x36	3	15	585
		Surface downlight	2x36	0	8	576
Corridors 1	150	T5	2x28	3	15	885
Corridors 2	205	T5	2x28	3	15	885
		Surface downlight	1x70	0	9	630
Atrium	850	T8	2x36	3	87	6525
		Surface downlight	1x150	0	10	1500
Carparks	7500	T5	2x28	3	436	25724
Staircase	300	T5	2x28	3	20	1180
					Total:	65335

Table 1-6-1 : Total power consumption based on each fitting type

Description	Areas (m^2) (A)	Design Data		MS 1525:2019 Requirements	
		Total Power Consumption (by area) (W) (F)	Design Lighting Power Budget (W/m^2) (F/A)	Reference Lighting Power Budget (W/m^2) (H)	Reference Total Power Consumption (by area) (W) (HxA)
Office Space 1	1500	14455	9.64	12	18000
Office Space 2	1250	12390	9.91	12	15000
Meeting Room	75	1161	13.35	12	900
Corridors 1	150	885	5.90	5	750
Corridors 2	205	1515	7.39	5	1025
Atrium	850	8025	9.44	5	4250
Carparks	7500	25724	3.43	5	37500
Staircase	300	1180	3.93	5	1500
Total:		65335			78,925

Table 1-6-2: Total power consumption based on design and MS 1525:2019

% improvement in the lighting power consumption

= [Σ (H x A) – Σ(F)] / Σ (H x A) x 100%
= (78925-65335)/78925 x 100%
=17.22

Credits scored = 0.25 x 17.42% = 4.30 credits

Therefore, credits scored should be 4.30 credits if tenant's lighting is included: and credits scored should be 5 credits (max) if tenant's light is excluded.

NRB 1-7 VENTILATION IN CARPARKS

OBJECTIVES

Encourage the use of energy efficient design and control of ventilation systems on carparks.

APPLICABILITY

Applicable to all carpark's spaces in the development.

REQUIREMENTS

1-7(a)

4 credits can be scored for car park spaces that are fully naturally ventilated.

1-7(b)

For carparks that have to be mechanically ventilated, credits can be scored for the use of carbon monoxide (CO) sensors in regulating such demand based on the mode of mechanical ventilation (MV) used; 2.5 credits for carparks using fume extract system and 2 credits for those with MV with or without supply.

Note: Where there is a combination of different ventilation modes adopted for carpark design, the credits scored under this requirement will be prorated accordingly.

DOCUMENTARY EVIDENCES

For 1-7(a)

- Plan layouts showing all car park provision for the development with highlights of the car park spaces that are designed to be naturally ventilated.
- Calculation showing the openings at the carpark level to meet the UBBL requirement.

For 1-7(b)

- Plan layouts showing all car park provision for the development with highlights of the car park spaces that are designed to be naturally ventilated and/or mechanical ventilated.
- Plan layout indicating the location of CO sensors and the mode of ventilation adopted for the design.
- Calculation showing the credits allocation if there is a combination of different ventilation mode adopted for the car park design.
- Technical product information of CO sensors and mechanical ventilation.

REFERENCES

MS 1525:2019 –Energy Efficiency and Use of Renewable Energy for Non-Residential Building – Code of Practice

WORKED EXAMPLE 1-7

Proposed development has a 6-storey naturally ventilated carparks and one level of mechanically ventilated basement carparks with CO sensor to be installed to regulate MV.

Areas of naturally ventilated carparks = 6 x 600 = 3600 m^2
Areas of basement carparks = 600 m^2
Total areas = 4200 m^2
Credits scored for 1-7 = (3600/4200) x 4 + (600/4200) x 2
= 3.71 credits

NRB 1-8 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 (Include BOMBA Staircase)
- Corridors
- Lift Lobbies
- Atriums

REQUIREMENTS

Up to 5 credits 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.

Credits are scored based on the mode of ventilation provided in these applicable areas.

Natural ventilation – 1.5 credits for each area

Mechanical ventilation – 0.5 credit for each area

DOCUMENTARY EVIDENCES

- Plan layouts showing the applicable areas and the respective modes of ventilation with proper demarcation of the opening.
- Schedules showing the numbers, locations of the applicable areas and the mode of ventilation used.
- Technical product information of mechanical ventilation system. (if applicable) of ventilation used

- Schematic drawing of the mechanical ventilation system.
- Calculation showing the credits allocation if there is a combination of different ventilation modes adopted for the applicable areas.

REFERENCES

MS 1525:2019 –Energy Efficiency and Use of Renewable Energy for Non-Residential Building – Code of Practice

WORKED EXAMPLE 1-8

Proposed development has the following details:

No. of toilet = 45; where 10 units are designed with air-conditioning.

% of toilet units with natural ventilation = (45-10)/45 = 77.8%
Hence, it is less than 90%; no credit for this item

No. Of staircases = 100; all are mechanical ventilated – 0.5 credit
No. Of lift lobbies = 22; all are naturally ventilated – 1.5 credits

Credits scored for 1-8 = 0.5 + 1.5 = 2 credits < 5 credits (max)

NRB 1-9 LIFTS AND ESCALATORS

OBJECTIVES

Encourage the use of energy efficient lifts and escalators.

APPLICABILITY

Applicable to **ALL** lifts and/or escalators in the development.

REQUIREMENTS

1 credit can be scored for the use of lift with energy efficient features such as sleep mode or regenerative features and motorless lift

1 credit 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 used.
- Plan layout showing the location of the lifts and escalators.
- Schedules showing the total number of lifts & escalators and its power consumption.
- Technical information of the lifts & escalators.

WORKED EXAMPLE 1-9

Proposed development has the following provision:

Two lift types: Type L1 with VVVF motor drive and sleep mode features
Type L2 with VVVF motor drive and sleep mode features

Two escalator types: Type E1 with VVVF motor drive and motion sensors
Type E2 without VVVF motor drive and motion sensors

1 credit for the use of lifts with VVVF motor drive; and sleep mode features

No credits for escalators as not all escalators are designed with motion sensors

Credits scored for 1-9 = 1 credits

NRB 1-10 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

1-10(a)

Applicable to all developments

1-10(b)

Applicable to practices and features that are not listed in the requirements under Part 1 – Energy Efficiency.

REQUIREMENTS

1-10(a)

1 credit can be scored for the practice of using Building Energy Intensity (BEI) as a building performance indicator to measure the building's unit area energy consumption for future monitoring and improvements.

Calculation of BEI:

BEI = [(TBEC – CPEC) / (GFA excluding carpark - GLA x FVR) x (NF/OH)

Where:

TBEC = Total building energy consumption (kWh/year) excluding renewable energy replacement
CPEC = Car Park Energy Consumption in (kWh/year)
GFA = Gross Floor Area (exclude car park area) (m^2)
GLA = Gross Lettable Area (m^2)
FVR = Floor Vacancy Rate (NLA) (m^2)
NF = Normalizing factor based on a typical weekly operating hour that is 52 Hrs/week [only for office category]
OH = Weighted weekly operating hours (hrs/week) [only for office category]

1-10(b)

Up to 1 credit can be scored for the provision of greenery system on east and west facade to reduce the heat gain through the building envelope. 1 credit for high impact where provision is more than 50% of applicable facade areas. 0.5 credit for low impact where provision is at 25% of the same.

1-10(c)

Up to 11 credits 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 cleaning system
- Auto-condenser tube cleaning system
- Photo sensors to maximize the use of daylighting

Note: For features that are not listed NRB 1-10(c) above, the QP is required to submit the details showing the positive environmental impacts and potential energy savings of the proposed features to GreenRE assessment.

DOCUMENTARY EVIDENCES

For 1-10(a)

- Calculation of the Building Energy Intensity (BEI) using the pre-determined daily usage pattern.
- Detail calculation including operation hours for the estimated energy load for each component in the building etc.: lighting, air conditioning system, pump, receptacle load.
- Technical product information and related drawing on the energy efficient features.
- List of the assumption for the BEI calculation.

For 1-10(b)

- Landscape plan layout showing the vertical greenery provision and building elevation.
- Calculation showing the extent of the vertical greenery provision over the east and west façade areas.

For 1-10(c)

- Extracts of the tender specification showing the provision of the proposed energy efficient features and the extent of implementation where applicable.
- Technical product information and related drawing on the energy efficient features used.
- Calculation of the percentage energy saving that could be reaped from the use of these features.

WORKED EXAMPLE 1-10

For 1-10(a):

1. Determine the total annual building electricity consumption (TBEC) based on the estimated electricity consumption and usage pattern in term of operation hours of all the major energy consumption systems and equipment
2. Compute the of the building

Background info:

Assume a proposed development with GFA excluding car park of86000 m^2, operational hours per week is 55 hours at 100% occupancy rate. No data centre in the building.

System/Equipment	Total Annual Building Electricity Consumption (kWh)/year
Lighting (air-conditioned space)	3094380
Lighting (non air-conditioned space)	236321
Exterior Lighting	405800
Air-conditioned Plant	7924425
Air System Fans	632293
Mechanical Ventilation Fans	207571
Lifts	792966
Escalators	45865
Receptacle Equipment *(16W/m^2)	3936517
Domestic Water Pump Systems	226088
Hot Water Systems	93789
Others	-
Total:	17596015

Table 1-10.1: Total Building Electricity Consumption per year

*For tenant receptacle load, the nominal values shown in the following table can be adopted.

Receptacle Loads	Nominal Values
Computer intensive offices	22 W/m²
General office areas	16 W/m²
Large conference areas	11 W/m²
Server/Computer rooms	540 W/m²

Source: ASHRAE STD 90.1:1999

Total annual Building Electricity Consumption (TBEC) excluding the carpark consumption = 17596015 kWh/year

Therefore, the BEI of the building is as follows:

BEI = (TBEC/GFA) x (NF/OH)
= (17596015/86000) x (55/55)
= 204.6 kWh/m²/yr

Credit scored for 1-10(a) = 1 credit

For 1-10(b):

The same proposed development has incorporated vertical greenery systems on the east and west facade to reduce heat gain to the building.

Areas of vertical greenery systems = 2000 m²	Percentage = 2000/4800 = 42% < 50%
Total east and west facade areas = 4800 m²	Therefore, credits scored for 1-10(b) = 0.5 credit

Table 1-10.2 : Total vertical greenery on east and west facade

For 1-10(c):

The same proposed development has included the use of motion sensors for all staircases and toilets

- Toilets

  Total light fittings to be controlled by motion sensors = 2 x 350 nos.

  Power consumption by light fitting = 2 x 350 x 36 W = 25200 W

  Assume 5 hours per day that the light fittings are off when it is not occupied.

  Electricity saving = 25200 W x 5 hours = 126 kWh

  Annual electricity saving = 126 x 365 = 45990 kWh

- Staircases

Total light fittings to be controlled by motion sensors = 2 x 180 nos.

Power consumption by light fitting = 2 x 180 x 18 W = 6480 W

Assume 10 hours per day that the light fittings are off when it is not used

Electricity saving = 6480 W x 10 hours = 64.8 kWh

Annual electricity saving = 64.8 x 365 = 23652 kWh

Total annual electricity saving using motion sensors = 45990+23652
= 69642 kWh

% energy savings = 69642/17596015 = 0.396%

Credits scored for 1-10(c) = 3 credits for every 1% energy saving
= 3 x 0.396% = 1.19 credit

NRB 1-11 RENEWABLE ENERGY

OBJECTIVES

Encourage the use of renewable energy sources in buildings.

APPLICABILITY

Includes all renewable energy sources

REQUIREMENTS

Up to 20 credits can be scored based on the percentage replacement of electricity by the renewable energy source:

5 credits for every 1% replacement of electricity (based on total electricity consumption) by renewable energy.

OR

3 credits for every 1% replacement of electricity (exclude tenant's usage) by renewable energy.

OR

3 credits for every 10% of roof area used for solar panels.

1 credit for solar ready roof

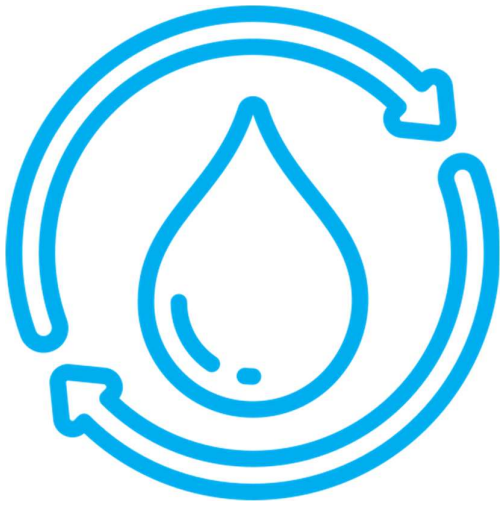
Note:

- Projects that implement Green Energy Tariff (GET) purchases are not eligible to score under this credit. GET is only applicable for scoring under Part 6: Operational Carbon Footprint of Development.
- Credits can be claimed if the renewable energy system is owned and operated beyond the certification boundary, provided that the energy generated is directly attributed to the project.
- The installation of onsite renewable energy systems that are used off-site is not eligible to score under this credit. However, such installations may be considered under Part 5: Other Green Features.

DOCUMENTARY EVIDENCES

- Extract of the tender specification of the renewable energy system and the extent of implementation. Technical product information for the renewable energy system and the expected renewable energy generated. Calculation of the percentage replacement of electricity and the total annual electricity consumption of the development.
- Architectural plan and elevations marking out areas allocated a renewable energy.

Other Green Requirements



Part 2 – Water Efficiency

NRB 2-1 Water Efficient Fittings

NRB 2-2 Water Usage and Leak Detection

NRB 2-3 Irrigation System

NRB 2-4 Water Consumption of Cooling Tower

NRB 2-1 WATER EFFICIENT FITTINGS

OBJECTIVES

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

APPLICABILITY

Applicable to the water fittings covered by the WEPLS as follows:

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

BASELINE STANDARD

As specified under Water Efficiency Product Labelling Scheme (WEPLS)

REQUIREMENTS

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

Rating Based on Water Efficiency Products Labelling Scheme (WEPLS)		
Efficient*	Highly Efficient**	Most Efficient***
4 credits	**6 credits**	**8 credits**

Pre-requisite requirement - To demonstrate reduction of potable water usage by 10% from baseline.

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 in the prescribed tabulated format shown in the Table 2.1-1.
- Schematic drawing of cold water and sanitary plumbing.
- WEPLS product specification or certificate. In the event no product recognition from WEPLS, product catalogue and test report from local or international body that equivalent to the SIRIM standard of testing is required.

REFERENCES

For more information about WEPLS, refer to
http://www.span.gov.my/index.php?option=com_content&view=article&id=580%3Aabout-us1&catid=175%3Awepls&Itemid=457&lang=en

WORKED EXAMPLE 2-1

Example of a water fitting schedule showing the numbers, types and the approve rating of the proposed fitting for a non-residential development (including common facilities such as clubhouse toilets).

Ref.	Water Fitting Type	WEPLS rating			Not Rated	Total
		Efficient	Highly Efficient	Most Efficient		
1	Shower taps and mixers	0	45	0	0	45
2	Basin taps and mixers	0	0	55	0	55
3	Sink/bib taps and mixers	0	70	0	0	70
4	Flushing cisterns	0	0	50	0	50
5	Others – Unrinals for club house	0	0	0	5	5
Total no. based on rating (A)		0	115	105	5	∑A = 225
Weightage (B)		**4**	**6**	**8**	**0**	
Total (A x B)		0	690	840	0	∑(AxB) = 1530

Table 2-1.1: Computation of the percentage for water fittings

Credits scored = ∑(A x B) / ∑A
= 1530 / 225
= 6.8 credits

NRB 2-2 WATER USAGE AND LEAK DETECTION

OBJECTIVES

Promote the use of sub-meter 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.

REQUIREMENTS

2-2(a)

1 credit can be scored if sub-meters are provided for **ALL** major water uses i.e. irrigation system, rainwater harvesting system, cooling towers and tenant's usage where applicable.

2-2(b)

1 credit 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

For 2-2(a)

- Extracts from the tender specification stating the locations and provision of sub meters for all major water uses.
- List of a submeter and its location.
- Schematic drawings of cold water distribution system showing the location of the sub meters provided.

For 2-2(b)

- Extracts from the tender specification and schematic drawing showing the location of sub-metering and its linkage to the Building Management System (BMS).

- List of input and output point of the Building Management System (BMS) with highlighted the submeter point.
- Write up on the specific alert features that can be triggered and detect the water leakage during operation.

NRB 2-3 IRRIGATION SYSTEM AND LANDSCAPING

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.

REQUIREMENTS

2-3(a)

1 credit can be scored for the use of non-potable water including rainwater for landscape irrigation.

For rainwater harvesting tank provision, RWHT to be sized in accordance to Guideline for Rainwater Harvesting and Utilisation System (SPAH) and MSMA guidelines. The rainwater tanks are to be optimally sized to cater for outdoor water use only

Summary calculation of % replacement of outdoor water requirements from rainwater harvesting to be provided as part of claim for this credit

2-3(b)

1 credit 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.

2-3(c)

1 credit can be scored if at least 50% of the landscape areas consist of drought tolerant plants or plants that require minimal irrigation.

WORKED EXAMPLE 2-3(a)

Landscape Consumption

Location	Landscape type	Water Required (L/day)	Quantity		Total watering requirement (L/Day)
GF	Tree	24	200	Nos	4800
	Shrub	6.3	5660	m2	35658
	Turf	3.1	1415	m2	4386.5
					44844.5

Irrigation water requirement (Litre/Day)	44844.5

Roof Catchment

Type	m2	Run-off coefficient
Pitched Tile		0.8
Steel Roof	1239	0.9
RC Roof	1110	0.5
Block Pavement		0.7
Gravel Roadway		0.3

Total Catchment Area (m^2) = 2349
Catchment Area x Run -off coefficient = 1670.1

Type Of System	First Flush System
Equation	Collectible Rainwater = Rainfall x Catchment Area x Run Off Coefficient - (Total Catchment Area x First Flush Diversion)
First Flush Diversion (L/sqm)	1
Tank Size (L)	160,000.00
Total Annual Collected Rain Water (L)	3,880,633.50
Average Daily Collected Rain Water (L)	10,631.87
Irrigation Consumption (L/Day)	44,844.50
Percentage of Reduction (%)	**23.71**

DOCUMENTARY EVIDENCES

For 2-3(a)

- 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
- Calculation of the estimation of saving of potable water for irrigation by the non -potable water source

For 2-3(b)

- 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 (at least 50%)
- Product technical information of the irrigation system.

For 2-3(c)

- Relevant layout plans showing the overall landscape areas and the areas that use drought tolerant plants or plants that require minimal irrigation.
- Calculation showing the percentage of the landscape areas that use drought tolerant plants or plants that require minimal irrigation (at least 50%).
- Plant species showing the minimum water requirement.

REFERENCES

1. Manual Saliran Mesra Alam Malaysia (MSMA) (2000), Ministry of Natural Resources and Environment
2. "Rainwater – Guideline for Installing A Rainwater Collection and Utilization System",KPKT (1999)
3. "Rainwater Harvesting – Guidebook Planning and Design" Department of Irrigation and Drainage, Ministry of Natural Resources and Environment.
4. The list of drought tolerant or resistant plant species may be obtained from the online website: http://florafaunaweb.nparks.gov.sg/

NRB 2-4 WATER CONSUMPTION OF COOLING TOWER

OBJECTIVES

Reduce potable water consumption for cooling purpose.

APPLICABILITY

Applicable to sub-metering provisions for major water uses of the building developments.

REQUIREMENTS

2-4(a)

1 credit 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 credit can be scored for the use of recycled water from approved sources to meet the water demand for cooling purpose.

DOCUMENTARY EVIDENCES

For 2-4(a)

- 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.
- Relevant drawings showing the location of the cooling towers and other supporting systems that are required to achieve the designed concentration.

For 2-4(b)

- Extracts of the tender specification showing how the recycled water source is to be provided.
- Details of the recycled water system.
- Schematic system showing the recycling system.

Other Green Requirements

Part 3 – Environmental Protection

NRB 3-1 Sustainable Construction

NRB 3-2 Sustainable Products

NRB 3-3 Greenery Provision

NRB 3-4 Environmental Management Practice

NRB 3-5 Green Transport

NRB 3-6 Stormwater Management

NRB 3-7 Refrigerants

NRB 3-1 SUSTAINABLE CONSTRUCTION

OBJECTIVES

Encourage recycling and the adoption of building designs, construction practices and materials that are environmentally friendly and sustainable.

APPLICABILITY

Generally applicable to all building developments.

REQUIREMENTS

3-1(a)

Up to 5 credits can be scored with the use of sustainable and recycled materials

Credits can be scored for use of Green Cements with approved industrial by-product such as Ground Granulated Blast Furnace Slag (GGBS), silica fume, and fly ash to replace Ordinary Portland Cement (OPC) based on percentage replacement of ordinary concrete by Green Concrete:

Replacement of OPC by approved industrial by-products (%)	Credit allocation
10	1
20	2
30	3
40	4
≥50	5

Table 3-1.1 : Credits allocation according to replacement percentage

3-1(b)

Up to 5 credits are allocated to encourage more efficient concrete usage for building components based on the percentage reduction in the prescribed Concrete Usage Index (CUI) limit.

Project CUI (m^3/m^2)	Credit allocation
≤ 0.70	1
≤ 0.60	2
≤ 0.50	3
≤ 0.40	4
≤ 0.35	5

Table 3-1.2 : Credits allocation for project CUI

Note: Concrete Usage Index (CUI) is an indicator of the amount of concrete used to construct the superstructure that 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 :

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

DOCUMENTARY EVIDENCES

For 3-1(a)

- Extract of tender specification showing the requirements to use of Green Cement / Concrete.
- Certificate of products showing the recycled content.
- Calculation of estimated quantity of replacement by mass of Green Cement / Concrete.

For 3-1(b)

- 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.
- Bill of quantities showing the volume of concrete to be used.
- Detail Concrete Usage Index (CUI) calculation showing the quantity of concrete for each floor level.

WORKED EXAMPLE 3-1(a)

Proposed development will used Grade 35, 40, 70 and 80 concrete.

From the concrete design mix the percentage of replacement of OPC by the green cements as follow:

Grade 35 = 15.52%
Grade 40 = 63%
Grade 70 = 59 %
Grade 80 = 58 %

No	Concrete Grade	Quantity (m^3)	Percentage of Green Cement (%)	Green Cement Quantity in (m^3)
1	Grade 35	27,381	15.52	4250
2	Grade 40	448	63	282
3	Grade 70	12141	59	7163
4	Grade 80	12155	58	7,050
	Total	**52,155**		**18,745**

Overall % Green Cement replacement = 18,745/52,155 = 35.96%

Therefore, credit scored for NRB 3-1(a)= **2 credits**

WORK EXAMPLE 3-1(b)

Proposed development comprises a 15-storey non-residential block with a basement carpark and the following details:

Concrete usage for the superstructure		Constructed floor areas	
For 1st storey	= 587 m^3	For 1st storey	= 1000 m^2
For 2nd to 15th storey(including roof level)	= 5400 m^3	For 2nd to 15th storey(including roof level)	= 14000 m^2
Therefore, Total concrete usage	= 5987 m^3	Therefore, Total constructed floor area	= 15000m^2

Table 3-1.3 : Concrete usage and constructed floor areas

Note: The concrete usage for foundation and two basements are not required to be included.

Concrete Usage Index (CUI) = $\frac{5987}{15000}$ = 0.4 m^3/m^2

Based on the calculation shown in Table 3-1.4

CUI of 0.4 m^3/m^2 ≤ 0.4 m^3/m^2

Therefore, credits scored = 4 credits

Refer to the following Table 3-1.4 for more details

COMPUTATION OF CONCRETE USAGE INDEX		COMMERCIAL BLDG		
Project Reference No.: AXXXX-00001-2015		Total no. of storey for the project: 15		
Block No: A				
	Structural System	**Thickness (mm) or size (mm x mm)**	**Volume of concrete (m^3)**	**Remark ***
1	**1st storey**			
	1.1 Columns	200x400, 200x200	72	Precast
	1.2 Beams	200x400,200x500	145	Precast
	1.3 Slabs	150,200	265	Post-tensioned
	1.4 Staircases	150	30	Precast
	1.5 Suspended structures like planter boxes, bay windows, ledges etc	150	10	Precast
	1.6 Parapets	150	5	RC
	1.7 External walls – load bearing walls	Nil	0	-
	1.8 External walls – non-load bearing walls	125	15	RC
	1.9 Internal walls – load bearing walls	200	40	RC
	1.10 Internal walls – non-load bearing walls	Nil	0	Light weight concrete
	1.11 Others (kerbs, ramps, services risers, etc)	Not required	5	RC
	Total volume of concrete for this storey (m^3)		587	
	Total constructed floor area for this storey (m^2)		1000	
2	**Typical floor layout**			
	2.1 Columns	200x400, 200x200	55	Precast
	2.2 Beams	200x400, 200x500	45	Precast
	2.3 Slabs	150,200	160	Post-tensioned
	2.4 Staircases	150	30	Precast
	2.5 Suspended structures like planter boxes, bay windows, ledges etc	150	10	Precast
	2.6 Parapets	150	5	RC
	2.7 External walls – load bearing walls	Nil	0	-
	2.8 External walls – non-load bearing walls	125	15	RC

COMPUTATION OF CONCRETE USAGE INDEX		COMMERCIAL BLDG		
Project Reference No.: AXXXX-00001-2015		Total no. of storey for the project: 15		
Block No: A				
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 – load bearing walls	200	40	RC
	2.10 Internal walls – non-load bearing walls	Nil	0	-
	2.11 Others (kerbs, ramps, services risers etc)	Nil	0	-
	Volume of concrete for one storey (m^3)		360	
	Constructed floor area for one storey		933.3	
	Total volume of concrete for 2nd to 15th storey		360x15=5400	
	Total constructed floor area for 2nd to 15th storey (m^2) (including roof level)		933.3x15=14000	
Total volume of concrete for this project (m^3)			5987	
Total constructed floor area for this project (m^2)			15000	
Concrete Usage Index (CUI in m^3/m^2)			0.4	

Table 3-1.4 - Concrete Usage Index

*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

Notes: The quantities of the concrete for all the structural and non-structural elements for each floor level are computed. All the elements listed in the table such as columns, beams, slabs, suspended structures (like planter boxes, bay windows and ledges etc), parapets, walls and others (service risers, kerbs, ramps etc) are to be included. The concrete usages for foundation and basement works are excluded in CUI computation.

NRB 3-2 SUSTAINABLE PRODUCTS

OBJECTIVES

Encourage the use of products that are environmentally friendly and sustainable.

APPLICABILITY

Applicable to non-structural and architectural building components.

REQUIREMENTS

Up to 8 credits are allocated to encourage the use of appropriate environmentally friendly products that are certified by approved local/international certification body. The products used should have considerably contributions in the overall environmental sustainability standard of the development. Credits scored will be based on the extent of coverage and impact.

The environmentally friendly product proposed must be approved by a valid international or local certification body and is subject to GreenRE's evaluation.

Extent of use of environmentally friendly product	Weightage for Credits Allocation
Low impact	0.5
Medium Impact	1
High Impact	2

Table 3-2.1 : Weightage for credits allocation

The use of environmental friendly products or recycled materials used for all dwelling units of the development will be considered as high impact (2 credits) on condition that quantities used by percentage are more than 50% (i.e extent of coverage as compared to total quantities used for same intended purpose. If not met, it will be classified as medium impact (1 credit).

Items that are used for all common areas, external works and communal facilities are considered as medium impact (1 credit) if quantities used by percentage are more than 80% (i.e extent of coverage as compared to total quantities used for same intended purpose in common areas If not met, it will be classified as low impact (0.5 credit)

Note:

1. The impact categories listed above generally apply to main building elements – i.e internal / external wall, floor, ceiling, roof, doors, etc. Singular products – i.e termite treatment system, playground equipment, gym flooring etc will be classed as low impact. All applications will be subject to GreenRE's evaluation.
2. Same type of the product not allowed to be double claimed for different area application
3. The credit allocated for low volatile organic compound (VOC) paints and adhesives certified by approved local certification body can be found in NRB 4-2 and hence shall not be included in the scoring for NRB 3-2.

3-2(b) Reuse Salvage Materials

Up to 1 credit are allocated to Salvage or reuse construction materials for 2% of building materials based on the total material cost (extracted from the bill of quantities).

3-2(c) Recycled Content

Up to 1 credit shall be awarded where the project utilises materials with recycled content such that the sum of post-consumer recycled content plus 50 % of pre-consumer recycled content constitutes not less than 10 % of the total material cost of the project.

DOCUMENTARY EVIDENCES

- Extracts from the tender specification and drawings showing the requirements to incorporate the environmental friendly products that are certified and approved by local/international certification body.
- Certification details from approved local/international certification body such as the material certification standards and rating within validity period.
- Technical product information on the sustainable products.
- Calculation of products and extent of coverage.

REFERENCES

https://www.myhijau.my/directory/

WORK EXAMPLE 3-2

Determine if the environmentally friendly products selected are certified with approved local/international certification body. Check if the products used are meant for main building elements or functional spaces and can be considered high impact or low impact. Products that are meant for common areas and external works such as toilets, lobbies and landscaping areas are considered as medium impact or low impact.

Note: Certain products can have more environmentally friendly features than others. Other than recycled materials, they may have features like low VOC assembly or manufactured with resource efficient processes, durability etc that will render the products more environmental friendly than others. If the certified products selected are more environmental friendly and are given a better rating by the approved local/international certification body, a higher weightage can be considered in credit scoring.

Example of a proposed development with the following provisions:

a. Use of carpets for all office spaces. Product is not certified.

b. Use of panel boards as internal partitions for more than 50% of the office spaces and the product is rated by an approved certification body.

c. Precast concrete road kerbs. Product is rated by approved local certification body. – (Singular product)

d. Use of roof waterproofing coating. Product is rated by approved local certification body.

e. Use of wooden doors for all areas. Product is rated by approved local certification body.

Products and Extent of coverage		With approved certification	Extent of use category	Credits scored
a.	Carpets for all office spaces	No	N/A	0
b.	Panel boards as internal partition for more than 50% of office spaces	Yes	2	2
c.	Precast road kerbs	Yes	0.5	0.5
d.	Roof waterproofing	Yes	1	1
e.	Wooden doors for all areas	Yes	2	2

Table 3-2.3 : Detail calculation for credits scoring

Therefore, credits scored for 3-2 = 2 + 0.5 + 1 + 2 = 5.5 credits

NRB 3-3 GREENERY PROVISION

OBJECTIVES

Encourage greater use of greenery and restoration of existing trees to reduce heat island effect.

APPLICABILITY

Applicable to building developments with landscaping areas.

REQUIREMENTS

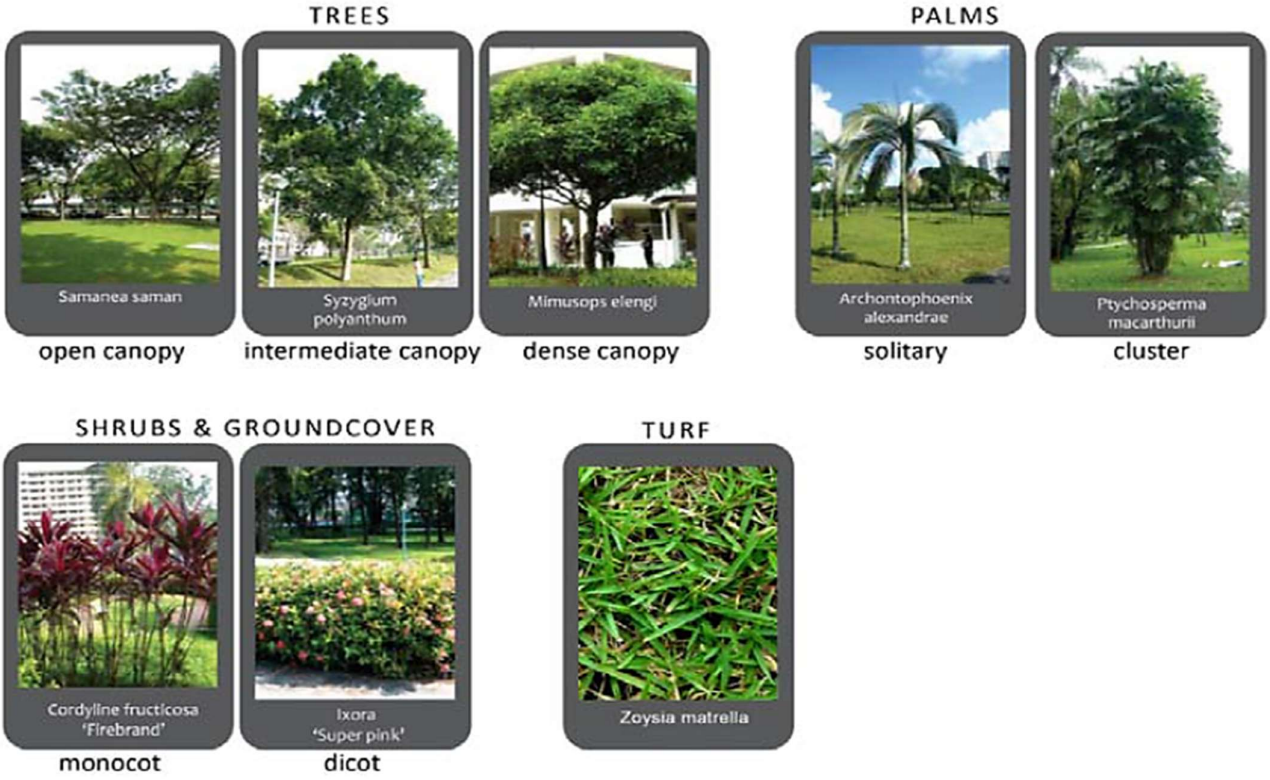
3-3(a)

Up to 6 credits can be scored for the provision of greenery within the developments including roof top/ sky garden and green roof.

Green Plot Ratio (GnPR) is calculated by considering the 3D volume covered by plants using the following Leaf Area Index (LAI)

Plant Group	Trees	Palms	Shrubs & Groundcover	Turf
LAI	Canopy: Open = 2.5 Intermediate = 3.0 Dense = 4.0	Solitary = 2.5 Cluster = 4.0	Monocot = 3.5 Dicot = 4.5	Turf = 2.0
Area	All = 60 m^2	Solitary = 20m^2 Cluster = 17m^2	Planted area	Planted area

Table 3-3.1: Leaf Area Index (LAI)



Green Plot Ratio (GnPR) = Total Leaf Area / Site Area

GnPR	Credits Allocation
1.0 to < 2.0	1
2.0 to < 3.0	2
3.0 to < 4.0	3
4.0 to < 5.0	4
5.0 to < 6.0	5
≥ 6.0	6

Table 3-3.2 : Credits Allocation according to GnPR

3-3 (b)

1 credit for restoration of trees on-site, conservation or relocation of existing trees on site. (at least 20%)

3-3 (c)

1 credit for the of compost bins to recycle organic waste to meet at least 30% of landscape fertilizer needs.

DOCUMENTARY EVIDENCES

For 3-3 (a)

- Plan layouts showing the site area as well as the greenery that is provided within the development (including a listing of the number of trees, palms, shrubs, turf and the respective sub category and LAI values).
- Calculation showing the extent of the greenery provision in the prescribed tabulated formats.
- The plant species sub categories and its LAI values obtained from the online website: http://florafaunaweb.nparks.gov.sg/

For 3-3 (d)

- Site layouts showing the existing and final locations (where applicable) and number of the trees to be restored or conserved or relocated.
- Documentary evidence showing the relocation or restoration activities.

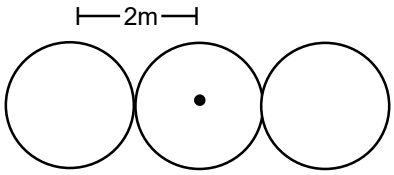
For 3-3 (e)

- Extracts of the tender specification showing the requirements to provide compost bin
- Product specifications.
- Method statement with details steps of composting process (if applicable).
- The calculation of the 30% of fertilizer replacement with the composting

EXCEPTIONS

Trees and Palms Spacing (Centre-to-Centre)

a. If the selected trees and palms are to be planted at ≤ 2m from trunk-to-trunk as illustrated below, the leaf area shall be calculated as the product of LAI value and planted area (in m^2).



Columnar Trees

b. For trees that have tight, columnar crowns, the canopy area of 12m2 is to be adopted for calculation of leaf area. These species include, but not limited to the following:

- Garciniacymosa forma pendula
- Garciniasubelliptica
- Polyalthialongifolia
- Carallia brachiate
- Gnetumgnemon

REFERENCES

The plant species, its sub categories and LAI values may be obtained from the online website: http://florafaunaweb.nparks.gov.sg

WORKED EXAMPLE 3-3(a)

1. Determine the number of trees, palms and the trees for shrubs and turfs and other greenery area.
2. The Leaf Area Index (LAI) of the individual plant species and its canopy area are predetermined design parameters applicable for all developments.
3. The plant species sub categories and its LAI values can be obtained from the online website: http://florafaunaweb.nparks.gov.sg/ (see example below) by searching the common / scientific names of the plants.
4. Compute the green areas as shown in the Table 3-3.3 below

Category	Sub Category	(A)	(B)	(C)	(A)x(B)x(C)
		LAI value	Canopy area	Qty/Planted Area	Leaf Area
Trees (no.)	Open Canopy	2.5	60 m^2	0 no.	0
	Intermediate Canopy	3.0	60 m^2	8 no.	1440
	Dense Canopy	4.0	60 m^2	12 no.	2880
Palms (no.)	Solitary	2.5	20 m^2	10 no.	500
	Cluster	4.0	17 m^2	10 no.	680
Shrubs (m^2)	Monocot	3.5	NA	0 m^2	0
	Dicot	4.5	NA	20 m^2	90
Turf(m^2)	Turf	2.0	NA	90 m^2	180
Vertical Greenery (m^2)	-	2.0	NA	10 m^2	20
				Total Leaf Area:	**5790**

Table 3-3.3: Calculation of the Green Plot Ratio

Note: Green roof landscaping would be calculated as per illustrated above

Assume site area is 4000 m^2
Green Plot Ratio (GnPR) = total leaf area / site area
= 5790 / 4000 = 1.45

Where GnPR = 1.0 to < 2.0

Therefore, credits scored for 3-3(a) = 1 credits

NRB 3-4 ENVIRONMENTAL MANAGEMENT PRACTICE

OBJECTIVES

Encourage the adoption of environmental friendly practices during construction and building operation.

APPLICABILITY

Generally applicable to building developments.

REQUIREMENTS

3-4(a)

1 credit 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 during the construction stage and include the following practices :

- To record the electrical consumption during the construction stage and hence, minimize energy usage by on-site utilities.
- Appointment of safety, health and environment officer.
- To prepare an Environmental Management Plan and conduct a complete Erosion Sedimentation Control Plan (ESCP).
- To prepare a Construction Waste Management Plan.
- To include commitment to recycle and/or salvage 50% of the volume of non-hazardous construction debris.
- Provide at least the minimum level of sanitation/safety facilities for construction workers.
- Use a low-flow flushing system and efficient fitting tap in the construction site office/ showroom.
- Provision of the Rainwater Harvesting System and the strategies of rainwater.
- Develop and implement and IAQ Management plan for Construction

3-4(b)

1 credit can be scored if main builder has good track records in completing internationally recognized accredited Green Buildings and adoption of sustainable, environmentally friendly and considerate practices during construction

3-4(c)

1 credit can be scored if the building quality is assessed and passed under the Quality Assessment System in Construction (QLASSIC) or Building Quality Assessment System (BuildQUAS).

3-4(d)

1 credit can be scored for IBS content scoring ≥ 50% based on CIDB IBS scoring scheme.
1 credits can be scored for IBS content scoring ≥ 70% based on CIDB IBS scoring scheme.

3-4(e)

Up to 1 credit if the developer, main builder, M&E consultant and architect are ISO 14000 certified. 0.25 credits are allocated for each firm that is certified.

3-4(f)

1 credit if the project team comprises Certified GreenRE Manager/ Green Mark Manager.

3-4(g)

1 credit can be scored for the provision of building users' guide with details of the environmentally friendly facilities and features within the building and their uses in achieving the intended environment performance during building operation. The minimum requirement of the Green Building User Guide as follows;

- Details of green building certification i.e rating tier, scorecard, certificate, validity etc.
- Summary of green building features (ideally with photographs and diagrams)
- Recommended practices for enhanced environmental performance of residence (refer to greenre green home user guide)
- Green fit out guidelines to details recommended minimum environmental standard to assist building users in making sustainable fit out decisions

3-4(h)

1 credit can be scored for provision of Sustainable Operation Management Guideline (SOMG) and at least one session of briefing to be conducted to the Building Management Team.

The minimum requirement of the Sustainable Operation Management Guideline as follow;

- Recommended performance standards to assist building users in making sustainable fit out decisions.
- Energy management and monitoring plan – common areas
- Water management and monitoring plan – common areas
- Waste management plan including details of recycling facilities – entire development
- Environmental policy and cleaning strategies / schedule – common areas

- Pandemic response plan (e.g increased cleaning requirements, closure of common facilities, signages etc)

3-4(i)

1 credit can be scored for the provision of facilities or recycling bins at each block of development for collection and storage of different recyclable waste such as paper, glass, plastic etc and establish the Waste Management Route and provide recycler details.

For commercial building, waste separation bins to be provided at each floor in a convenient location and suitable strategy should be available to manage the waste collection centrally.

DOCUMENTARY EVIDENCES

For 3-4(a)

- 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 during construction stage.
- Details of the environmental friendly programmes implemented.

For 3-4(b)

- Main builder's track records details in the adoption of sustainable, environmentally friendly and considerate practices during construction.

For 3-4(c)

- Extracts of the tender specification showing the requirement to adopt QLASSIC with the scoring > 70 %.

For 3-4(d)

- A copy of CIDB IBS Score form.
- Copy of structural drawings.

For 3-4(e)

- A certified true copy of the ISO 14000 certificate of developer, main contractor, M & E consultant and architect where applicable.

For 3-4(f)

- A certified true copy of the certificate of GreenRE Accredited Professional Green Mark Manager where applicable and a confirmation of their involvement performance in a project development.

For 3-4(g)

- 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 building operation.

For 3-4(h)

- A copy of Sustainable Operation Management Guideline (SOMG) containing the details of recommended minimum environmental practices for the building management organization

For 3-4(i)

- Plan layout showing the location of the recycling bins for collection and storage of different recyclable waste.
- Product catalogue showing the size of recycle bins.

REFERENCES

www.cidb.gov.my/index.php/my/bidang-utama/teknologi-dan-inovasi/ibs

https://www.iso.org/iso-14001-environmental-management.html

NRB 3-5 GREEN TRANSPORT

OBJECTIVES

Promote environmental friendly transport options and facilities to reduce pollution from individual car use.

APPLICABILITY

Generally applicable to building developments.

REQUIREMENTS

3-5(a)

1 credit can be scored for design that provides good access (<800m walking distance) to public transport networks such as MRT/LRT stations or bus stops.

3-5(b)

1 credit can be scored for provision of covered walkway to facilitate connectivity and the use of public transport.

3-5(c)

1 credit can be scored for provision of infrastructure for electric charging stations to at least 10% of available parking spaces.

3-5(d)

1 credit can be scored for provision of electric vehicle charging stations and priority parking lots within the development. Provision of minimum of isolator with 7kWp charger

Extent of coverage:

Minimum 1 number priority parking bays for every 100 carpark lots.
EV chargers – 1 for every 200 parking bays. (Cap at 3)

3-5(e)

Up to 1 credit can be scored for the provision of covered/sheltered bicycles parking lots with rack / locking bar.

Extent of Coverage:

Bicycles parking lot: Minimum 10 number and maximum 50 numbers of bicycle parking lot.

Shower Facilities: Minimum 1 number for every 100 regular occupant and additional 1 for every 150 occupants. (Cap at 7)

DOCUMENTARY EVIDENCES

For 3-5(a)

- Site layout plan in the context of the surrounding area showing the location of the development site and walking path to the location of the MRT/LRT stations and bus stops not more than 800m.
- Proposed bus-stop details drawing.

For 3-5(b)

- Site layout plan showing the connection of covered walkway from the development to the MRT/LRT stations or bus stops.
- Extracts of the tender specification showing the requirement to provide covered walkway.

For 3-5(c)

- Extracts of the tender specification showing the requirement to provide electric charging stations.
- Plan layout showing the location of the electric charging station in the development.
- Calculation showing infrastructure for electric charging stations is at least 10% of available parking spaces.
- Schematic showing the infrastructure of the EV charging station

For 3-5(d)

- Extracts of the tender specification showing the requirement to provide hybrid/electric vehicle refuelling/recharge stations and priority carparking bays.
- Plan layout showing the location of the electric vehicle charging station in the development.
- Product technical information.

For 3-5(e)

- Extracts of the tender specification showing the requirement to provide covered/sheltered bicycles parking lots for the development and the total quantity of bicycles lots provided.
- Plan layout showing the location of the covered/sheltered bicycle parking lots and rack/locking bar

NRB 3-6 STORMWATER MANAGEMENT

OBJECTIVES

Encourage the treatment of stormwater runoff through provision of infiltration or design features before discharge to public drains.

APPLICABILITY

Generally applicable to building developments.

REQUIREMENTS

Up to 3 credits can be scored for the provision of infiltration features or design features for new development and redevelopment whereby the post development stormwater peak discharge rate and quantity is lower than the pre-development peak discharge rate and quantity.

Note: The treatment of stormwater runoff shall be through provision of infiltration or design features as recommended in Urban Storm Water Management (MSMA).

DOCUMENTARY EVIDENCES

- Urban Storm Water Management (MSMA) report showing reduction of post development stormwater peak discharge rate and quantity from exceeding pre-development peak discharge rate and quantity.
- Drainage plan, schematic plan, location plan and details of water features such as the specification of filtration layer, transition layer and drainage layer, sub-soil drainage system, overflow arrangement, plant list etc.

REFERENCES

MSMA – Urban Storm Water Management

NRB 3-7 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.

REQUIREMENTS

3-7(a)

1 credit 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.

3-7(b)

1 credit can be scored for the use of refrigerant leak detection system at critical areas of plant rooms containing chillers and other equipment with refrigerants.

DOCUMENTARY EVIDENCES

For 3-7(a)

- Extracts of the tender specification showing the requirement for all refrigerants to have ODP of zero OR GWP of less than 100.
- Technical product information highlighted refrigerants to have ODP of zero OR GWP of less than 100.

For 3-7(b)

- Extracts of the tender specification showing the requirement to incorporate a refrigerant leak detection system.
- Schematic drawing showing the location of the refrigerant leak detection system at critical areas of plant room containing chillers and others equipment with refrigerants.
- Product technical information of the system.

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 Indoor Air Quality (IAQ) Management

NRB 4-5 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.

REQUIREMENTS

4-1(a)

1 credit 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 dry-bulb temperature between 23°C to 26°C
Relatively Humidity between 50% - 70%

4-1 (b)

Additional 1 credit will be awarded for provision of room temperature and humidity display.

DOCUMENTARY EVIDENCES

For 4-1 (a)

- Extracts of the tender specification showing the requirement to design the air-conditioning systems which would provide consistent indoor conditions for thermal comfort.
- Design brief of the air-conditioning system highlighted room temperature and humidity requirement.

For 4-1 (b)

- Extracts of the tender specification showing the requirements to provide the room temperature and humidity display.
- Plan layout showing the location of the room temperature and humidity display.

NRB 4-2 NOISE LEVEL

OBJECTIVES

Recognise buildings that are designed to consider the potential noise levels within the dwelling units are maintained at an appropriate level. All building partitions to shall be in accordance with required STC ratings.

APPLICABILITY

Generally applicable to building developments.

BASELINE STANDARD

ASTEM E413 or equivalent

REQUIREMENTS

1 credit can be scored if the building is designed to achieve ambient internal noise level as specified:

- 55dB (6am – 10pm) LAeq
- 45dB (10pm – 6 am) LAeq

This can be achieved by adhering to the following STC values for non-residential building partitions

Description	Sound Transmission Class (STC)
Separation between functional spaces within dwelling units and in-between adjacent dwelling units.	40 - 50
Spaces between mechanical and equipment spaces and occupied spaces	50 - 60

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. Credits 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 partitions meeting the required STC ratings as per table below:

Location	STC rating of partitions
Between General Office Space	40 - 50
Hotel Rooms, Classrooms, Lecture Theaters, Meeting Rooms, Conference Rooms and spaces where confidential speech is required	50 - 60
Between Mechanical / Equipment spaces and occupied spaces	50 - 60

- Architectural & structural plan layout, elevation and sectional plans showing types of wall system used, dimensions and size of all building and structural elements with STC ratings.

OR

- A report of detail analysis and recommendations from acoustic consultant (if applicable).

NRB 4-3 INDOOR AIR POLLUTANTS

OBJECTIVES

Minimise airborne contaminants, mainly from inside sources to promote a healthy indoor environment.

APPLICABILITY

Generally applicable to building developments.

REQUIREMENTS

4-3(a)

1 credit can be scored for the use of low volatile organic compounds (VOC) paints certified by approved local/ international certification body for at least 90% of the internal wall areas.

4-3(b)

1 credit can be scored for the use of environmentally friendly adhesives certified by approved local/ international certification body for at least 90% of the applicable building works or areas.

DOCUMENTARY EVIDENCES

For 4-3(a)

- Extracts of the tender specification showing the requirement to use low VOC paints that are certified by approved local/ international certification body or equivalent.
- Product catalogue.
- Product certificate with validity expiry.

For 4-3(b)

- Extracts of the tender specification showing the requirement to use adhesive with low emission formaldehyde and are certified by approved local/ international certification body.

- Product catalogue.
- Product certificate with validity expiry

NRB 4-4 INDOOR AIR QUALITY (IAQ) MANAGEMENT

OBJECTIVES

Ensure building ventilation systems are designed and installed to provide acceptable IAQ under normal operating conditions.

APPLICABILITY

Applicable to air-conditioned buildings

REQUIREMENTS

4-4(a)

1 credit can be scored for the provision of filtration media and differential pressure monitoring equipment in Air Handling Unit (AHU) with MERV 8

4-4(b)

1 credit can be scored for implementing effective IAQ management plan to ensure that building ventilation systems are clean and free from residuals left over from construction activities.

DOCUMENTARY EVIDENCES

For 4-4(a)

- Extracts of the tender specification showing the requirements of the filter media and pressure monitoring equipment.
- Technical product information which should include the minimum efficiency report value (MERV 8-12) parameters of the filter.
- Technical product information of the differential pressure monitoring equipment

For 4-4(b)

- Extracts of the tender specification showing the requirement for builder to provide and implement effective IAQ management and the details of the management plan.

NRB 4-5 HIGH FREQUENCY BALLASTS

OBJECTIVES

Encourage the use of high frequency ballasts in fluorescent luminaries and LED low flicker LED drivers to improve the workplace lighting quality.

APPLICABILITY

Generally applicable to workplace such as offices, classrooms and training rooms and the like.

REQUIREMENTS

a. 1 credit 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.

Or

b. 1 credit can be scored for the use of LED driver with output frequency < 200Hz and < 30% flicker for LED lighting in at least 90% of the applicable areas served by LED lighting.

DOCUMENTARY EVIDENCES

- Extracts of the tender specification showing the requirement to have high frequency ballasts or LED driver.
- A summary sheet listing all fluorescent and LED luminaries used for the developments.
- Electrical lighting layout indicating all the fittings with high frequency ballasts or LED lighting.
- Product catalogue specifying high frequency ballast for fluorescent luminaries. (if applicable)
- Product catalogue specifying the LED driver with output frequency <200 Hz and <30% flicker for LED lighting. (if applicable)

  Calculation showing at least 90% of the applicable areas that are served by high frequency ballast or LED lighting.

Other Green Requirements

Part 5 – Other Green Features

NRB 5-1 GREEN FEATURES & INNOVATIONS

OBJECTIVES

Encourage the use of green features that are innovative and have positive environment impact on water efficiency, environment protection and indoor environment quality of the buildings.

APPLICABILITY

Generally applicable to all building development.

REQUIREMENTS

Up to 7 credits are awarded for the use of the following green features depending on their potential environmental benefits or reduced environmental impacts.

Water efficiency

i. Use of self-cleaning façade system
   - 2 credits for more than 75% of the external walls.
   - 1 credit for more than 50% of the external walls.
   - 0.5 credit for at least 25% of the external walls.

ii. Use of grey water recycling system
   - 2 credits for all blocks of the development.
   - 1 credit for at least one block of the development.

iii. Recycling of AHU condensate
   - 1 credit for more than 75% of the AHU condensate
   - 0.5 credit for at least of 50% of the AHU condensate

iv. 0.5 credit for the use of membrane filtration system to recycle water during construction.

v. 0.5 credit for the use of non-chemical water treatment for cooling tower.

Environmental Protection

i. Provision of green roof and roof top garden
   - 1 credit for more than 50% of the roof areas
   - 0.5 credit or at least 25% of the roof areas

ii. Provision of vertical greening
   - 1 credit for more than 50% of the external wall areas
   - 0.5 credit for at least 25% of the external wall areas

iii. 1 credit for the provision of double refuse chutes for separating recyclable from non-recyclable waste.

iv. 0.5 credit for the use of non-chemical treatment system such as termite baiting system, anti-termite mesh.

v. Up to 1 credit 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 credit for each recycled product used. Credits can only be scored if the extent of implementation covers at least 50% of all concrete structural elements of the superstructures (by volume).

Indoor Air Quality

i. Use of Titanium Dioxide solutions to remove odour in toilets:
   - 1 credit for more than 50% of all toilets
   - 0.5 credit for at least 25% of all toilets

ii. 1 credit for the use of pneumatic waste collection system.

iii. 0.5 credit for the use of Ultraviolet light-C band (UV) emitters in all air handing units (AHUs) to improve indoor air quality.

Others

i. Provision of landscape drainage and infiltration trenches:
   - 1 credit for at least 25% of the green areas
   - 0.5 credit for less than 25% of the green areas

ii. Provision of system to recycle surface runoff from the vertical green wall and sky garden:
   - 1 credit for at least 25% of green areas
   - 0.5 credit for less than 25% green areas

iii. 0.5 credit for the use of siphonic rainwater discharge system at roof.

iv. 0.5 credit for the provision of eco-pond.

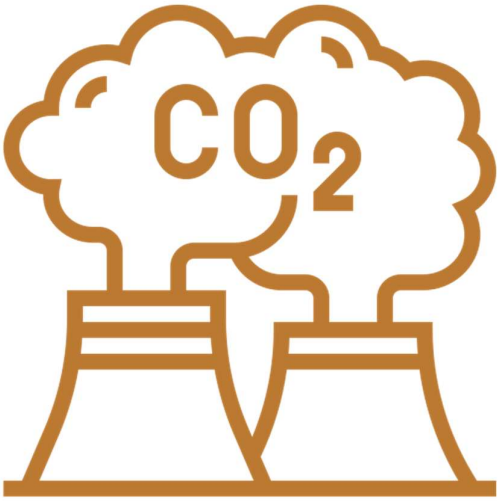
v. 0.5 credit for the provision of carpark guidance system.

Note: 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 GreenRE 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 drawing and supporting documents) of the green features.
- Quantified evidences on the potential environmental benefits that the features can bring to the development.

Other Green Requirements



Part 6 – Carbon Emission of Development

NRB 6-1 CARBON EMISSION OF DEVELOPMENT

OBJECTIVES

To calculate the carbon emission resulted from the associated energy used during construction and operational phase of a development.

APPLICABILITY

Generally applicable to all building development.

REQUIREMENTS

a. Recognise the carbon emission based on operational carbon footprint computation of the building comprising energy [B6] and water consumption [B7].

b. Calculation of product stage embodied carbon based on following building materials [A1-A3]:

- concrete
- steel
- bricks
- cement
- others: aluminium, glass, timber

c. Calculation of construction stage embodied carbon [A4-A5]

d. Reduction from reference embodied carbon (for Ready Mix Concrete, Cement, Steel Reinforcement, Bricks, Others: aluminium, glass, timber) [A1-A5]

EC (tCO_2eq/t)				
Ready Mixed Concrete	Cement	Steel Reinforcement	Bricks	Others
0.219	1.0857	2.41	0.279	Aluminums 2.498 Glass 1.44 Timber 0.266

DOCUMENTARY EVIDENCES

For 6-1 (a)

- Detail calculation for the estimated energy load for each component in the building e.g.: lighting, air-conditioning system, pump, receptacle load.
- Details calculation for estimated water consumption of the building e.g.: water fittings, landscape, water features.
- Technical product information on the energy efficient features and water efficient features used.
- Summary tabulation of estimated total energy savings and total water savings of the development for the year.
- Carbon operational emission calculation.

For 6-1 (b)

- Embodied carbon factor reference for material documents (CIDB-Embodied Carbon Inventory Data for Construction Materials, ICE (Inventory of Carbon & Energy) or another suitable local database.
- Bill of Quantity showing the amount/quantity of each material used for the construction
- Product stage embodied carbon calculation [A1-A3]

For 6-1(c)

- Supplier/manufacturer details - plants or factory location (for each material origin)
- Embodied carbon factor reference for transportation and waste factor (CIDB-Embodied Carbon Inventory Data for Construction Materials)
- Bill of Quantity showing the amount/quantity of each material used for the construction
- Construction stage embodied carbon calculation [A4-A5]

For 6-1 (d)

- Product declaration showing the embodied carbon factor for each material
- Reference carbon factor reference for construction material (CIDB Technical Report No 207-GHG Emission for Construction Industry in Malaysia)
- Calculation showing the reduction of carbon by using reference embodied carbon factor (for Ready Mix Concrete, Cement, Steel Reinforcement, Bricks, Others: aluminium, glass, timber) in compare to actual embodied carbon factor declared by supplier/manufacturer.

WORKED EXAMPLE 6-1

6-1 (a) Operational Carbon Calculation

Table 6-1.1: Energy Consumption

Type of usage	Design	Baseline
	(kWh/yr)	(kWh/yr)
Lighting	819,498	1,151,575
Air-Conditioning	860,589	1,406,899
M/V System	25,550	25,550
Total Energy Usage	1,705,637	2,584,024

Table 6-1.2: Water Consumption

(Please refer GreenRE Water Calculator)

Type of fixtures	Design	Baseline
	(m^3/yr)	(m^3/yr)
Flow Fixtures	2,402	6,899
Flush Fixtures	5,366	5,161
Total Water Usage	7,768	12,060

Table 6-1.3: Operational Carbon Footprint

Type of usage	Design	Baseline
	$kgCO_2e/yr$	$kgCO_2e/yr$
Energy	1,226,619	1,860,497
Water	155,344	241,192
Total Annual Carbon Footprint	1,381,963	2,101,689

Energy CO2 Emission Reduction (ktCO2e/annum, based on electricity energy reduction only @ 1kWh =

- 0.639 kg CO2- Peninsular
- 0.512 kg CO2- Sarawak
- 0.512 kg CO2- Sabah

Water CO2 Emission Reduction = 0.419 kg CO2e/m3

Percentage savings = (2,101,689 - 1,381,963) / 2,101,689 = 34.25%

Credits scored for 6-1 (a) = 1 credit

6-1 (b) Product Stage Embodied Carbon Calculation (A1-A3)

No	Material	Description	Embodied Carbon Factor ($kgCO_2e/kg$)	Quantity		Quantity (kg)	Total Embodied Carbon (tCO_2e)
				Value	Unit		
1	Concrete (G30)	Slab	0.13	5,047	m^3	12,112,800	1,574.66
2	Glass	10mm of Glass (Single Glass excluding Frame)	1.44	12,415	kg	12,415	17.88
3	Steel Reinforcement	Rebar	0.73	247,945	kg	247,945	181.00
4	Brick	Red brick – internal wall	0.21	9,574	m^3	16,850,240	3,538.55
5	Cement	Portland cement	0.91	6,217	m^3	9,748,256	8,870.91
6	Aluminium	Window & door frame	0.93	3,972	kg	3,972	3.69
	Total						**14,186.69**

Table 6-1.4: Tabulation of total embodied carbon of material for product stage (A1-A3)
Source: CIDB- Embodied Carbon Inventory Data For Construction Materials

Credits scored for 6-1 (b) = 1 credit

6-1 (c) Construction Stage Embodied Carbon Calculation (A4 Transport + A5 Material Waste)

No	Mode	TEFmode ($gCO_2e/kg/km$)	Description
1	Road transport emissions	0.1065	For HGV (all diesel)
2	Sea transport emissions	0.01614	For cargo ship, container ship
3	Freight flight emission	0.59943	International
4	Rail flight emissions	0.02556	Freight train

Table 6-1.5: Transport emissions factors for different modes of transport
Source: CIDB- Embodied Carbon Inventory Data For Construction Materials

No	Transport Detail	Emissions Coefficient Factors (ECF) ($kgCO_2e/kg$)
1	Transport for locally manufactured with average distance travelled by road 50km	0.005
2	Transport for national with average distance travelled by road 300km	0.0032

Table 6-1.6: Transport emissions factors for different modes of transport
Source: CIDB- Embodied Carbon Inventory Data For Construction Materials

A4: Quantity × TEFmode x ECF

where:

- Quantity of material in kg
- TEFmode based on mode of transport as in Table 6-1.5
- ECF based on distance for material transported to site (locally sourced or imported material) as in Table 6-1.6

No	Type of Waste	Waste Rate	Waste Factor (tCOe/t)
1	Concrete in situ	5%	0.053
2	Precast concrete	1%	0.01

3	Steel reinforcement	5%	0.053
4	Brick	20%	0.25
5	Cement	5%	0.053
6	Glass	5%	0.053
7	Aluminium	1%	0.01

Table 6-1.7: Waste rate (WR) and waste factor (WF)
Source: istructure.org

A5 : WF × (A13 + A4 + C2 + C34)

where:

- WF is the waste factor, based on expected % waste rate (Table 6-1.7)
- A13 is A1–A3 emissions for production of the wasted material, (6-1 (b))
- A4 for transporting the wasted material to site (Table 6-1.6)
- C2 for transporting the wasted material away from site (in the absence of better data, assume 50km by road to the nearest reuse/recycling location = 0.005kgCO_2e/kg)
- C34 is C3–C4 emissions for processing and disposal of the waste material (in the absence of better data, assume 1.77kgCO_2e/kg for timber products and 0.013kgCO_2e/kg for all other materials.

Concrete (A4 + A5)

A4: Quantity (kg) x TEFmode x ECF
= 12,112,800 x 0.1065 x 0.005
= 6,450 kgCO_2e

A5: WF × (A13 + A4 + C2 + C34)
Step 1: A13 = 1,574,664 kgCO2e
A4 = 6,450 kgCO_2e
C2 = 12,112,800 x 0.005 = 60, 564 kgCO2e
C34 = 12,112,800 x 0.013 = 157,467 kgCO2e

Step 2: Sum all components
(A13 + A4 + C2 + C34)

1,574,664 + 6,450 + 60, 564 + 157,467
= 1,799,145 kgCO_2e

Step 3: Apply waste factor
A5 = 0.053 x 1,799,145 = 95,354.68 kg CO_2e

Concrete (A4 + A5) = 6,450 + 95,354.68
= 101,804.68 kgCO_2e

Glass (A4 + A5)
A4: Quantity (kg) x TEFmode x ECF
= 12,415 x 0.1065 x 0.005
= 6.61 kgCO_2e

A5: WF × (A13 + A4 + C2 + C34)
Step 1: A13 = 17,877.60 kgCO2e
A4 = 6.61 kgCO_2e
C2 = 12,415 x 0.005 = 62.08 kgCO2e
C34 = 12,415 x 0.013 = 161.39 kgCO2e

Step 2: Sum all components
(A13 + A4 + C2 + C34)

17,877.60 + 6.61 + 62.08 + 161.39
= 18,107.68 kgCO_2e

Step 3: Apply waste factor
A5 = 0.053 x 18,107.68 = 959.71 kg CO_2e

Glass (A4 + A5) = 6.61 + 959.71
= 996.32 kgCO_2e

Steel Reinforcement (A4 + A5)
A4: Quantity (kg) x TEFmode x ECF
= 247,945 x 0.1065 x 0.005
= 132.03 kgCO_2e

A5: WF × (A13 + A4 + C2 + C34)
Step 1: A13 = 180,999.85 kgCO2e
A4 = 132.03 kgCO_2e
C2 = 247,945 x 0.005 = 1,239.73 kgCO_2e
C34 = 247,945 x 0.013 = 3,223.28 kgCO_2e

Step 2: Sum all components
(A13 + A4 + C2 + C34)

180,999.85 + 132.03 + 1,239.73 + 3,223.28
= 185,594.89 $kgCO_2e$

Step 3: Apply waste factor
A5 = 0.053 x 185,594.89
= 9,836.53 $kgCO_2e$

Steel Reinforcement (A4 + A5) = 132.03 + 9,836.53
= 9,968.56 $kgCO_2e$

Brick (A4 + A5)
A4: Quantity (kg) x TEFmode x ECF
=16,850,240 x 0.1065 x 0.005
= 8,972.75 $kgCO_2e$

A5: WF × (A13 + A4 + C2 + C34)
Step 1: A13 = 3,538,550.40$kgCO_2e$
A4 = 8,972.75 $kgCO_2e$
C2 = 16,850,240 x 0.005 = 84,251.2 $kgCO_2e$
C34 = 16,850,240 x 0.013 = 219,053.31 $kgCO_2e$

Step 2: Sum all components
(A13 + A4 + C2 + C34)

3,538,550.40 + 8,972.75 + 84,251.2 + 219,053.31
= 3,850,827.66 $kgCO_2e$

Step 3: Apply waste factor
A5 = 0.25 x 3,850,827.66
= 962,706,915 $kgCO_2e$

Brick (A4 + A5) = 8,972.75 + 962,706,915
= 971,679.67 $kgCO_2e$

Cement (A4 + A5)
A4: Quantity (kg) x TEFmode x ECF
= 9,748,256 x 0.1065 x 0.005
= 5,190.95 $kgCO_2e$

A5: WF × (A13 + A4 + C2 + C34)
Step 1: A13 = 8,870,912.96 $kgCO_2e$
A4 = 9,748,256 $kgCO_2e$
C2 = 9,748,256 x 0.005 = 48,741.28 $kgCO_2e$
C34 = 9,748,256 x 0.013 = 126,727.33 $kgCO_2e$

Step 2: Sum all components
(A13 + A4 + C2 + C34)

8,870,912.96 + 9,748,256 + 48,741.28 + 126,727.33
= 18,794,637.57 $kgCO_2e$

Step 3: Apply waste factor
A5 = 0.053 x 18,794,637.57
= 996,115.79 $kgCO_2e$

Cement (A4 + A5) = 5,190.95 + 996,115.79
= 1,001,306.74 $kgCO_2e$

Aluminium (A4 + A5)
A4: Quantity (kg) x TEFmode x ECF
= 3,972 x 0.1065 x 0.005
= 2.16 $kgCO_2e$

A5: WF × (A13 + A4 + C2 + C34)
Step 1: A13 = 3,693.96$kgCO_2e$
A4 = 2.16 $kgCO_2e$
C2 = 2.16 x 0.005 = 0.108 $kgCO_2e$
C34 = 2.16 x 0.013 = 0.028 $kgCO_2e$

Step 2: Sum all components
(A13 + A4 + C2 + C34)

3,693.96+ 2.16 + 0.108 + 0.028
= 3,696.26 $kgCO_2e$

Step 3: Apply waste factor
A5 = 0.01 x 3,696.26
= 36.96 $kgCO_2e$

Aluminium (A4 + A5) = 2.16 + 36.96
= 39.12 $kgCO_2e$

No	Material	Embodied Carbon Factor ($kgCO_2e$/ kg)	Quantity (kg)	Material Embodied Carbon *A1-A3* ($kgCO_2e$)	Transport Embodied Carbon *A4* ($kgCO_2e$)	Waste Embodied Carbon *A5* ($kgCO_2e$)	Total Embodied Carbon ($kgCO_2e$)	Total Embodied Carbon (tCO_2e)
1	Concrete (G30)	0.13	12,112,800	1,574,664	6,450	95,354.68	1,676,468.68	1,676.47
2	Glass	1.44	12,415	17,877.60	6.61	959.71	18,843.92	18.84
3	Steel Reinforcement	0.73	247,945	180,999.85	132.03	9,836.53	190,968.41	190.97
4	Brick	0.21	16,850,240	3,538,550.40	8,972.75	962,706,915	966,254,438.15	966,254.44
5	Cement	0.91	9,748,256	8,870,912.96	5,190.95	996,115.79	10,386,123.75	10,386.12
6	Aluminium	0.93	3,972	3,693.96	2.16	36.96	3,733.08	3.73
	Total							**978,530.57**

Table 6-1.8: Calculation tabulation of materials (A1-A3 + A4 + A5)

Credits scored for 6-1 (c) = 1 credit

For 6-1 (d) Reduction from reference embodied carbon [A1-A5]

Embodied Carbon of Material (Baseline)

EC (tCO_2eq/t)				
Ready Mixed Concrete	Cement	Steel Reinforcement	Bricks	Others
0.219	1.0857	2.41	0.279	Aluminium 2.498 Glass 1.44 Timber 0.266

Table 6-1.9: Embodied carbon factor for each material (baseline)
Source: CIDB Technical Report No 207-GHG Emission for Construction Industry in Malaysia

Sample Bill of Quantities

No	Description of Work/Material	Quantity		Quantity (kg)	RM
		Value	Unit		
1	Concrete (G30, in structural elements, 30% GGBS)	5,047	m^3	12,112,800	xxx
2	Glass (6mm, green tinted low-e glass)	12,415	kg	12,415	xxx
3	Steel Reinforcement (high yield bars, 16mm, >90% scrap content)	247,945	kg	247,945	xxx
4	Brick (fly-ash, hollow bricks)	9,574	m^3	16,850,240	xxx
5	Cement (Green cement – fly ash content)	6,217	m^3	9,748,256	xxx
6	Aluminium (secondary aluminium with >50% recycled content)	3,972	kg	3,972	xxx

Table 6-1.10: Sample of Bill of Quantity

No	Material	Baseline Embodied Carbon Factor ($kgCO_2e/kg$)	Reduced Embodied Carbon Factor ($kgCO_2e/kg$)	Quantity (kg)	Baseline Total Embodied Carbon A1-A3 ($kgCO_2e$)	Reduced Total Embodied Carbon ($kgCO_2e$)
1	Concrete (G30)	0.219	0.13	12,112,800	2,652,703.20	1,574,664
2	Glass	1.44	1.44	12,415	17,877.60	17,877.6
3	Steel Reinforcement	2.41	0.73	247,945	597,547.45	180,999.85
4	Brick	0.279	0.21	16,850,240	4,701,216.96	3,538,550.40
5	Cement	1.0857	0.91	9,748,256	10,583,681.54	8,870,912.96
6	Aluminium	2.498	0.93	3,972	9,922.056	3,693.96
	Total					**14,186.69**

Table 6-1.10: Calculation of total embodied carbon in compare to baseline specified

Material	Baseline Embodied Carbon				Reduced Embodied Carbon			
	Material *A1-A3* ($kgCO_2e$)	Transport *A4* ($kgCO_2e$)	Waste *A5* ($kgCO_2e$)	Total ($kgCO_2e$)	Material *A1-A3* ($kgCO_2e$)	Transport *A4* ($kgCO_2e$)	Waste *A5* ($kgCO_2e$)	Total ($kgCO_2e$)
Concrete (G30)	2,652,703.20	6,450.00	152,490.73	2,811,644.00	1,574,664.00	6,450.00	95,354.66	1,676,468.72
Glass	17,877.60	6.61	959.71	18,843.92	17,877.60	6.61	959.71	18,843.92
Steel Reinforcement	597,547.45	132.03	31,913.55	629,593.03	180,999.85	132.03	9,836.53	190,968.41
Brick	4,177,174.50	8,972.75	1,122,362.89	5,308,510.14	3,538,550.40	8,972.75	962,706.87	4,510,230.02
Cement	8,870,912.96	5,190.95	479,733.34	9,355,837.25	8,870,912.96	5,190.95	479,733.34	9,355,837.25
Aluminium	9,922.06	2.12	99.96	10,024.13	3,693.96	2.12	37.68	3,733.75
Total				**18,134,452.47**				**15,756,082.07**

**A4 - Assuming both quantity (kg) is the same for both cases*

(Baseline – Reduced)/Baseline x 100%
= (18,134,452.47 - 15,756,082.07) / 18,134,452.47
= 13.2%

GreenRE Requirement

>10% 0.5 credit

>30% 1 credit

Credits scored for 6-1 (d) = 0.5 credit

8. Documentation Requirements

All documents submitted for the REHDA GreenRE Assessment should be duly verified and signed by the Qualified Person (QP) and appropriate practitioners where applicable.

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

GreenRE Criteria	Required Signatories
Part 1 – Energy Efficiency	
NRB 1-1 Thermal Performance of Building Envelope- OTTV	PA
NRB 1-2 Air-Conditioning System	PE
NRB 1-3 Building Envelope – Design/ Thermal Parameters	PA
NRB 1-4 Natural Ventilation (exclude carparks)	PA
NRB 1-5 Daylighting	PA
NRB 1-6 Artificial Lighting	PE
NRB 1-7 Ventilation in Carparks	PE
NRB 1-8 Ventilation in Common Areas	PE
NRB 1-9 Lifts and Escalators	PE
NRB 1-10 Energy Efficient Practices & Features • Heat Recovery Devices • Motion Sensors/ Photo Sensors • Others	 PE PE S
NRB 1-11 Renewable Energy	S
Part 2 – Water Efficiency	
NRB 2-1 Water Efficient Fittings	PA
NRB 2-2 Water Usage and Leak Detection	PE
NRB 2-3 Irrigation System	PE
NRB 2-4 Water Consumption of Cooling Tower	PE
Part 3 – Environmental Protection	
NRB 3-1 Sustainable Construction	PE
NRB 3-2 Sustainable Products	PA
NRB 3-3 Greenery Provision	PE
NRB 3-4 Environmental Management Practice	PE
NRB 3-5 Green Transport	PA
NRB 3-6 Stormwater Management	PE
NRB 3-7 Refrigerants	PA
Part 4 – Indoor Environmental Quality	
NRB 4-1 Thermal Comfort	PE
NRB 4-2 Noise Level	S
NRB 4-3 Indoor Air Pollutants	PA
NRB 4-4 Indoor Air Quality (IAQ) Management	PA
NRB 4-5 High Frequency Ballasts	PE
Part 5 – Other Green Features	
NRB 5-1 Green Features & Innovations	S
Part 6 – Carbon Emission of Development	
NRB 6-1 Carbon Emission of Development	S

Table: Summary Checklist and the Corresponding Signatories for GreenRE Non-Residential Criteria

1. PA refers to Professional Architect
2. PE refers to Professional Engineer, Landscape Architect, Planner and Quantity Surveyor (QS)
3. S refers to Specialist which includes Facilitator, Project Manager, Facilities Manager, Energy or Sustainable consultant and Commissioning Specialist