DESIGN REFERENCE GUIDE

Residential Building & Landed Home

Version 3.1

15th March 2018

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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.

GreenRE Sdn Bhd
Wisma Rehda,
No.2C, Jalan SS5/6D,
47301 Petaling Jaya,
Selangor, Malaysia

2. Introduction

The GreenRE assessment scheme was established in 2013 and is a recognized 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 Residential Buildings and Landed Homes (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 building, the building regulations shall take precedence.

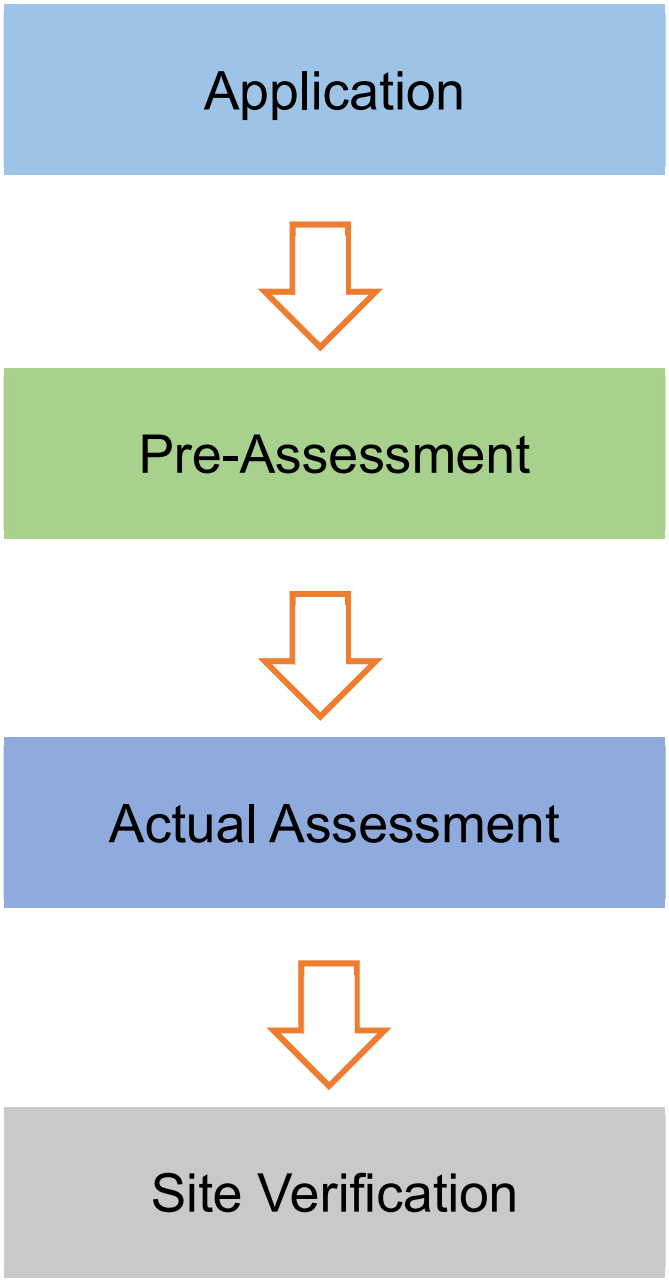
As part of this guideline, the following definitions apply:
Landed home – Residential bungalows, villas, terrace houses etc.
Multi-storey Residential – Residential flats or condominiums.

3. Revision Log

Revision	Description	Date Effective
1.1	Issued for pilot	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

4. GreenRE Assessment Stages

The GreenRE Residential Building & Landed Home certification process is as follows:



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

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 maximise opportunities at the earliest stages of the project.

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 infrastructure 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 to be conducted upon project completion.

A Final Certificate will be issued upon completion of this stage.

5. GreenRE Residential Building Rating System

Overview:
The GreenRE rating system is divided into six (6) sections as follows:

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

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

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

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

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

(f) Part 6- Carbon Emission of Development: This category focuses on the use of carbon calculator to calculate the carbon emission of the development.

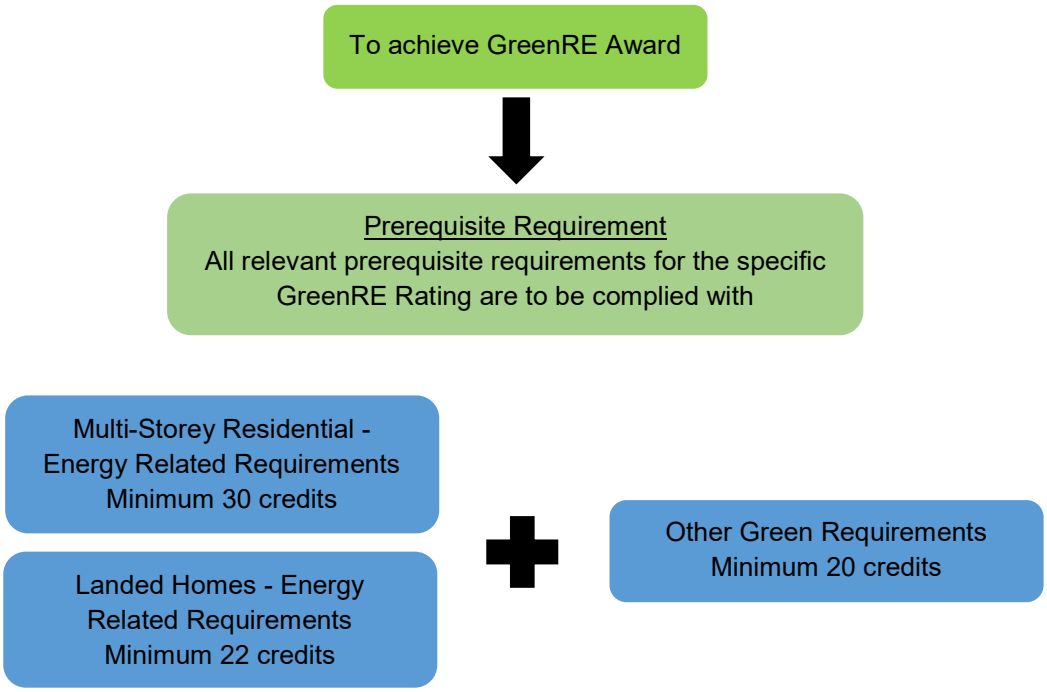
These environment impact categories are broadly classified under two main groups namely (I) Energy Related Requirements and (II) Other Green Requirements.

Energy Related Requirements consist of Part 1- Energy Efficiency where credits are allocated for the various energy efficient designs, practices and features used. For multi-storey residential buildings a minimum of 30 credits must be obtained from this group to be eligible for certification. For landed homes, a minimum of 22 credits must be obtained from this group to be eligible for certification. The number of credits achievable for this group is capped at 50 credits (exclude 15 bonus credits that are obtainable under RES 1-10 – Renewable Energy).

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 15 bonus credits that are obtainable under Energy Related Requirements if a project uses renewable energy sources.

Framework:



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

Part 1 – Energy Efficiency
RES 1-1 Thermal Performance of Building Envelope -RETV
RES 1-2 Naturally Ventilated Design and Air-Conditioning System
RES 1-3 Daylighting
RES 1-4 Artificial Lighting
RES 1-5 Ventilation in Carparks
RES 1-6 Domestic Hot Water System
RES 1-7 Lifts
RES 1-8 Cool Hardscaped Areas
RES 1-9 Energy Efficient Features
RES 1-10 Renewable Energy

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

Part 2 - Water Efficiency
RES 2-1 Water Efficient Fittings
RES 2-2 Water Usage Monitoring
RES 2-3 Irrigation System and Landscaping

Part 3 – Environmental Protection
RES 3-1 Sustainable Construction
RES 3-2 Sustainable Products
RES 3-3 Greenery Provision
RES 3-4 Environmental Management Practice
RES 3-5 Green Transport
RES 3-6 Stormwater Management
RES 3-7 Internet Connectivity
RES 3-8 Community Connectivity

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

Part 5 – Other Green Features
RES 5-1 Green Features & Innovations

Part 6 – Carbon Emission
RES 6-1 Carbon Emission of Development

Credit Allocation:

Category		Credits Allocations	
(I)	**Energy Related Requirements**	**High- Rise**	**Landed**
Minimum 30 credits	**Part 1: Energy Efficiency**		
	RES 1-1 Thermal Performance of Building Envelope -RETV	15	22
	RES 1-2 Naturally Ventilated Design and Energy Efficient Cooling	22	22
	RES 1-3 Daylighting	6	6
	RES 1-4 Artificial Lighting	8	4
	RES 1-5 Ventilation in Carparks	6	2
	RES 1-6 Domestic Hot Water System	3	3
	RES 1-7 Lifts	1	1
	RES 1-8 Cool Hardscaped Areas	2	2
	RES 1-9 Energy Efficient Features	7	7
	RES 1-10 Renewable Energy	15	15
	Category Score for Part 1 – Energy Efficiency	**85 (Max)**	**84 (Max)**
(II)	**Other Green Requirements**		
Minimum 20 credits	**Part 2: Water Efficiency**		
	RES 2-1 Water Efficient Fittings	8	8
	RES 2-2 Water Usage Monitoring	1	1
	RES 2-3 Irrigation System and Landscaping	3	3
	Category Score for Part 2 – Water Efficiency	**12**	**12**
	Part 3: Environmental Protection		
	RES 3-1 Sustainable Construction	10	10
	RES 3-2 Sustainable Products	8	8
	RES 3-3 Greenery Provision	8	8
	RES 3-4 Environmental Management Practice	10	10
	RES 3-5 Green Transport	4	4
	RES 3-6 Stormwater Management	3	3
	RES 3-7 Internet Connectivity	1	1
	RES 3-8 Community Connectivity	1	1
	Category Score for Part 3 – Environmental Protection	**45**	**45**
	Part 4: Indoor Environmental Quality		
	RES 4-1 Noise Level	1	1
	RES 4-2 Indoor Air Pollutants	2	2
	RES 4-3 Waste Disposal	1	1
	RES 4-4 Indoor Air Quality in Wet Areas	2	2
	Category Score for Part 4 – Environmental Quality	**6**	**6**
	Part 5: Other Green Features		
	RES 5-1 Green Features & Innovations	7	7
	Category Score for Part 5 – Other Green Features	**7**	**7**
	Part 6: Carbon Emission of Development		
	RES 6-1 Carbon Emission of Development	3	3
	Category Score for Part 6 – Carbon Emission of Development	**3**	**3**
	GreenRE Score:	**158 (Max)**	**156 (Max)**

6. GreenRE Residential Building Rating System Scoring

Score	Rating
90 and above	GreenRE Platinum
85 to < 90	GreenRE Gold
75 to < 85	GreenRE Silver
50 to < 75	GreenRE Bronze

7. GreenRE Residential Building Rating System Criteria

Pre-requisites:

1) Building envelope design with Residential Envelope Transmittance Value (RETV) computed based on the methodology and guides stipulated in the Code on Envelope Thermal Performance for Buildings, BCA and this GreenRE Design Reference Guide.

   GreenRE Gold - RETV of 22 W/m^2 or lower
   GreenRE Platinum - RETV of 20 W/m^2 or lower

2) To be eligible for GreenRE Platinum rating,
   - It is a requirement to perform ventilation simulation modelling and achieve minimum 70% of the selected typical dwelling units with good natural ventilation by demonstrating a wind velocity of 0.60 m/s. Common areas like staircases and lobbies (excluding those that are located in basement areas) are to be designed as naturally ventilated spaces. For landed home projects whereby ventilation simulation modelling is not performed, it is a requirement to achieve ≥ 16 credits under RES 1-2 (a) Option 2 (i) and (ii).

3) Prescribed system efficiency of air-conditioning system for all dwelling units to be as follows:

   GreenRE Gold, GreenRE Platinum } Air conditioners with Suruhanjaya Tenaga 5-star rating or equivalent

   Note: This can be prescribed and enforced via DMC and green fit out guidelines to residential unit owner if not installed by developer. However, credit scoring will not be allowed under section 2(ii).

4) For provision of energy efficient cooling system 100% of air-conditioners and / or mechanical ceiling fans used in all dwelling units must be energy labelled minimum Suruhanjaya Tenaga 3-star (or equivalent) and above.

5) Minimum score under RES 3-1 Sustainable Construction
   GreenRE Gold ≥ 3 credits
   GreenRE Platinum ≥ 5 credits

6) Minimum score under RES 3-2 Sustainable Products
   GreenRE Gold ≥ 3 credits
   GreenRE Platinum ≥ 4 credits

Part 1 - Energy Efficiency	GreenRE Credits
RES 1-1 THERMAL PERFORMANCE OF BUILDING ENVELOPE – RETV	
For Multi-storey Residential and Landed Homes	
Enhance overall thermal performance of building envelope to minimise heat gain thus reducing the overall cooling load requirement.	3 credits for every reduction of 1 W/m^2 in RETV from the baseline.
Baseline : Maximum permissible RETV = 25W/m^2	Credits scored = 75 – [3 x (RETV)] where RETV ≤ 25 W/m^2 (Up to 15 credits)
Prerequisite Requirement: *GreenRE Gold - RETV of 22 W/m^2 or lower* *GreenRE Platinum - RETV of 20 W/m^2 or lower*	
For Landed Homes	
Lightweight roof U-value ≤ 0.35W/m^2K / Heavyweight roof U-value ≤ 0.50W/m^2K **OR**	2 credits
Lightweight roof U-value ≤ 0.30W/m^2K / Heavyweight roof U-value ≤ 0.40W/m^2K **OR**	3 credits
Lightweight roof U-value ≤ 0.25W/m^2K / Heavyweight roof U-value ≤ 0.30W/m^2K **and / or**	4 credits (Up to 4 credits)
Provision of hardscaped roof that is finished with materials / finishes with Solar Reflectance Index (SRI) values of 40 **OR** provision of green roof to reduce local heat island effect. i. 25% of the roof area ii. 50% of the roof area iii. 75% of the roof area	1 credit 2 credits 3 credits (Up to 3 credits)

RES 1-2 NATURALLY VENTILATED DESIGN AND ENERGY EFFICIENT COOLING SYSTEM (a) Dwelling Unit Indoor Comfort Enhance building design to achieve good natural ventilation for better indoor comfort or through the use of better efficient air-conditioners if needed. Option 1 – Ventilation Simulation Modelling and Analysis Use of ventilation simulation modelling and analysis or wind tunnel testing to identify the most effective building design and layout to achieve good natural ventilation for all unit types. *Prerequisite Requirement:* *GreenRE Platinum - Minimum 70% of the selected typical dwelling units with good natural ventilation. Common areas are to be designed as naturally ventilated spaces* OR Option 2 – Ventilation Design (without the use of ventilation simulation modelling) and Energy Efficient Cooling System (i) Air flow within Dwelling Units • Building layout design: Proper design of building layout that utilises prevailing wind conditions to achieve adequate cross ventilation. • Dwelling unit design: Good ventilation in indoor units through sufficient openings	0.2 credits for every percentage of typical units with good natural ventilation Credits scored = 0.2 x (% of typical units with good natural ventilation) (Up to 20 credits) OR 0.5 credits for every 10% of units with window opening facing north and south directions Credits scored = 0.5 x (% of units/10) 0.5 credits for every 10% of living rooms and bedrooms design with true cross ventilation Credits scored = 0.5 x (% of rooms/10) (Up to 10 credits)

<table>
<tr>
<td>(ii) Encourage the use of better energy efficient cooling system to minimise energy consumption.

<u>Provision of air-conditioning system</u>
Use of air-conditioners that are certified under Energy Commission (Suruhanjaya Tenaga) or equivalent.

and / or

<u>Provision of mechanical ceiling fan</u>
Use of ceiling fan as the mechanical cooling system.

Note (1): Option 2(ii) is not applicable for developments where energy efficient cooling system is not provided. Credits can be scored and prorated accordingly under Option 2(i).

Note (2): For Option 2(ii) credit scoring only allowed if all dwelling units and internal areas are provided with energy efficient cooling system. Credits will be pro-rated accordingly based on area of coverage.

<u>Prerequisite requirement:</u>
GreenRE Gold } Air-conditioners with
GreenRE Platinum } ST 5-star rating or equivalent

Note: This can be prescribed and enforced via incorporation into DMC and green fit out guidelines to residential unit owner if not installed by developer. However, point scoring will not be allowed under section 2(ii).

<u>(b) Natural Ventilation in Common Areas</u>

Design for natural ventilation in following common areas:

i. Lift lobbies and corridors
ii. Staircases

Note: Applicable for landed home projects with common areas (e.g club-house, management office etc.)</td>
<td>Extent of coverage: 100% of energy efficient cooling systems used in all dwelling units are energy labelled.

<table><tr><td>4-Star</td><td>4 credits</td></tr><tr><td>5-Star</td><td>8 credits</td></tr></table>
<table><tr><td>4-Star</td><td>8 credits</td></tr><tr><td>5-Star</td><td>10 credits</td></tr></table>
(Capped at 10 credits)

Extent of coverage: At least 80% of the applicable areas

1 credit
1 credit</td>
</tr>
</table>

RES 1-3 DAYLIGHTING

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

a) Use of daylight simulation analysis or any relevant calculations to verify that 50% or more of all habitable spaces achieve adequate daylight illuminance levels as specified in MS 2680:2017. (i.e daylight factor above 2.0%)

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

(Up to 3 credits)

For Multi-Storey Residential

b) Daylighting in the following common areas:

i. Lift lobbies and corridors
ii. Staircases (non-bomba only)
iii. Carparks

Extent of coverage: At least 80% of the applicable areas

1 credit
1 credit
1 credit

Note: Applicable for landed home projects with common areas (e.g club-house, management office etc.)

RES 1-4 ARTIFICIAL LIGHTING

For Multi-Storey Residential

Encourage the use of energy efficient lighting in common areas to minimise energy consumption from lighting usage.

Baseline:
Luminance level stated in MS1525:2014.

0.2 credits for every percentage improvement in the lighting power budget.
Credits scored

= 0.2 x (% improvement)

(Up to 8 credits)

For Landed Homes

Encourage the use of energy efficient lighting in common areas to minimise energy consumption from lighting usage.

Applicable for landed home projects with common areas (e.g club-house, management office etc.)

0.1 credits for every percentage improvement in the lighting power budget.
Credits scored

= 0.1 x (% improvement)

(Up to 4 credits)

RES 1-5 VENTILATION IN CARPARKS **For Multi-Storey Residential** Encourage the use of energy efficient design and control of ventilation systems in car parks. (a) Car park spaces that are fully naturally ventilated. (b) CO sensors are used to regulate the demand for mechanical ventilation (MV) Note (2): Where there is a combination of different ventilation modes adopted for car park design, the credits scored under this requirement will be prorated accordingly. **For Landed Homes** Provision of naturally ventilated, covered parking space.	Naturally ventilated carparks – 6 credits Credits scored based on the mode of mechanical ventilation provided Fume extract – 4 credits MV with or without supply – 3 credits (Up to 6 credits) 2 credits
RES 1-6 DOMESTIC HOT WATER SYSTEM Use of innovative domestic hot water heating system: (a) Gas water heaters or energy efficient heat pump water heaters (b) Solar water heaters	2 credits 3 credits (Up to 3 credits)
RES 1-7 LIFTS Encourage the use of lift with energy efficient features such as AC variable voltage and variable frequency (VVVF) motor drive and energy efficient features such as sleep mode.	1 credit
RES 1-8 COOL HARDSCAPED AREAS All hardscaped non-roof areas are to be finished with materials or finishes with a Solar Reflective Index (SRI) value of 29 or more. i. ≥ 50% of non-roof hardscaped area ii. ≥ 75% of non-roof hardscaped area	1 credit 2 credits

RES 1-9 ENERGY EFFICIENT FEATURES Encourage the use of energy efficient features that are innovative and have positive environmental impact in term of energy saving. (a) Use of energy efficient equipment or product that are certified by approved local certification body (i.e ST 5-star rated appliances) (b) Use of the following energy efficient features: • Heat recovery devices • Regenerative lifts • Thermal Insulation • Calculation of Total Electricity Consumption (TEC) for common areas. • Provision of vertical greenery systems. • Provision of features to facilitate windows being kept open at night and during adverse weather.	Extent of coverage: At least 90% of the applicable equipment type or product 0.5 credits for each eligible certified equipment or product (Up to 2 credits) 2 credits for high impact item 1 credit for medium impact item 0.5 credits for low impact item (Up to 5 credits)
RES 1-10 RENEWABLE ENERGY **For Multi-storey Residential** Encourage the use of renewable energy sources in buildings such as solar energy. **For Landed Homes** Encourage the use of renewable energy sources in landed homes such as solar energy.	3 credits for every 1% replacement of electricity (based on annual electricity consumption exclude household's usage) by renewable energy and / or 3 credits for every 10% of roof area utilized for solar panels (Up to 15 credits) 3 credits for every 5% replacement of electricity by renewable energy (per house unit) (Up to 15 credits) Note: The credits scored for renewable energy provision shall not result in a double grade jump in GreenRE rating (i.e. from GreenRE Bronze to Silver to Gold to Platinum).
Part 1 – ENERGY EFFICIENCY CATEGORY SCORE:	Sum of GreenRE credits obtained from RES 1-1 to 1-10

<table>
<tr><th>Part 2 – Water Efficiency</th><th>GreenRE Credits</th></tr>
<tr><td><u>RES 2-1 WATER EFFICIENT FITTINGS</u>

Encourage the use of water efficient fittings covered under the Water Efficiency Product Labelling Scheme (WEPLS) or Water Efficiency Labelling Scheme (WELS).

a) Basin taps and mixers
b) Flushing cistern
c) Shower taps and mixers
d) Sink/bib taps and mixers
e) Urinals and urinal flush valve
f) Showerheads</td><td>Credits scored based on the number and water efficiency rating of the fitting type used

(Up to 10 credits)

<table><tr><td colspan="3">Rating Based on WEPLS or WELS</td></tr><tr><td>Efficient *</td><td>Highly Efficient **</td><td>Most Efficient ***</td></tr><tr><td>0.5 credits</td><td>1 credits</td><td>2 credits</td></tr></table></td></tr>
<tr><td><u>RES 2-2 WATER USAGE MONITORING</u>

Provision of private meters to monitor the major water usage such as irrigation, swimming pools and other water features.</td><td>1 credit</td></tr>
<tr><td><u>RES 2-3 IRRIGATION SYSTEM AND LANDSCAPING</u>

Provision of suitable systems that utilities rainwater or recycled water for landscape irrigation and use of plants that require minimal irrigation to reduce potable water consumption.

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

(b) Use of automatic water efficient irrigation system with rain sensor.

(c) Use of drought tolerant plants that require minimal irrigation.</td><td>

1 credit

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

Extent of Coverage : At least 50% of the landscape areas
1 credit</td></tr>
<tr><td>PART 2 – WATER EFFICIENCY CATEGORY SCORE:</td><td>Sum of GreenRE credits obtained from RES 2-1 to 2-3</td></tr>
</table>

<table>
<tr><th>Part 3 – Environmental Protection</th><th>GreenRE Credits</th></tr>
<tr><td>

RES 3-1 SUSTAINABLE CONSTRUCTION

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, and 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 RES 3-1:
GreenRE Gold ≥ 3 credits
GreenRE Platinum ≥ 5 credits

</td><td>

% 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 (m^3/m^2)	Credits Allocation
≤ 0.70	1
≤ 0.60	2
≤0.50	3
≤0.40	4
≤0.35	5

(Up to 5 credits)

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<tr><td>

RES 3-2 SUSTAINABLE PRODUCTS

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.

Prerequisite Requirement:
Minimum score under RES 3-1:
GreenRE Gold ≥ 3 credits
GreenRE Platinum ≥ 4 credits

</td><td>

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

Credits scored will be based on the extent of coverage and impact.

(Up to 8 credits)

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RES 3-3 GREENERY PROVISION

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

For Multi-storey Residential

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

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

For Landed Homes

(b) Provision of greenery area within non-built up area of each dwelling:

(i)	50% of non-built up area as greenery area	1 credit
(ii)	60% of non-built up area as greenery area (2 credits)	2 credits
(iii)	75% non-built up area as greenery area (3 credits)	3 credits
		(Up to 3 credits)

Note: Roof gardens can be considered part of green landscape area requirement.

(c) Provision of green space above regulatory requirements for entire development

(i)	5% more green space	1 credit
(ii)	10% more green space	2 credits
(iii)	15% more green space	3 credits
		(Up to 3 credits)

Note: For single residence projects, credits for 3-3(b) can be prorated up to 6 credits.

For Multi-storey Residential and Landed Homes

(d) Restoration of trees on site, conservation or relocation of existing trees on site. (at least 20%) — 1 credit

(e) Use of compost recycled from horticulture waste. — 1 credit

RES 3-4 ENVIRONMENTAL MANAGEMENT PRACTICE Encourage the adoption of environmental friendly practices during construction and building operation.	
(a) Implement effective environmental friendly programmes including monitoring and setting targets to minimise energy use, water use and construction waste.	1 credit
(b) Main builder has good track records in completing internationally recognized accredited Green Buildings and adoption of sustainable, environmentally friendly and considerate practices during construction.	1 credit
(c) Building quality is assessed under the Quality Assessment System (QLASSIC) or Construction Quality Assessment System (CONQUAS).	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 Certified GreenRE Manager/ Green Mark Manager	1 credit for Certified GRM/ GMM
(g) Provision of building users' guide with details of the environmental friendly facilities and features within the building and their uses in achieving the intended environment performance during building operation.	1 credit
(h) Provision of green fit out guidelines (to be included in management committee bylaws) to detail recommended minimum environmental standards to assist building users' in making sustainable fit-out decisions.	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
RES 3-5 GREEN TRANSPORT Promote environmental 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. (b) Provision of covered walkway to facilitate connectivity and the use of public transport. (c) Provision of infrastructure for electric charging stations to at least 10% of available parking spaces. (d) Provision of electric vehicle charging stations and priority carparking bays within the development. (e) Provision of covered / sheltered bicycles parking bays with rack / bar.	 1 credit 1 credit 1 credit 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 Credits scored based on the number of bicycle parking bays provided. 1 credit for the provision of ≥ 10% x number of dwelling units 0.5 credits for the provision ≥ 5% x number of dwelling units

RES 3-6 STORMWATER MANAGEMENT Provision of infiltration features or design features for new development and redevelopment to control quantity of stormwater run-off Encourage the treatment of stormwater runoff through provision of infiltration or design features before discharge to public drains to control quality of stormwater run-off through compliance to 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)
RES 3-7 INTERNET CONNECTIVITY To provide infrastructure for internet connectivity to meet requirements of high-speed internet service providers in all dwelling units.	1 credit
RES 3-8 COMMUNITY CONNECTIVITY Encourage development in urban area with existing infrastructure to minimise the use of private mode of transportation. Basic Services include, but are not limited to: • Bank • Beauty • Laundry • Day care • Fire Station • Hardware • Convenience/ Grocery • Hardware • Laundry • Library • Police station • Park • Restaurant • School • Clinic	1 credit can be scored for project located within 1km of at least 10 Basic Services.
PART 3 – ENVIRONMENTAL PROTECTION CATEGORY SCORE:	Sum of GreenRE credits obtained from RES 3-1 to 3-8

Part 4 – Indoor Environmental Quality	GreenRE Credits
RES 4-1 NOISE LEVEL Building is designed to achieve ambient internal noise level as specified: • 55 dB (6am – 10pm) L_{Aeq} • 45 dB (10pm – 6am) L_{Aeq}	1 credit
RES 4-2 INDOOR AIR POLLUTANTS Minimise airborne contaminants, mainly from inside sources to promote a healthy indoor environment. (a) Use of low volatile organic compounds (VOC) paints certified by approved local/ international certification body. (b) Use of environmentally friendly adhesives certified by approved local/ international certification body.	Extent of Coverage: At least 90% of the total internal wall areas 1 credit Extent of Coverage: At least 90% of the applicable areas 1 credit
RES 4-3 WASTE DISPOSAL **For Multi-storey Residential** Minimise airborne contaminants from waste by locating refuse chutes or waste disposal area at open ventilation areas such as service balconies or common corridors. **For Landed Homes** Provision of space that is naturally ventilated in a convenient location for kerbside collection.	1 credit 1 credit
RES 4-4 INDOOR AIR QUALITY IN WET AREAS Provision for adequate natural ventilation and day lighting in wet areas i.e. kitchens, bathroom and toilets	Credits scored based on the % of applicable areas with such provision 2 credits for more than 90% of all applicable areas. 1 credit for at least 50% to 90% of all applicable areas. (Up to 2 credits)
PART 4 – INDOOR ENVIRONMENTAL QUALITY **CATEGORY SCORE:**	Sum of GreenRE credits obtained from RES 4-1 to 4-4

Part 5 – Other Green Features	GreenRE Credits
RES 5-1 GREEN FEATURES & INNOVATIONS Encourage the use of green features that are innovative and have positive environment impact. Examples: • Self-cleaning facade system • Integrated basin/cistern pedestal system • Grey water recycling system • Dual chute system • Calculation of Concrete Usage Index (CUI) • Conservation of existing building structure • Water efficient washing machines with “Good” rating and above. • 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 RES 5-1

Part 6 – Carbon Footprint of Development	GreenRE Credits
RES 6-1 CARBON FOOTPRINT OF DEVELOPMENT Recognise the carbon emission savings based on operational carbon footprint computation of the building comprising energy and water consumption To identify carbon debt and quantify environmental impact and embodied energy, as well as allow benchmarking of projects over time using BCA's online embodied carbon calculator.	1 credit 1 credit – Carbon footprint calculation of any four (4) building materials listed 2 credits – complete carbon footprint calculation for all building materials listed. (up to 2 credits)
PART 6 – CARBON FOOTPRINT OF DEVELOPMENT **CATEGORY SCORE:**	Sum of GreenRE credits obtained from RES 6-1

GreenRE Score (Residential Building & Landed Home)

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

Where:
Category Score for Part 1≥ 30 credits (Multi-Storey Residential) **or** Part 1 ≥ 22 credits (Landed Homes) and Σ Category score for Part 2 to Part 6 ≥ 20 credits

(I) Energy Related Requirements

Part 1- Energy Efficiency

RES 1-1 Thermal Performance of Building Envelope-RETV
RES 1-2 Naturally Ventilated Design and Air-Conditioning System
RES 1-3 Daylighting
RES 1-4 Artificial Lighting
RES 1-5 Ventilation in Carparks
RES 1-6 Domestic Hot Water System
RES 1-7 Lifts
RES 1-8 Cool Hardscaped Areas
RES 1-9 Energy Efficient Features
RES 1-10 Renewable Energy

RES 1-1 THERMAL PERFORMANCE OF BUILDING ENVELOPE – RETV

Objectives	Enhance overall thermal performance of building envelope to minimise heat gain thus reducing the overall cooling load requirement.
Applicability	Applicable to all type of residential buildings; multi-storey and landed home
Baseline Standard	For all Residential Buildings Maximum permissible RETV = 25 W/m^2 (RETV stands for Residential Envelope Transmittance Value.) The computation of RETV shall be based on the methodology specified in the Code on Envelope Thermal Performance for Building issued by BCA. For Landed Homes Only Lightweight roof U-value shall be ≤ 0.4W/m^2K / Heavyweight roof U-value shall be ≤ 0.6 W/m^2K as stipulated in MS 2680:2017. Due to higher roof area to building envelope area ratio for landed homes heat gain through roof takes on greater importance.
Requirements	For all Residential Buildings Up to 15 credits can be scored for building envelope with better thermal performance than the baseline standard: 3 credits for every reduction of 1 W/m^2 in RETV from the baseline. Credits scored = 75 – [3 x (RETV)] where RETV ≤ 25 W/m^2 For developments consisting of more than one residential building, the weighted average of the RETVs based on the façade areas of these buildings shall be used as the basis for credits allocation. That is: $RETV_{Weighted\ average} = \sum (RETV_{bldg} \times A_{bldg}) / A_{devt}$ Where: $RETV_{bldg}$= RETV for a residential building (W/m^2) A_{bldg}= Summation of all façade areas that enclose all living rooms, dining rooms, study rooms and bedrooms of a residential building.(m^2) A_{devt}= Summation of total applicable façade areas of all residential buildings within the development (m^2) (i.e. $\sum A_{bldg}$)

	<u>For Landed Homes Only</u> Up to 3 credits can be scored for improvement in roof U-value beyond baseline requirement of MS-2680:2017. Up to 3 credits can be scored for provision of cool hardscaped roof area.
Prerequisite Requirements	GreenRE Gold - RETV of 22 W/m^2 or less GreenRE Platinum - RETV of 20 W/m^2 or less
Documentary Evidences	• Architectural elevation drawings showing the composition of the different façade or wall systems that are relevant for the computation of RETV; • Architectural plan layouts and elevation showing the living rooms, dining rooms, study rooms and bedrooms; • Extracts of the tender specification or material schedules showing the salient data of the material properties that are to be used for the façade or external wall system; and • RETV calculation. • Calculation of U-value for each roof type. The average roof U-value for all roof coverage areas shall apply. • SRI value for materials used on hardscaped roof area (where applicable)
References	Code on Envelope Thermal Performance for Building issued by BCA.
Worked Example 1-1	<u>Example 1</u> RETV = 22 W/m^2 Credits scored = 75 – [3 x (RETV)] = 75 – [3 x (22)] = 9 credits Therefore, credits scored should be 9 credits <u>Example 2</u> RETV = 19 W/m^2 Credits scored = 75 – [3 x (RETV)] = 75 – [3 x (19)] = 18 credits > 15 credits (max) Therefore, credits scored should be 15 credits (Max) <u>Example 3</u> A proposed building development comprises three residential building blocks. The individual RETV of the each residential computed are as follows: $RETV_{bldg1}$ = 20 W/m^2 A_{bldg}= 4000 m^2 $RETV_{bldg2}$ = 25 W/m^2 A_{bldg}= 3600 m^2 $RETV_{bldg3}$ = 19 W/m^2 A_{bldg}= 5000 m^2 A_{devt}= 4000 + 3600 + 5000 = 12600 m^2 Therefore; $RETV_{Weighted} = \sum (RETV_{bldg} \times A_{bldg}) / A_{devt}$

	$RETV_{average} = \frac{(RETV_{bldg1} \times A_{bldg1}) + (RETV_{bldg2} \times A_{bldg2}) + (RETV_{bldg3} \times A_{bldg3})}{A_{devt}}$ $= \frac{(20 \times 4000) + (25 \times 3600) + (19 \times 5000)}{12600}$ $= 21.03\ W/m^2$ Credits scored = 75 - [3 X (RETV)] = 75 – [3 X (21.03)] = 11.91 credits Note: Refer to the Code on Envelope Thermal Performance for Buildings, BCA for more detailed examples on how to compute the RETV.

RES 1-2 NATURALLY VENTILATED DESIGN AND ENERGY EFFICIENT COOLING SYSTEM

Objectives	Enhance building design to achieve good natural ventilation for better indoor comfort or through the use of better efficient air-conditioners if needed.
Applicability	Applicable to all dwelling units within the development.
Baseline Standard	1-2 (a) Option 1 - Ventilation simulation modelling and analysis shall be based on the methodology specified in Appendix A – Ventilation Simulation Methodology and Requirements. 1-2 (a) Option 2(ii) – As specified under the Energy Commission (Suruhanjaya Tenaga) for air-conditioners and/or mechanical cooling fans.
Requirements	1-2 (a) Dwelling Unit Indoor Comfort For Option 1 – Ventilation Simulation Modelling and Analysis Up to 20 credits can be scored for the use of ventilation simulation modelling & analysis or wind tunnel testing to identify the most effective building design and layout to achieve good natural ventilation for all unit types. All typical dwelling unit types should be included in the ventilation simulation (up to maximum of 5 types). If there are more than 5 typical dwelling unit types, the selection of the units for simulation will be based on extent of coverage that is the five typical dwelling units with most number of units. The units are deemed to have good natural ventilation if the area-weighted average wind velocity within the unit is not less than 0.60 m/s based on the ventilation simulation analysis. The percentage of units achieving good natural ventilation is given by: $\frac{\sum(\text{No. of Selected Units for Each Layout} \times \text{Area-Weighted Average Wind Velocity}) \times 100\%}{\text{Total Number of Selected Units} \times 0.60 \text{ m/s}}$ 0.2 credit for every percentage of typical units with good natural ventilation Credits scored = 0.2 x (% of typical units with good natural ventilation) For Option 2 – Ventilation Design (without the use of ventilation simulation modelling) and use of Energy Efficient Cooling System Up to 10 credits can be scored for the following design Option 2(i) Air flow within Dwelling Units • **Building layout design** that utilises prevailing wind conditions to achieve adequate cross ventilation.

0.5 credit for every 10% of units with window opening facing north **AND** south directions
Credits scored = 0.5 x (% of units/10)

- **Dwelling unit design** that allows for true cross ventilation in the living room and bedrooms of the dwelling units

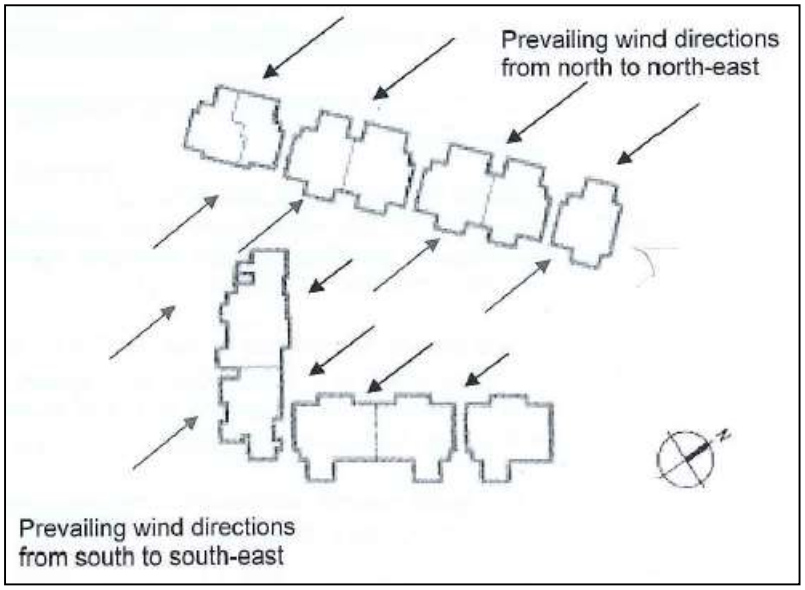
  0.5 credit for every 10% of living rooms and bedrooms design with true cross ventilation
  Credits scored = 0.5 x (% of rooms/10)

Note: In Malaysia, the prevailing wind comes from two predominant directions; that is the north-east during the Northeast monsoon season and south to south-east during South-west monsoon season. Hence, buildings designed with window openings facing the north and south directions have the advantage of the prevailing wind conditions that 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.

Building Layout Design

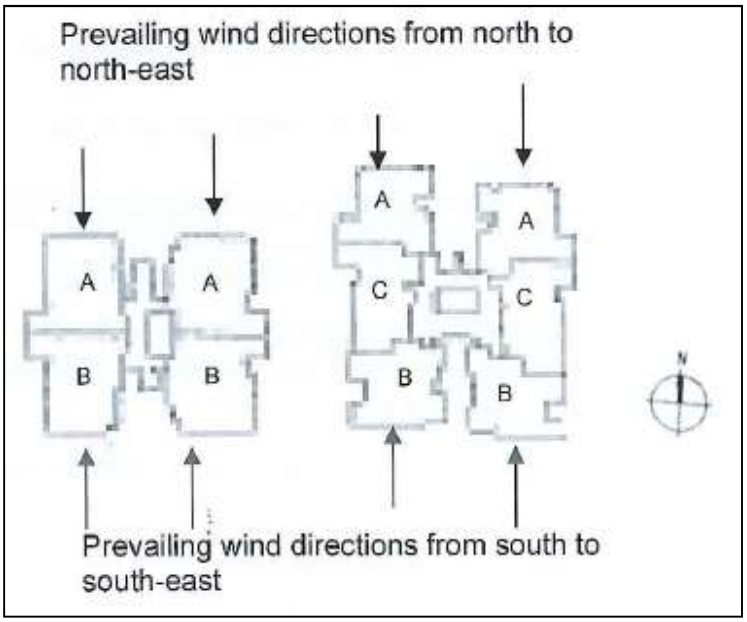
It is not necessary for the window openings to be located perpendicularly to the prevailing wind direction. An oblique angle is considered acceptable as illustrated (Refer Illustration 1-2.1 to 1-2.4).

Illustration 1-2.1: Building layout design that facilitate cross ventilation



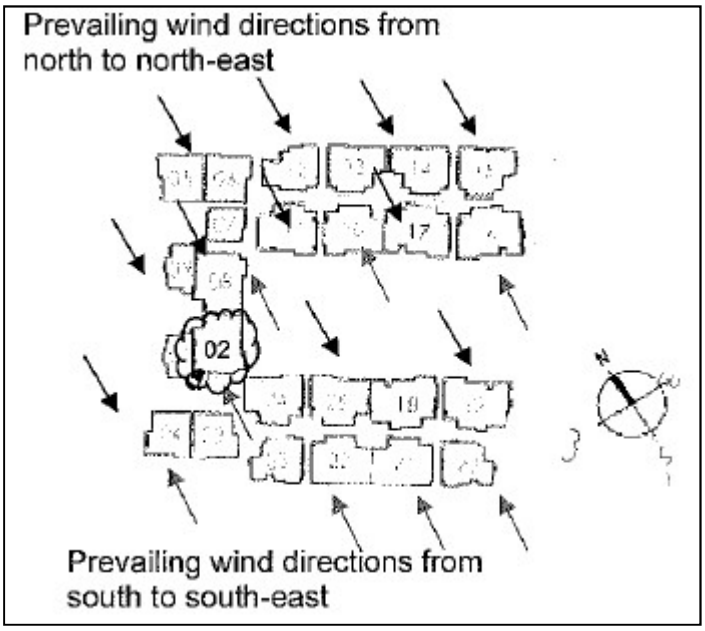
Building layout showing all dwelling units with window openings facing the north and south direction. In this instance, all units can be considered meeting the requirement 1-2(a) Option 2(i).

Illustration 1-2.2: Building layout design that facilitate cross ventilation



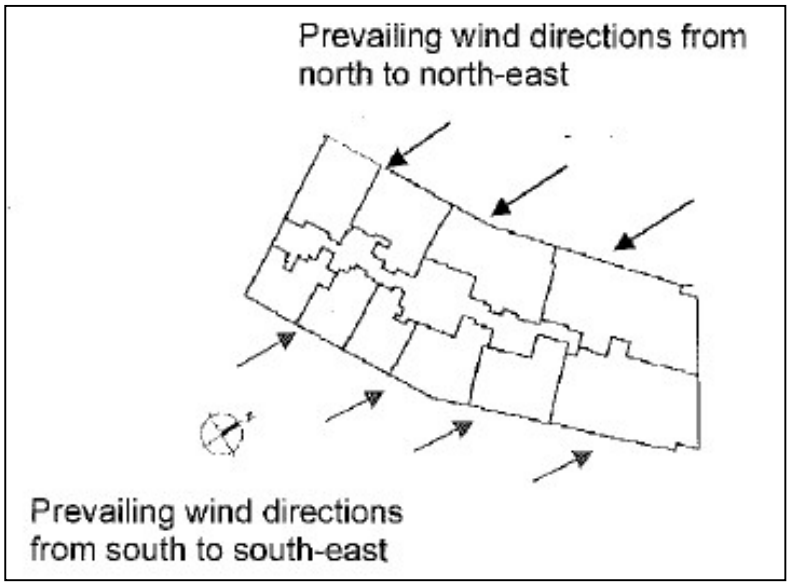
Building layout showing all dwelling unit Type A and B with window openings facing the north or south direction. The dwelling unit Types C has no window openings in the north and south directions. In this instance, no unit can be considered meeting the requirement 1-2(a) Option 2(i)

Illustration 1-2.3: Building layout design that facilitate cross ventilation



Building layout showing the window openings of all dwelling units facing the north and south direction except dwelling unit 02. Dwelling unit 02 has window opening facing only the south direction and hence it is not considered meeting the requirements 1-2(a) Option 2(i)

Illustration 1-2.4: Building layout design that facilitate cross ventilation



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

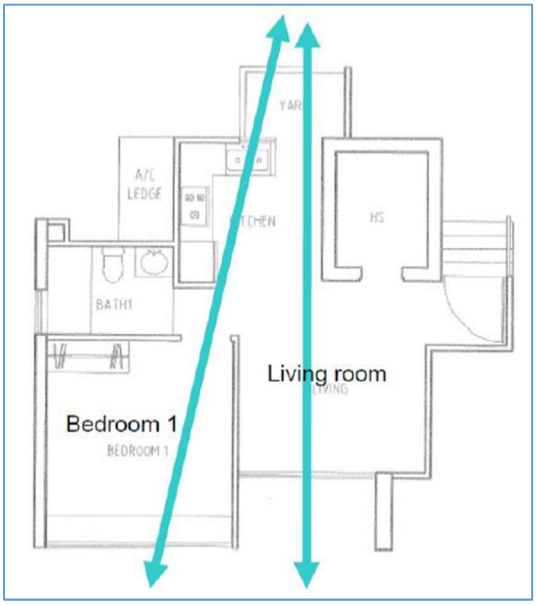
Dwelling Unit Design

Dwelling unit design is considered to have true cross-ventilation when there is a reasonably unobstructed air flow path between the windows or vents on opposite sides of the building. For this requirement, the main entrance of dwelling units is assumed to be closed and all the windows/ internal doors are assumed to be open. The cross-ventilation path is allowed to traverse multiple functional spaces whereby doors are reasonably expected to be kept open. This includes bedrooms, living-room, dining and kitchen areas. Cross ventilation path traversing functional spaces whereby doors will normally be closed (e.g toilets, store-rooms etc) shall not be considered.

The cross-ventilation path between the inlet and outlet should consist of no more than two straight lines (one turn only), from the middle of one opening to the other. The angle of the cross-ventilation path must be no greater than 90^0. The maximum distance between the inlet and outlet for adequate cross ventilation is ≤ 12m.

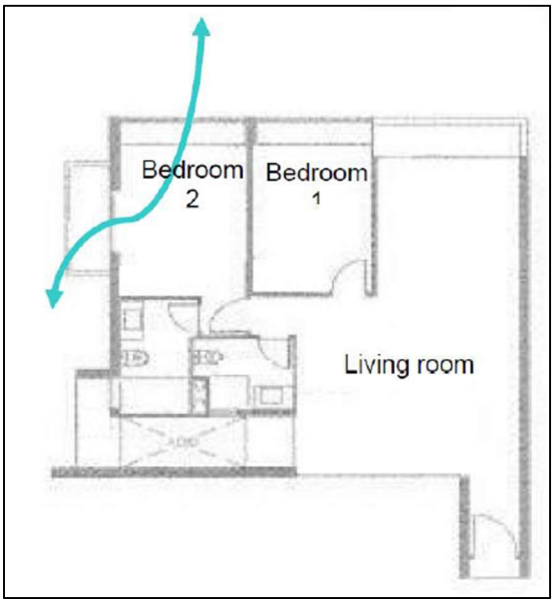
The total openable window area in aggregate should not be less than 1/8th of the total usable area of the room. The minimum opening size (i.e either inlet or outlet) shall be 1/20th of the total usable area of the room.

Illustration 1-2.5: Dwelling unit design that facilitates true cross ventilation



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

Illustration 1-2.6: Dwelling unit design that facilitates true cross ventilation



Dwelling unit layout showing bedroom 2 which is considered to have true cross ventilation.

<u>Option 2(ii) Provision of energy efficient cooling system</u>

Up to 10 credits can be scored for the use of the air-conditioners or mechanical ceiling fans that are certified under the Energy Commission (Suruhanjaya Tenaga) or equivalent based on the following rating:

Table 1-2.1: Unitary air-conditioners, electrically driven, rated cooling capacity < 4.5kW: Minimum EER-cooling

Star rating	EER [(Btu/h) / W]
5	≥11.94
4	11.16 to 11.93
3	10.37 to 11.15

Table 1-2.2: Unitary air-conditioners, electrically driven, rated cooling capacity ≥ 4.5kW ≤ 7.1kW: Minimum EER-cooling

Star rating	EER [(Btu/h) / W]
5	≥10.71
4	9.83 to 10.70
3	8.94 to 9.82

Note:
1. The EER for the air-conditioner unit is the weighted value, which is calculated based upon the following equation:

$$EER_{weighted} = [\ EER_{100\%} \times 0.40\ ] + [\ EER_{50\%} \times 0.60\ ]$$

4-Star	4 credits
5-Star	8 credits

Table 1-2.3: Mechanical ceiling fan, electrically driven: Minimum COP

Star rating	COP
5	≥3.00
4	2.74 – 2.99

Note:
1. The COP for domestic ceiling fan is as follows:

$$\text{COP} = \frac{\textbf{Air Delivery}\left(\frac{\textbf{m3}}{\textbf{min}}\right)}{\textbf{Input Power (W)}}$$

4-Star	8 credits
5-Star	10 credits

	Extent of coverage: All 100% of air-conditioners and / or mechanical ceiling fans used in all dwelling units are energy labelled minimum Suruhanjaya 3-star (or equivalent) and above. Note (1) : Option 2(ii) is not applicable for developments where air-conditioners and/or mechanical ceiling fans are not provided. Credits can be scored and prorated accordingly under Option 2(i). Note (2): For Option 2(ii) credits scoring only allowed if all dwelling units are provided with energy efficient cooling system. Credits will be pro-rated accordingly based on area of coverage. <u>1-2 (b) Natural Ventilation in Common Areas</u> 1-2 (b) (i) 1 credit can be scored if at least 80% of the lift lobbies (including private lift lobbies) and corridors areas are designed to be naturally ventilated. 1-2 (b) (ii) 1 credit can be scored if at least 80% of the staircases areas are designed to be naturally ventilated.
Prerequisite Requirements	a) To be eligible for GreenRE Platinum, it is a requirement to use ventilation simulation modelling and analysis to identify the most effective building design and layout. The simulation results and the recommendations derived are to be implemented. A minimum 70% of the selected typical dwelling units must have a weighted average wind velocity of 0.60 m/s. Other than the dwelling units, common areas like staircases and lobbies (excluding those that are located in the basement areas) must also be designed as naturally ventilated spaces with provision of openable windows or other opening with aggregate area of not less than 5% of the space required to be ventilated. b) Prescribed system efficiency of air-conditioning system for all dwelling units to be as follows: GreenRE Gold GreenRE Platinum } Air conditioners with ST 5-Star rating or equivalent
Documentary Evidences	<u>For 1-2(a) Option 1 - Ventilation Simulation Modelling</u> • Ventilation simulation or wind tunnel testing reports summarising the analysis and modelling results for each typical space as well as the recommendations for design. • Calculation showing the percentage of units achieving good natural ventilation in the prescribed tabulated format as shown in worked example 1-2(a) Option 1. <u>For 1-2(a) Option 2(i) - Air Flow within Dwelling Units</u> • Floor plan of all the unit types with highlights if those with window openings facing the north and south directions and/or with true cross ventilation; • Schedules showing the total number of units in the development and those with window openings facing the north and south direction.

	• Schedules showing the total number of living rooms and bedrooms in the development and those with true cross ventilation. • Calculation showing the percentage of living rooms and bedrooms of dwelling units with true cross ventilation in the prescribed tabulated format as shown in the worked example 1-2(a) Option 2. <u>For 1-2(a) Option 2(ii) – Provision of Energy Efficient Cooling System</u> • Extracts of the tender specification showing the provision of the types of air-conditioners and mechanical ceiling fans for the dwelling units of the development; • Schedule of air-conditioners showing the numbers, types and the approved rating from Suruhanjaya Tenaga or equivalent; • Schedule of mechanical ceiling fans showing the numbers, types and the approved rating from Suruhanjaya Tenaga or equivalent; • Technical product information of the air-conditioners and approved rating. • Technical product information of the mechanical ceiling fans and approved rating. <u>For 1-2(b)(i & ii) – Natural Ventilation in Common Areas</u> • Plan layouts showing the applicable common areas and confirmation that they are designed to be naturally ventilated.
References	1. MS 1525:2014 –Energy Efficiency and Use of Renewable Energy for Non-Residential Building - Code of Practice. 2. MS 2680:2017 – Energy Efficiency and Use of Renewable Energy for Residential Building – Code of Practice 3. For air-conditioner / mechanical ceiling fan rating, can visit Energy Commission (Suruhanjaya Tenaga) www.st.gov.my

Worked Example 1-2(a) Option 1

A residential development with one block of 20-storey apartments comprises 200 units and with 7 typical dwelling unit layouts or types.

1. Select the five typical dwelling unit types with the most number of units for ventilation simulation.
2. Based on the ventilation simulation results, list down the total number of units for each typical dwelling unit type and its corresponding area-weighted average wind velocity as tabulated below.

Table 1-2.2: Total number of units according to dwelling unit types.

Dwelling Units Layouts / Types		No. of Units (**A**)	Area Weighted Average Wind Velocity (**B**)
1	Typical Layout A	80	0.60
2	Typical Layout B	30	0.60
3	Typical Layout C	20	0.70
4	Typical Layout D	20	0.50
5	Typical Layout E	20	0.40
Total Number of Selected Units (**C**) : 170			
6	Typical Layout F*	15	Not included
7	Typical Layout G*	15	Not included

**Dwelling Unit Layout not selected for simulation*

Percentage of units achieving good natural ventilation is given by:

$$= \frac{\sum(A \times B)}{C \times 0.60 \text{ m/s}} \times 100\%$$

$$= \frac{(80x0.60) + (30x0.60) + (20x0.70) + (20x0.5) + (20x0.40)}{170x0.60 \text{ m/s}} \times 100\%$$

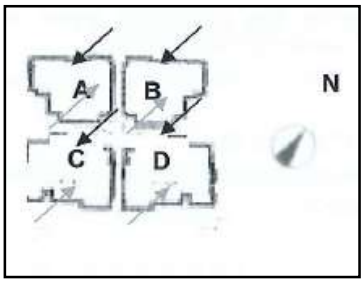
= 96%

Credits scored for 1-2(a) Option 1 = 0.2 x 96% = 19.2 credits

Worked Example 1-2(a) Option 2

For 1-2(a) Option (2)(i)

Proposed residential development with one block of 10 storey apartment comprises 40 units. Each dwelling comes with a living room and two bedrooms. There are four different unit types for this development as illustrated below.



Building Layout Design

Total no. of units in the developments = 40

Total units with all window openings facing north and south directions = 40

% of units with window openings facing north and south directions = 40/40 x 100%

Credits scored = 0.5 x (% unit/10)
= 0.5 x (100/10)
= **5 credits**

Two-bedroom Type A

The living room, bedroom 1 and bedroom 2 are considered to have true cross ventilation.

Two-bedroom Type B

The living room, bedroom 1 and bedroom 2 are considered to have true cross ventilation.

Two-bedroom Type C

Only living room is considered to have true cross ventilation. Bedroom 1 and 2 do not meet this requirement.

Two-bedroom Type D

Only living room is considered to have true cross ventilation. Bedroom 1 and 2 do not meet this requirement.

Dwelling Unit Design

Table 1-2.3 : Percentage of rooms with true cross ventilation

Type of dwelling unit	No. of units (a)	For each unit		Total living rooms and bedrooms with true cross ventilation (b + c) x (a)
		Living room with true cross ventilation (b)	Bedrooms with true cross ventilation (c)	
2-bedroom Type A	10	1	1	20
2-bedroom Type B	10	1	1	20
2-bedroom Type C	10	1	0	10
2-bedroom Type D	10	1	0	10
			Total :	60

Total no. of living rooms and bedrooms = 3 x 40 units = 120

Total no. of living rooms and bedrooms with true cross ventilation = 60

Percentage of living rooms and bedrooms with true cross ventilation = 60/120 x 100%
= 50%

Credits scored = 0.5 x (% rooms/10)
= 0.5 x (50/10)
= **2.5 credits**

For 1-2(a) Option (2)(ii)
All dwelling units are provided with 5-star rated air-conditioners

Credits scored for 1-2(a) Option 2 (ii) = **8 credits**

Total credits scored for 1-2(a) Option 2 = 5 + 2.5 + 8
= **15.5 credits**

Worked Example 1-2(b)

Proposed development has the following provision:

All lift lobbies and corridors are designed to be naturally ventilated except for two private lobbies of the penthouses units that are designed with air-conditioning system. All staircases are designed to be naturally ventilated.

No credit for 1-2(b)(i) if less than 80% of lift lobbies are naturally ventilated.

1 credit for 1-2(b)(ii) for staircases that are all designed to be naturally ventilated.

Therefore, credit scored for 1-2(b) = 1 credit

RES 1-3 DAYLIGHTING

<table>
<tr><td>Objectives</td><td>Encourage design that optimises the use of effective day lighting to reduce energy use for artificial lighting.</td></tr>
<tr><td>Applicability</td><td>1-3(a) Applicable to all normally occupied areas within the development.

1-3(b) Applicable to all common areas within the development.</td></tr>
<tr><td>Baseline Standard</td><td>1-3(a) The minimum illuminance level for day lighting shall be in accordance with MS 2680:2017.</td></tr>
<tr><td>Requirements</td><td>1-3(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 MS 2680:2017.

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

Table 1-3.1:Credits allocation according to Habitable Spaces
<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>
1-3(b) (i) 1 credit for provision of day lighting for lift lobbies and corridors.

1-3(b) (ii) 1 credit for provision of day lighting for staircases.

1-3(b) (iii) 1 credit for provision of day lighting for car parks.</td></tr>
<tr><td>Documentary Evidences</td><td><u>For 1-3(a)</u>
• Schedules showing the total number of living and dining areas in the development and those with effective daylighting; and
• Daylight analysis (simulation/calculations) report summarizing the analysis and modelling results for each living and dining area that meets the requirement.

<u>For 1-3(b)</u>
• Extracts of the tender specification or drawings showing the use of day lighting for lift lobbies and corridors, staircases and car parks where applicable.</td></tr>
<tr><td>References</td><td>MS 2680:2017 –Energy Efficiency and Use of Renewable Energy for Residential Building - Code of Practice</td></tr>
</table>

Worked Example 1-3(a)

Proposed development comprises a 20 storey apartments consists of 250 units with 7 typical layouts. Daylight and glare simulation has been conducted for the development. Based on simulation, a tabulation of daylight factor for each of the habitable rooms according to 7 typical layouts as schedule below:

Table 1-3.2: Daylight factor for each of the room in every type of layout

	Room 1	Room 2	Room 3	Room 4	Room 5	Family	Living/Dining
Type A	3.9	4.1	2.1	NA	NA	NA	2.8
Type B	3.9	4.1	2.1	NA	NA	NA	2.8
Type C	3.3	2.5	2.3	1.9	NA	NA	3.8
Type D	3.3	2.5	2.3	1.9	NA	NA	3.8
Type E	3.3	2.5	2.3	1.9	NA	NA	3.8
Type F	4.5	1.1	2.6	2.3	NA	1.7	4.0
Type G	3.3	3.5	3	2.5	2.1	1.6	4.7

Total no. of habitable rooms calculated based on each type of units = 36

Total no. of habitable rooms with DF ≥ 2.0% = 30

Total % of habitable rooms with DF ≥ 2.0% = 30/36 x 100 = 83.3%

Credits scored for 1-3(a) = 2 credits

Worked Example 1-3(b)

Proposed 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 lightings during anytime to maintain proper lighting level.

No.	Criteria	Credit Allocated	Credit
1-3(b) (i)	Lift lobbies and corridors	1	1
1-3(b) (ii)	Staircases	1	1
1-3(b) (iii)	Day lighting for carparks.	1	0
		TOTAL	2

No credit given for carpark as it does not meet the minimum 80% of the applicable areas.

Therefore, credits scored for 1-3(b) = 2 credits

RES 1-4 ARTIFICIAL LIGHTING

<table>
<tr><td>Objectives</td><td>Encourage the use of energy efficient lighting to minimise energy consumption from lighting usage</td></tr>
<tr><td>Applicability</td><td>Applicable to lighting provisions that designed in accordance to the luminance level as recommended in MS 1525:2014.

Use of suitable and effective light fitting such as LED, T5 and etc can contribute to better energy efficiency in buildings.</td></tr>
<tr><td>Baseline Standard</td><td>Luminance level stated in MS 1525:2014 –Energy Efficiency and Use of Renewable Energy for Non-Residential Building - Code of Practice</td></tr>
<tr><td>Requirements</td><td>Up to 8 credits can be scored for the improvement in the lighting power budget in common areas.

0.2 credit for every percentage improvement in the lighting power budget over the baseline standard. That is:

Credits scored = 0.2 x (% improvement)

Please refer to Table 11 in MS 1525:2014 for maximum lighting power budget (intensity) according to type of usage. Below are some examples:

Table 1-4.1:Lighting power budget
<table><tr><th>Type of usage</th><th>Maximum Lighting Power Budget (W/m^2)</th></tr><tr><td>Stairs</td><td>5</td></tr><tr><td>Car parks</td><td>5</td></tr><tr><td>Corridors</td><td>5</td></tr><tr><td>Lobbies</td><td>5</td></tr><tr><td>Toilets</td><td>6</td></tr><tr><td>Gymnasium (Exercise area)</td><td>5</td></tr></table>
Remarks:
1. Display lighting, specialised lighting and building’s exterior lighting are to be included in the calculation of lighting power budget.
2. The lighting power budget shall not apply in individual residences and apartments but shall apply to common area such as landscape lighting, mechanical rooms, stairs, lobbies, corridors and car parks within the residential building.</td></tr>
<tr><td>Documentary Evidences</td><td>• Lighting layout plan, Lighting schedules showing the numbers, locations and types of luminaries used;
• Calculation of the proposed lighting power budget and the percentage; improvement in the prescribed tabulated format as shown in the worked example 1-4;
• Tabulation showing the designed lux level and the minimum lux level based on code requirement for the respective areas;
• Luminance value calculations for respective areas; and
• Technical product information of the lighting luminaries used.</td></tr>
</table>

References	MS 1525:2014 –Energy Efficiency and Use of Renewable Energy for Non-Residential Building - Code of Practice
Worked Example 1-4	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 1525:2014. c) Calculate the percentage improvement in the total power consumption.

Table 1-4.2 : Total power consumption based on each fitting type

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)]
Corridors	580	T5	1x28	3	70	2170
Staircases	420	T5	1X28	3	35	1085
Car parks	1500	T5	1x28	3	130	4030
Exterior Lighting	200	LED bollard	4x1	1	28	140
		Floodlight CDM-TC	1x35	4	15	585
					Total:	8010

Table 1-4.3 : Total power consumption based on design and MS 1525 requirements

Description	Areas (m^2) (A)	Design Data		MS 1525:2014 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)
Corridors	580	2170	3.74	5	2900
Staircases	420	1085	2.85	5	2100
Car parks	1500	4030	2.69	5	7500
Exterior Lighting	200	725	3.63	3	600
Total:		8010			13100

% improvement in the lighting power budget

$= [\sum (H \times A) - \sum(F)/\sum(H \times A) \times 100]$

$= (13100 - 8010)/13100 \times 100)$

$= 38.85\%$

	Credits scored = 0.2 x 38.85% = 7.8 (capped at 8 credits) Therefore, credit scored for 1-4 should be **7.8 credits.**

RES 1-5 VENTILATION IN CARPARKS

Objectives	Encourage the use of energy efficient design and control of ventilation systems in car parks.
Applicability	Applicable to all car park spaces in the development.
Baseline Standard	-
Requirements	For Multi-Storey Residential Building Only 1-5(a) 6 credits can be scored for car park spaces that are fully naturally ventilated. 1-5(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; 4 credits for car parks using fume extract system and 3 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. For Landed Homes Only 1-5 2 credits can be scored for provision of covered car park space that is fully naturally ventilated.
Documentary Evidences	For 1-5(a) and (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; and • Calculation showing the credits allocation if there is a combination of different ventilation mode adopted for the car park design.
References	-
Worked Example 1-5	Proposed development has two levels of basement car parks. Level 1 basement car park (B1) is designed with more than 20% openings for natural ventilation and fume extract system. Level 2 basement car park (B2) is fully mechanically ventilated. CO sensors are installed to control the ventilation system for both car park levels. Areas of basement car park – B1 = 700m^2 Areas of basement car park – B2 = 500m^2 Total areas = 1200m^2 Credits scored for 1-5 = (700/1200) x 4 + (500/1200) x 3 = 3.58 credits

RES 1-6 DOMESTIC HOT WATER SYSTEM

Objectives	Encourage the use of innovative hot water heating system to reduce energy bills.
Applicability	Applicable to all domestic hot water systems in all dwelling units.
Baseline Standard	-
Requirements	2 credits can be scored for installation of gas water heaters or energy efficient heat pump water heaters. 3 credits can be scored for the use of solar water heaters.
Documentary Evidences	• Extracts of the tender specification indicating the specification and details of water heater system used. • Calculation of percentage energy saving in comparison to baseline electric water heater of similar capacity. • Hot water piping schematics.
References	-
Worked Example 1-6	Proposed development has the following provision; Solar water heater system serving all hot water needs of dwelling. Therefore, credits scored for 1-6 = 3 credits

RES 1-7 LIFTS

Objectives	Encourage the use of energy efficient lifts.
Applicability	Applicable to **ALL** lift in the development.
Baseline Standard	-
Requirements	1 credit can be scored for the use of lift with energy efficient features such as AC variable voltage and variable frequency (VVVF) motor drive and energy efficient features such as sleep mode.
Documentary Evidences	• Extracts of the tender specification indicating the types of lifts and related features used; and • Technical information of the lifts.
References	-
Worked Example 1-6	Proposed development has the following provision; All lifts are VVVF motor drive with sleep mode features 1 credit for the use VVVF motor drive with sleep mode features. Therefore, credits scored for 1-6 = 1 credit

RES 1-8 COOL HARDSCAPED AREAS

Objectives	Encourage the use of higher SRI materials for non-roof hardscaped areas.
Applicability	Applicable to all non-roof hardscaped areas in the development.
Baseline Standard	-
Requirements	1 credit can be scored if ≥ 50% of non-roof hardscaped areas are finished with materials or finishes with a Solar Reflective Index (SRI) value of 29 or more. 2 credits can be scored if ≥ 75% of non-roof hardscaped areas are finished with materials or finishes with a Solar Reflective Index (SRI) value of 29 or more.
Documentary Evidences	• Extracts of the tender specification indicating the types of materials and finishes from non-roof hardscaped areas including SRI values. • Scaled site plan showing the extent of proposed hardscape. Indicate percentage of hardscape out of total site area.
References	-
Worked Example 1-8	Proposed development has the following provision; ≥ 75% of all non-roof hardscaped area have material with SRI of 29 or more. Therefore, credits scored for 1-8 = 2 credits

RES 1-9 ENERGY EFFICIENT FEATURES

Objectives	Encourage the use of energy efficient features that are innovative and have positive environmental impact in term of energy saving.
Applicability	Applicable to practices and features that are not listed in the requirements under Part 1 – Energy Efficiency.
Baseline Standard	-
Requirements	(a) 0.5 credit for the use of energy efficient equipment or products that are certified by approved local certification body for at least 90% of the applicable equipment type or products. (Up to 2 credits) (b) Up to 5 credits can be scored for the use of the following energy efficient features based on their potential environmental benefits and the extent of coverage. i. Use of thermal insulation on the east and west facing external walls • 2 credits for window to wall ratio (WWR) of less than 0.5 • 1 credit for WWR that is between 0.5 – 0.75 • 0.5 credit for WWR of more than 0.75 ii. Use of occupancy sensors for private lift lobbies, staircases, common toilets • 1 credit for at least 50 occupancy sensors installed • 0.5 credit for less than 50 occupancy sensors installed iii. Provision of vertical greenery system on building façades abutting the living, dining and bedrooms areas of dwelling units and club house • 2 credits for more than 50% of building façades • 1 credit for at least 25% of building façades • 0.5 credit for clubhouse iv. Provision of clothes drying facilities and open spaces • 1 credit for more than 90% of all dwelling units • 0.5 credit for between 50% to 90% of dwelling units v. Provision of lifts with better energy efficient features (Up to 2credits) • 1 credit for the use of regenerative drive system for at least 90% of lifts installed • 1 credit for the use of gearless drive system for at least 90% of lifts installed vi. 0.5 credit for the provision of ductless fans for basement ventilation.

vii. 0.5 credit for the computation of Total Electricity Consumption (TEC) for common facilities of the development.

Calculation of TEC for Common Facilities:

TEC : Total electricity consumption for common facilities (kWh/day)

The common facilities and the daily usage hours of these facilities are pre-determined for consistency as shown in Table 1-7.1. They are to be used in the computation for EEI. Other common facilities that are not listed should be included under 'Others' and the operation hours can be estimated based on the likely usage pattern.

Table 1-7.1: Common Facilities and Daily Usage Pattern

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

Notes: For features that are not listed in RES 1-7 (i) to (vii) above, the QP is required to submit the details showing the positive environmental impacts and potential energy savings of the proposed features to GreenRE for assessment

<table>
<tr><td>Documentary Evidences</td><td>

Extracts of the tender specification showing the provision of the proposed energy efficient features and the extent of implementation where applicable;
Technical product information on the energy efficient features used; and
Calculation of the potential energy saving that could be reaped from the use of these features.
Calculation of the Total Electricity Consumption (TEC) using the pre-determined daily usage pattern as in Table 1-7.1 and in the prescribed tabulated format as shown in the worked example 1-7(vii).

</td></tr>
<tr><td>References</td><td>-</td></tr>
<tr><td>Worked Example 1-7(vii)</td><td>
<u>Background info:</u>
Proposed residential development with the following estimated electricity consumption for common facilities.
Table 1-7.2: Estimated electricity consumption for common facilities
<table>
<tr><th></th><th>Description</th><th>Estimated Load (KW)</th><th>Daily usage (hr)</th><th>Load per day (KWh)</th></tr>
<tr><td></td><td colspan="4">A) Mechanical Load</td></tr>
<tr><td></td><td>MV fan (plant room)</td><td>9</td><td>9</td><td>81</td></tr>
<tr><td></td><td>Car park fan</td><td>320</td><td>4</td><td>1280</td></tr>
<tr><td></td><td>A/C for club house</td><td>8</td><td>12</td><td>96</td></tr>
<tr><td></td><td>A/C for lobbies (1st sty & Basement)</td><td>0</td><td>12</td><td>0</td></tr>
<tr><td></td><td>A/C for guard house</td><td>2</td><td>24</td><td>48</td></tr>
<tr><td></td><td>Domestic pump</td><td>70</td><td>2</td><td>140</td></tr>
<tr><td></td><td>Ejector pump</td><td>13</td><td>2</td><td>26</td></tr>
<tr><td></td><td>Booster pump</td><td>28</td><td>3</td><td>84</td></tr>
<tr><td></td><td>Sump pump</td><td>12</td><td>0.5</td><td>6</td></tr>
<tr><td></td><td colspan="4">B) Lift Load</td></tr>
<tr><td></td><td>Passenger Lifts</td><td>470</td><td>2</td><td>940</td></tr>
<tr><td></td><td>Service lifts</td><td>0</td><td>2</td><td>0</td></tr>
<tr><td></td><td colspan="4">C) General lighting</td></tr>
<tr><td></td><td>Car park lighting – 24 hours operation</td><td>23</td><td>24</td><td>552</td></tr>
<tr><td></td><td>Car park lighting – 5 hours operation</td><td>23</td><td>5</td><td>115</td></tr>
<tr><td></td><td>Guard house lighting</td><td>0.3</td><td>12</td><td>3.6</td></tr>
<tr><td></td><td>Façade lighting</td><td>0</td><td>5</td><td>0</td></tr>
<tr><td></td><td>Landscape lighting – 12 hours operation</td><td>30</td><td>12</td><td>360</td></tr>
<tr><td></td><td>Landscape lighting – 5 hours operation</td><td>28</td><td>5</td><td>140</td></tr>
<tr><td></td><td>Lift lobbies, corridor & staircase Lighting – 12 hours operation</td><td>20</td><td>12</td><td>240</td></tr>
<tr><td></td><td>Lift lobbies, corridor & staircase Lighting – 5 hours operation</td><td>19</td><td>5</td><td>95</td></tr>
<tr><td></td><td colspan="4">D) Club Facilities</td></tr>
<tr><td></td><td>Club house interior lighting</td><td>12</td><td>12</td><td>144</td></tr>
<tr><td></td><td>Power Gym equipment, SPA, etc</td><td>85</td><td>6</td><td>510</td></tr>
<tr><td></td><td>Swimming Pool Filtration</td><td>50</td><td>12</td><td>600</td></tr>
<tr><td></td><td>Water Feature</td><td>25</td><td>8</td><td>200</td></tr>
<tr><td></td><td colspan="3">Total KWh per day (TEC)</td><td>5660.60</td></tr>
</table>
</td></tr>
</table>

RES 1-10 RENEWABLE ENERGY

Objectives	Encourage the use of renewable energy sources in buildings.
Applicability	Includes all renewable energy sources
Baseline Standard	-
Requirements	Up to 16 credits can be scored based on the percentage replacement of electricity by the renewable energy source For Multi-Storey Residential 3 credits for every 1% replacement of electricity (based on annual electricity consumption exclude household's usage) by renewable energy or 3 credits for every 10% of roof area utilized for solar panels. For Landed Homes 3 credits for every 5% replacement of electricity by renewable energy (per house unit) Condition: The credits scored for renewable energy provision shall not result in a double grade jump in GreenRE rating (i.e. from GreenRE Bronze to Silver to Gold to Platinum).
Documentary Evidences	• Extract of the tender specification and plans showing the location of the renewable energy system and the extent of implementation; • Technical product information on the salient features if the renewable energy system and the expected renewable energy generated; and • Calculation of the percentage replacement of electricity and the total annual electricity consumption of the development.
References	-
Worked Example 1-8	A residential development with GFA of 15,000m^2. The Energy Efficiency Index for its common facilities is 50 kWh/m^2/year The installation of solar array on the roof of its open car park was estimated to generate 7,500 kWh annually Total electricity consumption of the development's common areas = 50 x 15,000 = 750, 000 kWh/year Percentage of replacement of electricity by renewable energy = 7,500 / 750,000 x 100% = 1% Credits scored for 1-8 for 1% replacement of electricity = 3 credits

Part 2- Water Efficiency

RES 2-1 Water Efficient Fittings
RES 2-2 Water Usage Monitoring
RES 2-3 Irrigation System and Landscaping

RES 2-1 WATER EFFICIENT FITTINGS

<table>
<tr><td>Objectives</td><td>Reduce the use of potable water by using water efficient fittings covered under the Water Efficiency Product Labelling Scheme (WEPLS) or Water Efficiency Labelling Scheme (WELS).</td></tr>
<tr><td>Applicability</td><td>Applicable to the water fittings covered by the WEPLS or WELS as follows:
Basin taps and mixers
Flushing cistern
Sink/bib taps and mixers
Shower taps and mixers or showerheads
Urinals and urinals flush valve
Showerheads</td></tr>
<tr><td>Baseline Standard</td><td>As specified under Water Efficiency Product Labelling Scheme (WEPLS) or Water Efficiency Labelling Scheme (WELS).</td></tr>
<tr><td>Requirements</td><td>Up to 10 credits can be scored based on the number and water efficiency rating of the fitting type used (at least 90% of the fitting used).

<table><tr><td colspan="3">Rating Based on Water Efficiency Products Labelling Scheme (WEPLS)</td></tr><tr><td>Efficient *</td><td>Highly Efficient **</td><td>Most Efficient ***</td></tr><tr><td>0.5 credit</td><td>1 credit</td><td>2 credits</td></tr></table></td></tr>
<tr><td>Documentary Evidences</td><td>Extracts of the tender specification showing all the water fitting provisions for the development;
Water fitting schedules showing the numbers, types and the approved rating of the proposed fittings in the prescribed tabulated format shown in the worked example; and
Calculation showing the percentage of proposed water fittings that are approved under any international recognized water efficiency labelling scheme e.g. WEPLS or WELS.</td></tr>
<tr><td>References</td><td>1. For more information on WEPLS, please refer to: (http://www.span.gov.my/index.php?option=com_content&view)

2. For more information of WELS, please refer to: http://www.pub.gov.sg/wels/Pages/default.aspx</td></tr>
</table>

Worked Example 2-1

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

Table 2-1.1: Computation of credits for water fittings

Ref.	Water Fitting Type	WEPLS rating				Total	Credits Allocated
		Efficient	Highly Efficient	Most Efficient	Not Rated		
1	Shower taps and mixers	0	45	0	0	45	1
2	Basin taps and mixers	0	0	55	0	55	2
3	Sink/bib taps and mixers	0	70	0	0	70	1
4	Flushing cisterns	0	0	50	0	50	2
5	Others - Urinals for club house	0	0	0	5	5	0
	Total	0	115	105	5	225	6

Credits scored = 6 credits

Percentage of fittings with water efficiency rating = 220/225 = 97.7%

RES 2-2 WATER USAGE MONITORING

Objectives	Promote the use of sub meters for better control and monitoring of major water usage.
Applicability	Applicable to sub-metering provisions for major water uses of the building developments.
Baseline Standard	-
Requirements	1 credit can be scored if sub meters are provided for **ALL** major water uses i.e. irrigation system, cooling tower and tenant's usage.
Documentary Evidences	• Extracts from the tender specification stating the locations and provision of private meters for all major water uses. • Schematic drawings of cold water distribution system showing the location of the sub meters provided.
References	-

RES 2-3 IRRIGATION SYSTEM AND LANDSCAPING

Objectives	Reduce potable water consumption by provision of suitable systems that utilities rainwater or recycled water for landscape irrigation and use of plants that require minimal irrigation to reduce potable water consumption.
Applicability	Applicable to residential development with landscaping provision.
Baseline Standard	-
Requirements	2-3(a) 1 credit can be scored for the use of non-potable water including rainwater for landscape irrigation. 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.
Documentary Evidence	For 2-3(a) • Extracts of the tender specification showing how the non-potable water source is provided; and • Relevant drawings showing the location and design of 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. 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.
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/

Part 3- Environmental Protection

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

RES 3-1 SUSTAINABLE CONSTRUCTION

<table>
<tr><td>Objectives</td><td>Encourage recycling and the adoption of building designs, construction practices and materials that are environmentally friendly and sustainable.</td></tr>
<tr><td>Applicability</td><td>Generally applicable to all building developments.</td></tr>
<tr><td>Baseline Standard</td><td>-</td></tr>
<tr><td>Requirements</td><td>
3-1(a) Up to 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 by mass for superstructural works:

Table 3-1.1 : Credits allocation according to replacement percentage
<table>
<tr><th>Replacement of OPC by approved industrial by-products (%)</th><th>Credit Allocation</th></tr>
<tr><td>10</td><td>1</td></tr>
<tr><td>20</td><td>2</td></tr>
<tr><td>30</td><td>3</td></tr>
<tr><td>40</td><td>4</td></tr>
<tr><td>>50</td><td>5</td></tr>
</table>
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.

Table 3-1.2 : Credits allocation for project CUI
<table>
<tr><th>Project CUI (m^3/m^2)</th><th>Credits Allocation</th></tr>
<tr><td>≤ 0.70</td><td>1</td></tr>
<tr><td>≤ 0.60</td><td>2</td></tr>
<tr><td>≤0.50</td><td>3</td></tr>
<tr><td>≤0.40</td><td>4</td></tr>
<tr><td>≤0.35</td><td>5</td></tr>
</table>
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 :

$$\text{Concrete Usage Index} = \frac{\text{Concrete Volume } (m^3)}{\text{Constructed Floor Area } (m^2)}$$
</td></tr>
</table>

<table>
<tr><td>Documentary Evidences</td><td><u>For 3-1(a)</u>
• Extract of tender specification showing the requirements to use Green Cement.

<u>For 3-1(b)</u>
• Architectural and structural plan layout, elevation and sectional plans showing the type of wall system used, the dimensions and sizes of all the building and structural elements; and
• Calculation showing the quantity of concrete used for each floor level.</td></tr>
<tr><td>Worked Example 3-1(a)</td><td>Proposed development comprises a 15 storey residential block with a basement car park and the following details:

Gross Floor Areas (GFA) = 10,000 m^2

Use of Green Cements to replace 10% of OPC for superstructural works

Credits scored = 1 credit

Credits scored for 3-1(a) should be 1 credits</td></tr>
<tr><td>Worked Example 3-1(b)</td><td>Proposed development comprises a 15 storey residential block with a basement carpark and the following details:

Table 3-1.3 : Concrete usage and constructed floor areas
<table><tr><th>Concrete usage for the superstructure</th><th>Constructed floor areas</th></tr><tr><td>For 1st storey = 587 m^3
For 2nd to 15th storey = 5400 m^3
(including roof level)

Therefore,
Total concrete usage = 5987 m^3</td><td>For 1st storey = 1000 m^2
For 2nd to 15th = 14000 m^2
(including roof level)

Therefore,
Total constructed floor area = 15000m^2</td></tr></table>
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 $m^3/m^2 \leq$ 0.4 m^3/m^2

Therefore, credits scored = 4 credits

Refer to the following Table 3-1.4 for more details</td></tr>
</table>

Worked Example 3-1(b) – Cont'd

Table 3-1.4 – Concrete Usage Index

COMPUTATION OF CONCRETE USAGE INDEX RESIDENTIAL 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

Worked Example 3-1(b) Cont'd

COMPUTATION OF CONCRETE USAGE INDEX				RESIDENTIAL 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	

*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.

RES 3-2 SUSTAINABLE PRODUCTS

<table>
<tr><td>Objectives</td><td>Encourage the use of products that are environmentally friendly and sustainable.</td></tr>
<tr><td>Applicability</td><td>Applicable to non-structural and architectural building components.</td></tr>
<tr><td>Baseline Standard</td><td>-</td></tr>
<tr><td>Requirements</td><td>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.

Table 3-2.1 : Weightage for credits allocation
<table><tr><th>Extent of use of environmentally friendly product</th><th>Weightage for Credits 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>
The use of environmental friendly products or recycled materials used for all dwelling units of the development will be considered as <u>high impact</u> (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 <u>medium impact (1 credit)</u> 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 <u>low impact.</u> All applications will be subject to GreenRE’s evaluation.

(2) The credit allocated for low volatile organic compound (VOC) paints and adhesives certified by approved local certification body can be found in RES 4-2 and hence shall not be included in the scoring for RES 3-2.</td></tr>
</table>

<table>
<tr><td>Documentary Evidences</td><td>

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, rating and details; and
Technical product information.

</td></tr>
<tr><td>References</td><td>For more info on product certification, please refer to:

http://www.sirim-qas.com.my/index.php/zh/our-services/product-certification/eco-labelling-scheme

http://www.sec.org.sg/sgls or http://www.sgbc.sg/green-certifications</td></tr>
<tr><td>Worked Example 3-2</td><td>
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 (all approved by local / international certification body :

(a) Use of certified wooden doors for all dwelling units.
(b) Use of certified bamboo flooring for all units' bedrooms.
(c) Use of certified roof waterproofing coating.

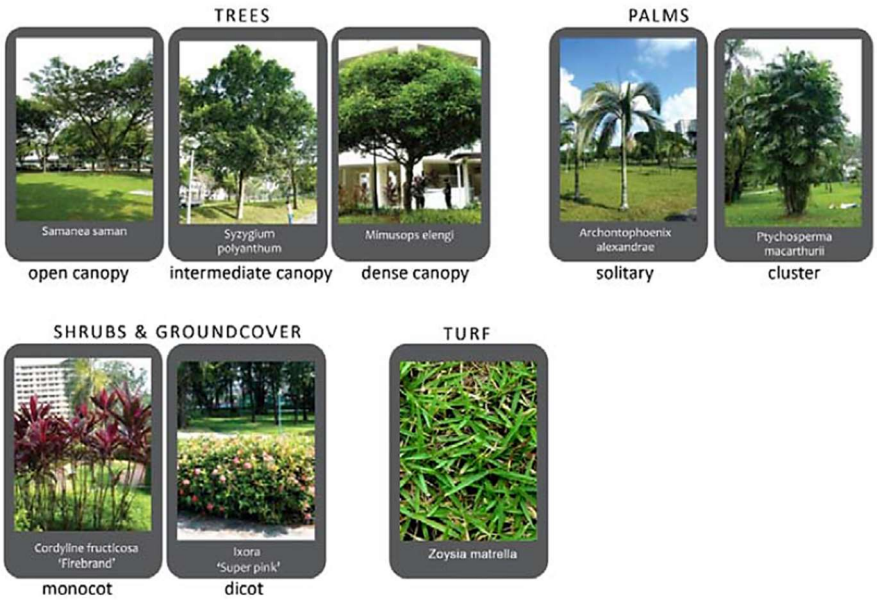
Table 3-2.3 : Detail calculation for credits scoring
<table>
<tr><th colspan="2">Products and Extent of coverage</th><th>With approved certification</th><th>Extent use category</th><th>Total credits</th></tr>
<tr><td>(a)</td><td>Wooden doors for all dwelling units</td><td>Yes</td><td>High</td><td>2</td></tr>
<tr><td>(b)</td><td>Bamboo flooring for all units' bedrooms</td><td>Yes</td><td>High</td><td>2</td></tr>
<tr><td>(c)</td><td>Roof waterproofing</td><td>Yes</td><td>Low</td><td>0.5</td></tr>
</table>

Therefore, credits scored for 3-2 = 2 + 2 + 0.5 = 4.5 credits
</td></tr>
</table>

RES 3-3 GREENERY PROVISION

<table>
<tr><td>Objectives</td><td>Encourage greater use of greenery and restoration of existing trees to reduce heat island effect.</td></tr>
<tr><td>Applicability</td><td>Applicable to building developments with landscaping areas.</td></tr>
<tr><td>Baseline Standard</td><td>-</td></tr>
<tr><td>Requirements</td><td>Multi-storey Residential
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).

Table 3-3.1: Leaf Area Index (LAI)
<table>
<tr><th>Plant group</th><th>Trees</th><th>Palms</th><th>Shrubs & Groundcover</th><th>Turf</th></tr>
<tr><td>LAI</td><td>Canopy:
Open = 2.5
Intermediate = 3.0
Dense = 4.0</td><td>Solitary = 2.5
Cluster = 4.0</td><td>Monocot = 3.5
Dicot = 4.5</td><td>Turf = 2.0</td></tr>
<tr><td>Area</td><td>All = 60 m^2</td><td>Solitary = 20m^2
Cluster = 17m^2</td><td>Planted area</td><td>Planted area</td></tr>
</table>

</td></tr>
</table>

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

Table 3-3.2 : Credits Allocation according to GnPR

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

Landed Homes

3-3(b) Up to 3 credits can be scored for provision of greenery within non-built up area of each dwelling.

i) 50% of non-built up area as greenery area = 1 credit
ii) 60% of non-built up area as greenery area = 2 credits
iii) 75% of non-built up area as greenery area = 3 credits

3-3(c) Up to 3 credits can be scored for provision of green space above regulatory requirements for entire development

i) 5% more green space = 1 credit
ii) 10% more green space = 2 credits
iii) 15% more green space = 3 credits

For all Residential Developments

3-3 (d) 1 credit for restoration of trees on-site, conservation or relocation of existing trees on site. (at least 20%)

3-3 (e) 1 credit for the use of compost recycled from horticulture waste.

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; and
- Calculation showing the extent of the greenery provision in the prescribed tabulated formats as in worked example 3-3(a).

For 3-3 (b)

- Plan layouts showing the site area as well provision of greenery within non-built up area of each dwelling (softscape).

For 3-3 (c)

- Masterplan of development highlighting provision of additional green space above regulatory requirements.

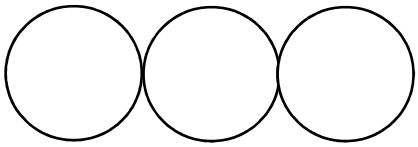
	For 3-3 (d) • Site layouts showing the existing and final locations (where applicable) and number of the trees to be restored or conserved or relocated. For 3-3 (e) • Extracts of the tender specification showing the requirements to use compost recycled from horticulture waste.
Exceptions	**TREES AND 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). I——2m——I  COLUMNAR TREES (b) For trees that have tight, columnar crowns, the canopy area of $12m^2$ 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	National Parks Board, Singapore - 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

Table 3-3.3: Calculation of the Green Plot Ratio

Category	Sub category	(A) LAI value	(B) Canopy area	(C) Qty/Planted Area	(A)x(B)x(C) 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**

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

Assume site area is 2000 m^2

Green Plot Ratio (GnPR) = total leaf area / site area

= 5790 / 4000 = 2.9 < 3.0

Where GnPR = 2.0 to < 3.0

Therefore, credits scored for 3-3(a) = 2 credits

RES 3-4 ENVIRONMENTAL MANAGEMENT PRACTICE

Objectives	Encourage the adoption of environmental friendly practices during construction and building operation.
Applicability	Generally applicable to building developments.
Baseline Standard	-
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. 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 under the Quality Assessment System in Construction (QLASSIC) or Construction Quality Assessment System (CONQUAS). 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 environmental friendly facilities and features within the building and their uses in achieving the intended environment performance during building operation. 3-4(h) 1 credit can be scored for provision of green fit out guidelines (to be included in management committee bylaws) to detail recommended minimum environmental standards to assist building users' in making sustainable fit-out decisions. 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.

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; and • Details of the environmental friendly programmes implemented. For 3-4(b) • A certified true copy of the main builder's Green award; or • Details of track records 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 Construction Quality Assessment System (CONQUAS) or Quality Assessment System in Construction (QLASSIC) where applicable. For 3-4(d) • Extracts of the tender specification showing the requirement to adopt CIDB IBS scoring. 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 Manager/Green Mark Manager where applicable and a confirmation of their involvement in design team. 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 the building green fit-out guidelines highlighting requirements for sustainable fit-out. For 3-4(i) • Plan layout showing the location of the recycling bins for collection and storage of different recyclable waste.
References	-

RES 3-5 GREEN TRANSPORT

Objectives	Promote environmental friendly transport options and facilities to reduce pollution from individual car use.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
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(c) 1 credit can be scored for provision of electric vehicle charging stations and priority parking lots within the development. 3-5(d) Up to 1 credit can be scored for the provision of covered/sheltered bicycles parking lots with rack / locking bar.
Documentary Evidences	For 3-5(a) • Site layout plan in the context of the surrounding area showing the location of the development site and the location of the MRT/LRT stations and bus stops. For 3-5(b) • Site layout plan showing the connection of covered walkway from the development to the MRT/LRT stations or bus stops; and • 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 tapping points for future installation of electric charging stations to at least 10% of available parking spaces. For 3-5(d) • Extracts of the tender specification showing the requirement to provide hybrid/electric vehicle refuelling/recharge stations.

	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.
References	-

RES 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.
Baseline Standard	-
Requirements	Up to 3 credit 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	• Site layout plans indicating the total site area, total paved area within the site as well as the total catchment areas. Other information such as the total paved areas within the catchment areas, treatment areas and the hydraulic retention time of the design features area to be included where applicable. • 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. Relevant design calculations and simulation/modelling results are to be provided where applicable. • Calculations showing reduction in stormwater peak discharge rate and quantity beyond minimum MSMA requirements.
References	MSMA – Urban Storm Water Management

RES 3-7 INTERNET CONNECTIVITY

Objectives	Encourage working from home via internet connection, thereby discouraging commuting.
Applicability	Applicable to all dwelling units in the development.
Baseline Standard	-
Requirements	1 credit can be scored if infrastructure for high speed broadband is provided to all dwelling units.
Documentary Evidences	• Extracts from the tender specification stating the requirement for provision of high speed broadband infrastructure to all dwellings. • Letter of support from Internet Service Provider or evidence that locality has accessibility to high speed broadband service.
References	-

RES 3-8 COMMUNITY CONNECTIVITY

Objectives	Encourage development in urban area with existing infrastructure to minimise the use of private mode of transportation.
Applicability	Generally applicable to building developments.
Baseline Standard	-
Requirements	1 credit can be scored for project located within walking distance of 1km to at least 10 Basic Services. Basic Services include, but are not limited to: • Bank • Beauty • Convenience/Grocery • Day care • Fire Station • Hardware • Laundry • Library • Police station • Park • Pharmacy • Post Office • Restaurant • School • Supermarket • Clinic
Documentary Evidences	• Site layout plan showing the location of the development site and the location of Basic Services mentioned above.
References	-

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

RES 4-1 NOISE LEVEL

<table>
<tr><td>Objectives</td><td>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.</td></tr>
<tr><td>Applicability</td><td>Generally applicable to building developments.</td></tr>
<tr><td>Baseline Standard</td><td>ASTEM E413 or equivalent</td></tr>
<tr><td>Requirements</td><td>1 credit can be scored if the building is designed to achieve ambient internal noise level as specified:

• 55dB (6am – 10pm) L_{Aeq}
• 45dB (10pm – 6 am) L_{Aeq}

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

<table>
<tr><th>Description</th><th>Sound Transmission Class (STC)</th></tr>
<tr><td>Separation between functional spaces within dwelling units and in-between adjacent dwelling units.</td><td>40 - 50</td></tr>
<tr><td>Spaces between mechanical and equipment spaces and occupied spaces</td><td>50 - 60</td></tr>
</table>

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.</td></tr>
<tr><td>Documentary Evidences</td><td>• Extracts of the tender specification showing the requirement to design the occupied space with the ambient sound levels and STC ratings.
• A report of the detailed analysis and recommendations from acoustic consultant on how the designed ambient sound levels can be met where applicable.</td></tr>
<tr><td>References</td><td>-</td></tr>
</table>

RES 4-2 INDOOR AIR POLLUTANTS

Objectives	Minimise airborne contaminants, mainly from inside sources to promote a healthy indoor environment.
Applicability	Generally applicable to building developments.
Baseline Standard	-
Requirements	4-2(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. 4-2(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 4-2(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. • Technical product information For 4-2(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 or equivalent for all composite wood products used. • Technical product information
References	-

RES 4-3 WASTE DISPOSAL

Objectives	Minimise airborne contaminants from waste.
Applicability	Generally applicable to building developments.
Baseline Standard	-
Requirements	For Multi-storey Residential 1 credit can be scored if the refuse chutes or waste disposal are located at open ventilation areas such as service balconies or common corridors For Landed Homes 1 credit can be scored for provision of space that is naturally ventilated in a convenient location for kerbside collection.
Documentary Evidences	• Plan layouts showing the location of the refuse chutes for all typical dwelling units. • Plan layout showing location of waste disposal space for all landed home units.
References	-

RES 4-4 INDOOR AIR QUALITY IN WET AREAS

Objectives	Encourage provision of adequate natural ventilation and day lighting in wet areas.
Applicability	Generally applicable to all wet areas such as kitchens, bathroom and toilets of the development.
Baseline Standard	-
Requirements	Up to 2 credits can be scored if there is provision for adequate natural ventilation and day lighting in wet areas i.e. kitchens, bathroom and toilets. • 2 credits for more than 90% of all applicable areas. • 1 credit for at least 50% to 90% of all applicable areas.
Documentary Evidences	• Plan layouts showing the location of the window openings of the kitchens, bathrooms and toilets for all typical dwelling units.
References	-

Part 5 – Other Green Features

RES 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.
Baseline Standard	-
Requirements	Up to 7 credits can be scored for the use of the following green features depending on their potential environmental benefits and the extent of coverage. <u>Water efficiency</u> i. Use of self-cleaning façade system • 2 credits for more than 75% of the applicable facades areas • 1 credit for more than 50% of the applicable facades areas • 0.5 credit for at least 25% of the applicable facades areas ii. Use of integrated basin/cistern pedestal system • 2 credit s for more than 50% of all dwelling units' flushing cisterns • 1 credit for more than 25% of all dwelling units' flushing cisterns • 0.5 credit for at least 10% of all dwelling units' flushing cisterns iii. Use of grey water recycling system • 2 credits for all blocks of the development. • 1 credit for at least one block of the development. iv. Provision of system to recycle surface runoff from the vertical green wall and sky garden • 1 credit for at least 25% of the green areas • 0.5 credit for less than 25% of the green areas v. Use of water efficient washing machine with WEPLS "Efficient" rating and above • 1 credit for more than 90% of all dwelling units. • 0.5 credit for at least 50% of all dwelling units. <u>Environmental Protection</u> i. Use of precast toilet • 2 credits for more than 75% of all toilets • 1 credit for more than 50% of all toilets • 0.5 credit for at least 25% of all toilets ii. 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

	iii. 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 iv. 1 credit for the provision of double refuse chutes for separating recyclable from non-recyclable waste. v. 0.5 credit for the use of non-chemical termite treatment system. vi. 0.5 credit for the provision of at least 5 nos. of compost bins to recycle organic waste. vii. 0.5 credit for the use of non-chemical water treatment system for swimming pools. viii. Conservation of existing building structure or building envelope (by areas). • 2 credits for conserving more than 50% of the existing structure or building envelope • 1 credit for conserving at least 25% of the existing structure or building envelope ix. 1 credit for the computation of Concrete Usage Index (CUI) of the building development. x. Adoption of demolition protocol to maximise resource recovery of demolition materials for reuse or recycling. • 2 credits for recovery rate of more than 35% crushed concrete waste to be sent to the approved recycles with proper facilities • 1 credit for recovery rate at least 20% crushed concrete waste to be sent to the approved recyclers with proper facilities <u>Indoor Air Quality</u> 1 credit for the use of pneumatic waste collection system. <u>Others</u> 0.5 credit for the use of siphonic rainwater discharge system at roof. **Notes:** For features that are not listed above, the QP is required to submit the details showing the positive environmental impacts, possible saving 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;

	• A summary sheet listing the breakdown and the extent of implementation as well as the total requirements for the same intended purpose for the specific green features used; and • Quantified evidences on the potential environmental benefits that the features can bring to the development. • Computation of Concrete Usage Index (CUI) and supporting documents as stated under RES 3-1(b) • Demolition audit from showing the summary of the total and actual quantity of concrete waste and delivery records or receipts from approved recycling firm.
References	-

Part 6 – Carbon Emission of Development

RES 6-1 CARBON EMISSION OF DEVELOPMENT

<table>
<tr><td>Objectives</td><td>To calculate the carbon emission resulted from the associate energy used during construction and operational phase of development.</td></tr>
<tr><td>Applicability</td><td>Generally applicable to all building development.</td></tr>
<tr><td>Baseline Standard</td><td>-</td></tr>
<tr><td>Requirements</td><td>1 credit can be scored for the calculation of the carbon footprint report of the building comprising of energy and water consumption savings with comparison of the baseline parameters.

Up to 2 credits can be scored for identifying embodied carbon of building materials used for construction.</td></tr>
<tr><td>Documentary Evidences</td><td>• Electricity bill of the development for the year
• Water bill of the development for the year
• Operational Carbon footprint calculation
• Embodied carbon footprint calculation based on BCA’s online calculator</td></tr>
<tr><td>Worked Example 6-1</td><td>Energy Consumption
<table>
<tr><td rowspan="2">Type of usage</td><td>Design</td><td>Baseline</td></tr>
<tr><td>(kWh/yr)</td><td>(kWh/yr)</td></tr>
<tr><td>Lighting</td><td>819,498</td><td>1,151,575</td></tr>
<tr><td>Air-Conditioning</td><td>860,589</td><td>1,406,899</td></tr>
<tr><td>M/V System</td><td>25,550</td><td>25,550</td></tr>
<tr><td>Total Energy Usage</td><td>1,705,637</td><td>2,584,024</td></tr>
</table>
Water Consumption
<table>
<tr><td rowspan="2">Type of fixtures</td><td>Design</td><td>Baseline</td></tr>
<tr><td>(m^3/yr)</td><td>(m^3/yr)</td></tr>
<tr><td>Flow Fixtures</td><td>2,402</td><td>6,899</td></tr>
<tr><td>Flush Fixtures</td><td>5,366</td><td>5,161</td></tr>
<tr><td>Total Water Usage</td><td>7,768</td><td>12,060</td></tr>
</table>
Carbon Footprint
<table>
<tr><td rowspan="2">Type of usage</td><td>Design</td><td>Baseline</td></tr>
<tr><td>kgCO_2e/yr</td><td>kgCO_2e/yr</td></tr>
<tr><td>Energy</td><td>1,226,619</td><td>1,860,497</td></tr>
<tr><td>Water</td><td>155,344</td><td>241,192</td></tr>
<tr><td>Total Annual Carbon Footprint</td><td>1,381,963</td><td>2,101,689</td></tr>
</table>
*CO_2 conversion factor for energy = 0.72, water = 0.02.
Please use up-to-date CO_2 conversion factor for both energy and water.

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

Credits scored for 6-1 = 1 credit</td></tr>
</table>

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.

Table: Summary Checklist and the Corresponding Signatories for GreenRE Residential & Landed Home Criteria

GreenRE Criteria	Required Signatories
Part 1 – Energy Efficiency	
RES 1-1 Thermal Performance of Building Envelope- RETV	PA
RES 1-2 Naturally Ventilated Design and Air-Conditioning System • Dwelling Unit Comfort - Ventilation Simulation/ Design - Use of energy efficient air conditioners • Natural Ventilation in Common Areas	 PA PE PA
RES 1-3 Daylighting	PA
RES 1-4 Artificial Lighting	PE
RES 1-5 Ventilation in Carparks	PE
RES 1-6 Lifts	PE
RES 1-7 Energy Efficient Features • Heat Recovery Devices • Motion Sensors/ Photo Sensors • Others	 PE PE S
RES 1-8 Renewable Energy	S
Part 2 – Water Efficiency	
RES 2-1 Water Efficient Fittings	PA
RES 2-2 Water Usage Monitoring	PE
RES 2-3 Irrigation System and Landscaping	PE
Part 3 – Environmental Protection	
RES 3-1 Sustainable Construction	PE
RES 3-2 Sustainable Products	PA
RES 3-3 Greenery Provision	PE
RES 3-4 Environmental Management Practice	PE
RES 3-5 Green Transport	PA
RES 3-6 Stormwater Management	PE
RES 3-7 Community Connectivity	PA
Part4 – Indoor Environmental Quality	
RES 4-1 Noise Level	S
RES 4-2 Indoor Air Pollutants	PA
RES 4-3 Waste Disposal	PA
RES 4-4 Indoor Air Quality in Wet Areas	PA
Part 5 – Other Green Features	
RES 5-1 Green Features & Innovations	S
Part 6 – Carbon Emission of Development	
RES 6-1 Carbon Emission of Development	S

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

Appendix A

VENTILATION SIMULATION METHODOLOGY AND REQUIREMENTS

A1 General

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

A2 Simulation Software

The CFD modelling shall be carried out using well validated software. The CFD solver shall have the minimum capability of solving the Navier-Stokes fluid flow equations for a three-dimensional incompressible flow at steady state on a body conforming computational grid. Turbulence modelling shall also be included with the minimum requirement of using the standard k-ε turbulence model, coupled with standard wall function.

A3 Ventilation Simulation Methodology

A3.1 All simulation shall be carried out under isothermal condition of 33.0°C air temperature at steady state condition.

A3.2 The computational domain shall include the development of interest, the characteristics of the immediate surroundings and buildings reside within the proximity of minimum 3 times or more the length of the longest distance measured across the boundary of the development. In the event that the building and surrounding development are located within hilly terrain, the topography information shall also be included in the simulation models. The computational domain shall be further extended from the outer edge of the proximity regions to the boundary such that it would not result in non-physical airflow solution, after the solution has converged. The computational domain shall also be aligned along with the wind flow direction. The domain height shall be extended, approximately 3 times the height of the tallest building within the defined vicinity.

A3.3 The computational grid generated for all simulations should resolve the salient flow features in the apartment units and around the development. As a guide, the dimension of the computational elements should be set at 0.1 to 0.2m in the apartment unit, 0.5 to 1.0m at all buildings and ground level and 10m at the far field boundary with a minimum 50m away from the ground.

A3.4 Based on local climatic wind condition, meteorological data on the precise wind direction and velocity of the proposed site location for the month of December, March, June and September shall be used for the CFD simulation. The prevailing wind condition such as the mean speed and direction for Malaysia shall be taken from Table A3.4 below. The inbound vertical wind profile shall assume to be given by the Logarithmic Law reference height at 15.0m

Table A3.4: Tabulation of Prevailing Wind Direction & Speed obtained from Malaysian Meteorological Department (MMD) over a period of 18 years.

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

A3.5 There shall have two large scale simulation models using the specified computational domain and grid stated in paragraph A3.2 and A3.3, to assess the wind flow conditions and air-flow pattern within the development and units. The simulation modelling can be conducted based on the two best prevailing wind directions for the building development that is North or North-East (N or NE) and South or South-East (S or SE).

Stage 1 CFD Simulation model for development	i. Determine up to five (5) typical unit design layouts that have the majority number of units. If the proposed building development comprises less than 5 typical types, all the typical unit design layout are to be selected for the simulation. ii. Conduct a large scale CFD simulation to assess the wind flow conditions around the proposed building development and adjacent buildings. Natural ventilated corridor linked to the unit should be taken into consideration for the simulation models. iii. From the simulation results, determine the wind pressure taken at 0.5m from every assumed opening of all units at mid height level (capped at 20 storey height) and the pressure difference (i.e. the difference of the maximum and minimum wind pressure) of each unit. In instances, where all or some of the typical unit layouts are not designed at mid-height level, the average wind

	pressure and respective pressure differences should be determined for these typical units located at the level closest to the mid-height level. iv. Derive the average pressure difference of all units at mid-height or selected level. v. Select the unit with pressure difference that is closest to the average pressure difference derived in A3.5 (iv) from each typical unit design layout as determined in A3.5 (i) for Stage 2 simulation. The maximum allowable margin of ± 10% difference from the average pressure difference is deemed acceptable.
Stage 2 CFD Simulation model for units	vi. Conduct a large scale CFD simulation to assess the air flow conditions of these five (5) selected units. All living or functional spaces in the unit are to be included in the simulation modelling except for enclosed spaces such as storeroom or CD shelter. For the simulation model, all windows and doors are assumed to be fully opened except for the main door, which is assumed to be closed at all time. vii. From the simulation results, determine the area-weighted average wind velocity of each selected unit by considering the air flow conditions of the applicable areas. For residential buildings, the applicable areas refer to living room, open kitchen (that is connected to the living room), study rooms and all bedrooms. The area-weighted average wind velocities of these areas are to be computed at horizontal-plane 1.2m above the floor level. The same applies to naturally ventilate functional spaces for non-residential buildings.

A3.6 The selected unit is deemed to have good natural ventilation if the area-weighted average wind velocity of the unit is not less than 0.6 m/s. The overall percentage of units achieving good natural ventilation is given by:

$$\frac{\sum(\text{No. of Selected Units for Each Layout} \times \text{Area-Weighted Average Wind Velocity})}{\text{Total Number of Selected Units} \times 0.60 \text{ m/s}} \times 100$$

A4 Documentation Requirements

A4.1 The Qualified Person (QP) and the other appropriate practitioners shall ensure that the following report is available as evidences to demonstrate compliance with the ventilation simulation framework. The report should comprise the following items:

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

ii. Table of Content

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

iv. Background/Introduction

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

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

vii. Simulation settings
- Boundary conditions
- CFD software/models used/numerical scheme
- Mesh/cell sizing
- Solution control-converge criteria

viii. Result and discussions

- Simulation results for development for all directions showing the main graphical plots of the plan pressure and velocity vector and salient findings
- Tabulation showing the listing and details of all typical unit types and the selected unit types as well as the corresponding number of units and the area-weighted average wind velocity within each selected unit where applicable.
- Calculation of percentage of units with good natural ventilation and area-weighted average wind velocity of 0.60 m/s or more.

ix. Conclusion

x. The following plots are to be placed in the appendixes

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