DESIGN REFERENCE GUIDE

Industrial Facilities

Version 1.0

22nd November 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
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No.2C, Jalan SS5/6D,
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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 Industrial Facilities (referred to as “this Guideline”) is to establish environmentally friendly practices for the planning, design and construction of buildings, which would help to mitigate the environmental impact of built structures.

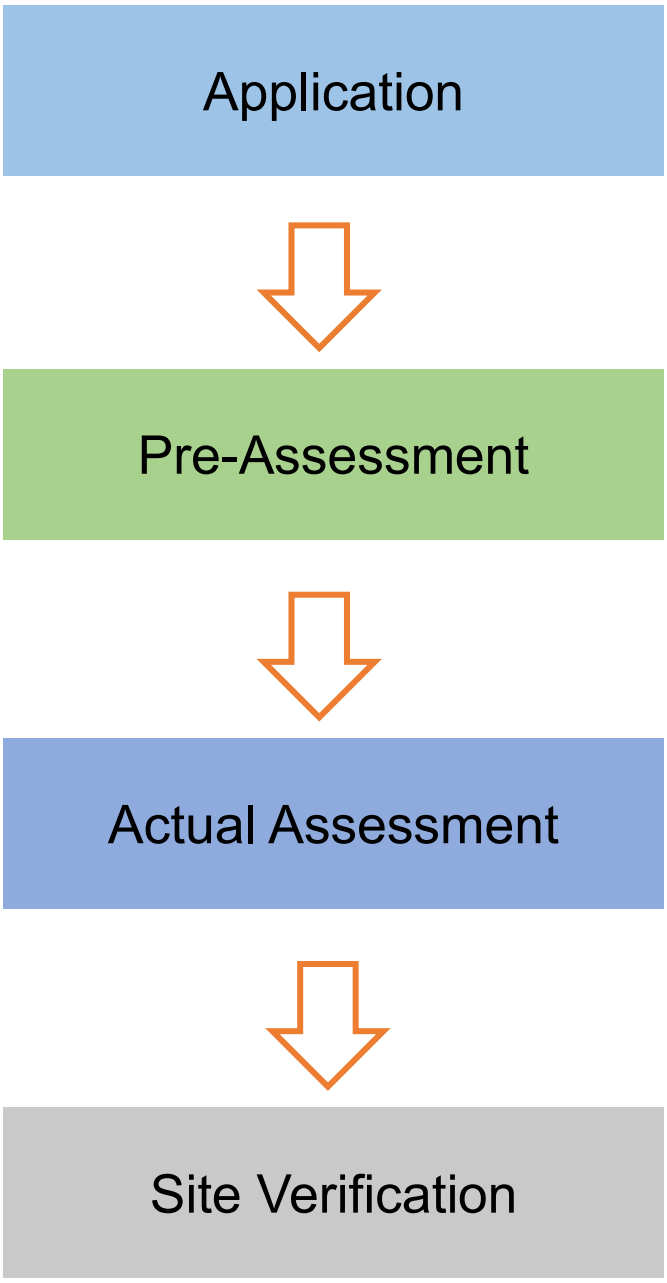
This Guideline is not intended to abridge safety, health, environmental or related requirements contained in other applicable laws, codes or policies administered by relevant authorities. Where there is a conflict between a requirement of this Guideline and such other regulations affecting the design,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

3. Revision Log

Revision	Description	Date Effective
1.0	Issued for Implementation	22nd November 2018

4. GreenRE Assessment Stages

The GreenRE Industrial Facilities 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 building 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.

Final Certificate will be issued upon completion of this stage.

5. GreenRE Industrial Facilities Rating System

Overview:

This design guide is to be read in conjunction with Non-Residential Building toolkit (NRBv3.1). The GreenRE industrial facilities rating system is divided into six (6) sections as follows:

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.

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

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.

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.

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.

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

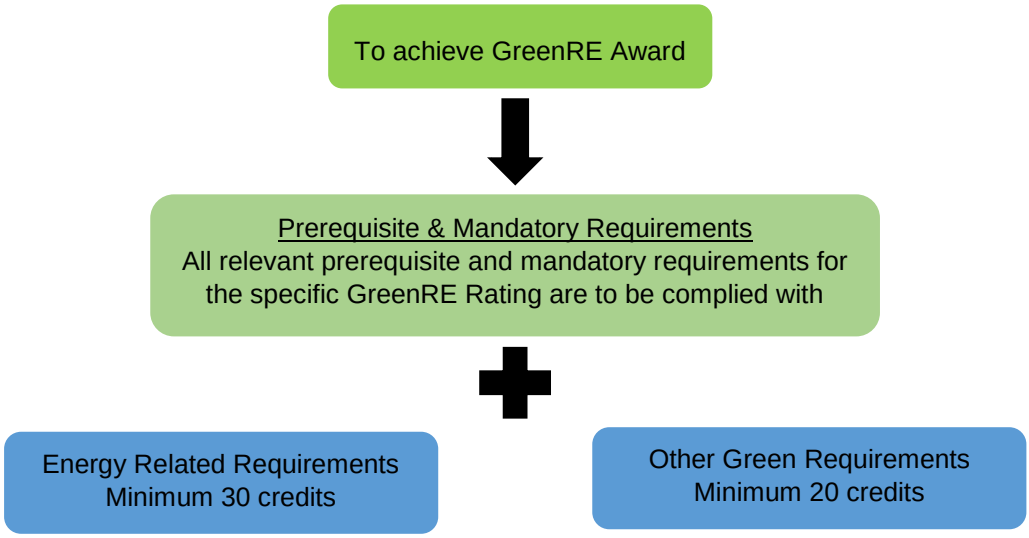
These environment impact categories are broadly classified under two main groups namely (I) Energy Related Requirements and (II) Other Green Requirements.

Energy Related Requirements consist of Part 1- Energy Efficiency where credits are allocated for the various energy efficient designs, practices and features used. A minimum of 30 credits must be obtained from this group to be eligible for certification. The number of credits achievable for this group is capped at 50 credits (exclude 15 bonus credits that are obtainable under IND 1-14 – On-site Energy Generation).

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 on-site energy generation sources.

Framework:



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

Part 1 – Energy Efficiency
IND 1-1 Thermal Performance of Building Envelope -OTTV
IND 1-2 Air-Conditioning System
IND 1-3 Building Envelope – Design/ Thermal Parameters
IND 1-4 Natural Ventilation/Mechanical Ventilation
IND 1-5 Daylighting
IND 1-6 Artificial Lighting
IND 1-7 Lighting Zoning
IND 1-8 Ventilation in Carparks
IND 1-9 Ventilation in Common Areas
IND 1-10 Vertical Transportation Efficiency
IND 1-11 Electrical Services
IND 1-12 Local Energy Generation for Service Hot Water
IND 1-13 Energy Efficiency Practices and Features
IND 1-14 On-site Energy Generation

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

Part 2 - Water Efficiency
IND 2-1 Water Efficient Fittings
IND 2-2 Water Usage and Leak Detection
IND 2-3 Alternative Water Sources
IND 2-4 Irrigation System and Landscaping
IND 2-5 Water Consumption of Cooling Tower

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

Part 4 - Indoor Environmental Quality
IND 4-1 Thermal Comfort
IND 4-2 Noise Level
IND 4-3 Indoor Air Pollutants
IND 4-4 Indoor Air Quality (IAQ) Management
IND 4-5 External Views
IND 4-6 Quality of Artificial Lighting

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

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

Category			Credits Allocation
	(I) Energy Related Requirements		
Minimum 30 credits	**Part 1: Energy Efficiency**		
	IND 1-1 Thermal Performance of Building Envelope – OTTV	Section (A) Applicable to air-cond. areas	10
	IND 1-2 Air – Conditioning System		33
	Sub -Total (A) – IND 1-1 to 1-2		**43**
	IND 1-3 Building Envelope – Design/ Thermal Parameters	Section (B) Applicable to non air- cond. areas	30
	IND 1-4 Natural Ventilation/Mechanical Ventilation		15
	Sub – Total (B) – IND 1-3 to 1-4		**45**
	IND 1-5 Daylighting	Section(C) Applicable to all areas	6
	IND 1-6 Artificial Lighting		10
	IND 1-7 Lighting Zoning		3
	IND 1-8 Ventilation in Carparks		2
	IND 1-9 Ventilation in Common Areas		5
	IND 1-10 Vertical Transportation Efficiency		1
	IND 1-11 Electrical Services		7
	IND 1-12 Local Energy Generation for Service Hot Water		6
	IND 1-13 Energy Efficiency Practices and Features		10
	IND 1-14 On-site Energy Generation		16
	Sub – Total (C) – IND 1-5 to 1-14		**66**
	Category Score for Part 1 – Energy Efficiency [Prorate Subtotal (A) + Prorate Subtotal (B)] + Subtotal (C)		**111 (MAX)**
	(II) Other Green Requirements		
Minimum 20 credits	**Part 2: Water Efficiency**		
	IND 2-1 Water Efficient Fittings		6
	IND 2-2 Water Usage and Leak Detection		2
	IND 2-3 Alternative Water Sources		3
	IND 2-4 Irrigation System and Landscaping		3
	IND 2-5 Water Consumption of Cooling Tower		2
	Category Score for Part 2 – Water Efficiency		**16**
	Part 3: Environmental Protection		
	IND 3-1 Sustainable Construction		10
	IND 3-2 Sustainable Products		8
	IND 3-3 Greenery Provision		8
	IND 3-4 Environmental Management Practice		11
	IND 3-5 Green Transport		5
	IND 3-6 Stormwater Management		3
	IND 3-7 Refrigerants		2
	Category Score for Part 3 – Environmental Protection		**47**
	Part 4: Indoor Environmental Quality		
	IND 4-1 Thermal Comfort		2
	IND 4-2 Noise Level		2
	IND 4-3 Indoor Air pollutants		2
	IND 4-4 Indoor Air Quality (IAQ) Management		2
	IND 4-5 External Views		1
	IND 4-6 Quality of Artificial Lighting		2
	Category Score for Part 4: Indoor Environmental Quality		**11**
	Part 5: Other Green Features		
	IND 5-1 Green Features & Innovations		9
	Category Score for Part 5: Other Green Features		**9**
	Part 6: Carbon Emission of Development		
	IND 6-1 Carbon Emission of Development		3
	Category Score for Part 6: Carbon Emission of Development		**3**
	Category Score for Part 2 to Part 6 – Other Green Requirements		**86**
GreenRE Non-Residential Building Score:			**197 (MAX)**

6. GreenRE Industrial Facilities 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 Industrial Facilities Rating System Criteria

Pre-requisites:

1) Air-Conditioned Buildings

General

- To demonstrate the stipulated energy savings over its reference model using an energy modelling framework set out. Details and submission requirements on energy modelling can be found in Appendix A of NRBv3.1 guideline.
  GreenRE Gold - At least 25% energy savings
  GreenRE Platinum - At least 30% energy savings

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

- Minimum score under IND 3-2 Sustainable Products
  GreenRE Gold ≥ 3 credits
  GreenRE Platinum ≥ 4 credits

- To be eligible for GreenRE Platinum Rating, roof of entire facility to be solar panel installation ready. Appropriate roof pitch (5-30 degrees tilt from horizontal), static loads, mounting system and roof access to be considered.

Minimum System Efficiency

- Minimum Design System Efficiency/Operating System Efficiency (DSE/OSE)

(i) For buildings using Water-Cooled Chilled Water Plant

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

(ii) For buildings using Air-Cooled Chilled Water Plant or Unitary Air-Conditioner

GreenRE Rating	Building Cooling Load (RT)	
	< 500	≥ 500
	Efficiency (kW/RT)	
Bronze	1.1	1.0
Silver	1.0	Not applicable[(ii)]
Gold	0.85	
Platinum	0.78	

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

Chiller Plant M&V Instrumentation

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

2) Non Air-Conditioned Buildings

- To be eligible for GreenRE Platinum Rating, ventilation simulation must be carried out to identify the most effective building design and layout. The simulation results and the recommendations derived are to be implemented to ensure good natural ventilation. Details and submission requirements on ventilation simulation can be found in Appendix B of this Guideline.
  .
- Minimum score under IND 3-1 Sustainable Construction
  GreenRE Gold ≥ 3 credits
  GreenRE Platinum ≥ 5 credits

- Minimum score under IND 3-2 Sustainable Products
  GreenRE Gold ≥ 3 credits
  GreenRE Platinum ≥ 4 credits

- To be eligible for GreenRE Platinum Rating, roof of entire facility to be solar panel installation ready. Appropriate roof pitch (5-30 degrees tilt from horizontal), static loads, mounting system and roof access to be considered.

Mandatory Requirements:

1) Building Envelope – OTTV

- The OTTV of the building envelope for a building, having a **total air-conditioned area exceeding 1000 m² and above should not exceed 50 W/m².**

2) Roof

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

- For roofs with skylight, the maximum required RTTV is 25 W/m².

3) Roof – U-Value

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

Table 2-1 Maximum U-Value for Roof (W/m²K)

Roof Weight Group	Maximum U-Value (W/m²K)
Light (Under 50 kg/m²)	0.4
Heavy (Above 50 kg/m²)	0.6

- **The roof of a non-airconditioned** space shall either comply to Table 2-1 or the ceiling surface should be low-e (emissivity 0.1 or lower) facing down.

4) EMS System

- To install Energy Management System where air-conditioned space is greater than 4000m².

<table>
<tr><th>Part 1 - Energy Efficiency</th><th>GreenRE Credits</th></tr>
<tr><td colspan="2">(A) Applicable to Air-Conditioned Building Area
(with an aggregate air-conditioned areas > 1000m^2)</td></tr>
<tr><td><u>IND 1-1 THERMAL PERFORMANCE OF BUILDING ENVELOPE - OTTV</u>

Enhance overall thermal performance of building envelope to minimise heat gain thus reducing the overall cooling load requirement.

<u>Baseline:</u>
Maximum permissible OTTV = 50 W/m^2</td><td>2 credits for every reduction of 1 W/m^2 in OTTV from the baseline.

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

(Up to 10 credits)</td></tr>
<tr><td><u>IND 1-2 AIR-CONDITIONING SYSTEM</u>

Applicable to Air-conditioned Building Areas (with an aggregate air-conditioned areas > 1000m^2)

Encourage the use of better efficiency air-conditioned equipment to minimize the energy consumption.
(System efficiency in kW/ton)

<u>(a) Water-Cooled Chilled-Water Plant:</u>
i. Water-Cooled Chiller
ii. Chilled water pump
iii. Condenser water pump
iv. Cooling tower

<table>
<tr><td rowspan="2">Baseline</td><td colspan="2">Building Cooling Load</td></tr>
<tr><td>< 500 RT</td><td>≥ 500 RT</td></tr>
<tr><td><u>Prerequisite Requirements</u>
Minimum system efficiency of central chilled-water plant</td><td>0.85 kW/RT</td><td>0.75 kW/RT</td></tr>
</table>

OR</td><td><u>(a) Water-Cooled Chilled-Water Plant:</u>

Building cooling load < 500RT

14 credits for achieving plant efficiency of 0.85 kW/ton

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

Credit scored = 0.3 x (% improvement)

Building cooling load ≥ 500RT

14 credits for achieving plant efficiency of 0.75 kW/ton

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

Credit scored = 0.35 x (% improvement)

(up to 20 credits)

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

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

Air cooled Chilled-Water Plant:

- Air-Cooled Chiller
- Chilled Water Pump

Unitary Air-Conditioners:

- Variable Refrigerant Flow (VRF) System
- Water-Cooled Package Unit
- Single-Split Unit
- Multi-Split Unit

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

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

(c) Air Distribution system:

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

Baseline – Fan power limitation in air conditioning system

Allowable nameplate motor power	
Constant volume	Variable volume
1.7 kW/m^3/s	2.4 kW/m^3/s

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

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

Building cooling load < 500RT

14 credits for achieving plant efficiency of 1.1 kW/ton

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

Credit scored = 0.2 x (% improvement)

Building cooling load ≥ 500RT

14 credits for achieving plant efficiency of 1.0 kW/ton

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

Credit scored = 0.25 x (% improvement)

(up to 20 credits)

(c) Air Distribution system:

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

Credit scored = 0.15 x (% improvement)

(up to 8 credits)

(d) *Prerequisite requirements:* Provision of permanent measuring instruments for monitoring of water-cooled chilled water plant and air-cooled chilled water plant efficiency. The installed instrumentation shall have the capability to calculate resultant plant efficiency (i.e. kW/RT) within 5% of its true value and in accordance with ASHRAE Guide 22 and AHRI 550/590. The following instrumentation and installation are also required to be complied: • Location and installation of the measuring devices to meet the manufacturer's recommendation. • Data acquisition system to have a minimum resolution of 16 bit. • All data logging with capability to trend at 1minute sampling time interval. • Dedicated digital power meters shall be provided for the following groups of equipment: chiller(s), chilled water pump(s), condenser water pump(s) and cooling tower(s). • Flow meters to be provided for chilled-water and condenser water loop and shall be of ultrasonic / full bore magnetic type or equivalent. • Temperature sensors are to be provided for chilled water and condenser water loop and shall have an end-to-end measurement uncertainty not exceeding ± 0.05°Cover entire measurement or calibration range. All thermo-wells shall be installed in a manner that ensures that the sensors can be in direct contact with fluid flow. Provisions shall be made for each temperature measurement location to have two spare thermo-wells located at both side of the temperature sensor for verification of measurement accuracy.	Applicable only to buildings with provision of water-cooled chilled water plants 2 credits
(e) *Prerequisite requirements*: Verification of central water cooled chilled-water plant instrumentation: Heat Balance – substantiating test for water cooled chilled-water plant to be computed in accordance with AHRI 550/590. The operating system efficiency and heat balance to be submitted to GreenRE upon commissioning.	1 credit

(f) Provision of variable speed controls for chiller plant equipment such as chilled-water pumps and cooling tower fans to ensure better part-load plant efficiency.	1 credit
(g) Sensors or similar automatic control devices are used to regulate outdoor air flow rate to maintain the concentration of carbon dioxide. Indoor carbon dioxide acceptable range ≤700 ppm above outdoor concentration.	1 credit
Sub-Total (A):	Sum of GreenRE credits obtained from IND 1-1 to 1-2

Part 1-Energy Efficiency	**GreenRE Credits**
(B) Applicable to Non Air-Conditioned Building Areas (with an aggregate non air-conditioned areas > 10% of total floor area excluding carparks and common areas)	
IND 1-3 BUILDING ENVELOPE – DESIGN/THERMAL PARAMETERS Enhance the overall thermal performance of building envelope to minimise heat gain which would improve indoor thermal comfort and encourage natural ventilation or mechanical ventilation.	
(a) Minimum direct west facing façade through building design orientation. Note (3): Orientation of façade that falls within the range of 22.5° N of W and 22.5° S of W will be defined as west facing façade. Core walls for lift or staircases and toilets that are located within this range are exempted in computation.	Credits scored = 10 – [0.2 x (% of west facing façade areas over total façade areas)] (Up to 10 credits) Where there is no west facing façade, the total credits scored for this item will be 25 credits; the IND 1-3 b (i), b (ii) and (c) as listed below will not be applicable.
(b)(i) Minimum west facing window opening.	Credits scored = 10 – [0.1 x (% of west facing window areas over total west facing façade areas)]
(b)(ii) Effective sun shading provision for windows on the west façade with minimum shading of 30%.	Credits scored = 0.1 x (% of west facing window areas with sun shading devices over

<table>
<tr>
<td>(c) Better thermal transmittance (U-value) of external west facing walls.

The U-value of external west facing wall should be equal or less than 2W/m^{2}K</td>
<td>total west facing façade areas)

(Up to 10 credits for IND 1-3(b)(i) &(b)(ii))

Credits scored = 0.05 x (% of the external west facing walls areas with U-value of 2 W/m^{2}K or less over the total west facing façade areas)

(Up to 5 credits)</td>
</tr>
<tr>
<td>(d) Better thermal transmittance (U-value) of roof.

Baseline: U-value for roof stated below depending on the weight range of roof structure:
<table>
<tr><th>Roof Weight Group (kg/m^2)</th><th>Maximum U-value (W/m^{2}K)</th></tr>
<tr><td>Light (Under 50)</td><td>0.4</td></tr>
<tr><td>Heavy (Over 50)</td><td>0.6</td></tr>
</table>
</td>
<td>2 credits for every 0.1 W/m^{2}K reduction
(Up to 5 credits)</td>
</tr>
<tr>
<td><u>IND 1-4 NATURAL VENTILATION / MECHANICAL VENTILATION</u>

(a) <u>Natural Ventilation</u>
Encourage building that facilitates good natural ventilation.

(i) Proper design of building layout that utilises prevailing wind conditions to achieve adequate cross ventilation.

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

OR

(b) <u>Mechanical Ventilation</u></td>
<td>1 credit for every 10% of NV areas with window openings facing north and south directions and cross ventilation
Credits scored = 1 x (% units/10)
(Up to 10 credits)

5 credits

OR

0.6 credit for every subsequent 1%</td>
</tr>
</table>

<table>
<tr><td>Encourage energy efficient mechanical ventilation system as the preferred ventilation mode to non-air-conditioning in buildings.

Baseline: Fan power limitation in mechanical ventilation systems:
<table><tr><th colspan="2">Allowable nameplate motor power</th></tr><tr><td>Constant volume</td><td>Variable volume</td></tr><tr><td>1.7 kW/m^3/s</td><td>2.4 kW/m^3/s</td></tr></table>
Note (3): Where there is a combination of naturally ventilated and mechanical ventilated spaces, the credits scored will only be based on the predominant ventilation modes of normally occupied spaces.</td><td>improvement from the baseline
Credits scored = 0.6 x (% improvement)

(Up to 15 credits)</td></tr>
<tr><td>Sub-Total (B):</td><td>Sum of GreenRE credits obtained from IND 1-3 to 1-4</td></tr>
<tr><th>Part 1 – Energy Efficiency</th><th>GreenRE Credits</th></tr>
<tr><td colspan="2">(C) General</td></tr>
<tr><td><u>IND 1-5 DAYLIGHTING</u>

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 calculation to verify that 50% or more of all normally occupied areas achieve adequate daylight illuminance levels as specified in MS 1525:2014. Areas with illuminance levels below or above the range do not comply.

b) Daylighting in the following common areas:
i. Lift lobbies and corridors
ii. Staircases
iii. Carparks</td><td><table><tr><th>Percentage of Occupied Spaces with Adequate Ambient Lighting Level</th><th>Credits Allocation</th></tr><tr><td>50% - 75%</td><td>1</td></tr><tr><td>76% - 90%</td><td>2</td></tr><tr><td>>90%</td><td>3</td></tr></table>(Up to 3 credits)

1 credit
1 credit
1 credit</td></tr>
<tr><td><u>IND 1-6 ARTIFICIAL LIGHTING</u>

Encourage the use of better efficient lighting to minimise energy consumption from lighting usage while maintaining proper lighting level.
<u>Baseline:</u> Luminance level stated in MS 1525:2014</td><td>0.25 credit for every percentage improvement in the lighting power budget

Credits scored = 0.25 x (% improvement)

(Up to 10 credits)</td></tr>
</table>

IND 1-7 LIGHTING ZONING Lighting zones to not exceed 100m^2 for 90% of the occupied areas with controls clearly labelled and accessible for occupants To use photocell and / or motion sensors in the following areas (>90% of spaces): Circulation areas (staircases and corridors) Transient spaces (lift lobbies, atrium, toilets)	1 credit 1 credit 1 credit
IND 1-8 VENTILATION IN CARPARKS Encourage the use energy efficient design and control of ventilation systems on carparks. (a) Carparks designed with natural ventilation. (b) CO sensors are used to regulate the demand for mechanical ventilation (MV). Note (4): Where there is a combination of different ventilation mode adopted for car park design, the credits scored under this requirement will be prorated accordingly.	Naturally ventilated carparks (covered and sheltered) – 2 credits Credits scored based on the mode of mechanical ventilation provided Fume extract- 1 credit MV with or without supply – 1 credits (Up to 2 credits)
IND 1-9 VENTILATION IN COMMON AREAS Encourage the use of energy efficient design and control of ventilation systems in the following common areas: • Toilets • Staircases • Lift Lobbies • Corridors • Atriums	Credits scored based on the mode of ventilation provided in the applicable areas. Natural vent. – 1.5 credits for each area Mechanical vent. – 0.5 credit for each area (Up to 5 credits)
IND 1-10 VERTICAL TRANSPORTATION EFFICIENCY Lifts and escalators shall be equipped with AC variable voltage and variable frequency (VVVF) motor drive and sleep mode features.	Extent of Coverage: All lifts and/or escalators 1 credit

IND 1-11 Electrical Services Encourage the provision of better energy efficient service transformers, UPS and related controls of energy monitoring (a) Energy Use and Sub-metering Promote energy use monitoring with sub-metering to facilitate building operations, and to allow engagement of building occupants. I) Separately meter either i. Substantial energy uses such as space cooling, domestic hot water, ventilation, lighting and plug loads **OR** ii. High energy load and process areas II) And link all energy sub-meters to BMS, EMS or other automated system (b) Provision of low-loss service transformers Efficiency of service transformers to meet the requirements of MS-1525.	2 credits 2 credits

(c) Provision of energy-efficient UPS (uninterrupted power supply)

All UPS operating in the following systems must meet the minimum efficiency: -

i. Double conversion on-line mode

	UPS Range (kVA)				
	≥5 to <10	10 to <20	20 - <40	40 - <200	≥200
25% load	82.5%	86.5%	87.5%	89.0%	90.0%
50% load	85.0%	91.0%	91.5%	92.0%	92.5%
75% load	87.0%	92.0%	92.5%	93.0%	93.5%
100% load	87.0%	92.0%	92.5%	93.0%	93.5%

ii Line interactive or ECO mode

	UPS Range (kVA)				
	≥5 to <10	10 to <20	20 - <40	40 - <200	≥200
25% load	85.5%	90%	91%	91.5%	93%
50% load	91.5%	93%	93.5%	94%	95.5%
75% load	92.5%	93.5%	94%	94.5%	96%
100% load	92.5%	93.5%	94%	94.5%	96%

iii Stand-by mode

	UPS Range (kVA)				
	≥5 to <10	10 to <20	20 - <40	40 - <200	≥200
25% load	90%	94%	94.5%	95%	95.5%
50% load	93%	96%	96.5%	97%	97.5%
75% load	94%	96.5%	97%	97.5%	98%
100% load	94%	96.5%	97%	97.5%	98%

The credits awarded will be based on the aggregated kVA meeting the minimum efficiency as a proportion to the total installed kVA for UPS rated ≥ 5 kVA

(Up to 3 credits for IND 1-11 (c))

<table>
<tr>
<td>

IND 1-12 Local Energy Generation for Centralised Service Hot Water Heating

Promote local energy generation from renewable sources or waterside energy recovery to meet service hot water heating demand in industrial facilities:

(a) Solar Thermal Hot Water System

The solar thermal hot water system must meet minimum Solar Fraction (SF) of 0.5 or Solar Energy Factor (SEF) of 2.

(b) Heat Pumps

The heat pump meeting minimum heating COP of 3.5 under the standard testing conditions as follows: -

- Heating water from 15°C to 55°C
- Air source heat of 20°C dry bulb/15°C wet bulb for air-to-water heat pump
- Water source heat of 15°C for water-to- water heat pump

(c) Combined Heat and Power (CHP) System

The CHP system such as co-generation or tri- generation must meet the minimum Effective Electrical Efficiency as follows: -

Type of CHP	Effective Electrical Efficiency
Combustion turbine-based CHP	0.50
Reciprocating engine-based CHP	0.70

(d) Photovoltaic Thermal (PV/T) or other low and zero carbon technology hot water systems

</td>
<td>

2 credits for every 30% of service hot water needs catered by local energy generation.

(up to 6 credits)

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<td>

IND 1-13 ENERGY EFFICIENT PRACTICES & FEATURES

Encourage the use of energy efficient practices and features which are innovative and have positive environmental impact

(a) To create an energy breakdown of entire facility to indicate major energy consumers within the facility and to calculate energy efficiency index (EEI).

</td>
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1 credit

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</table>

<table>
<tr>
<td>(b) To benchmark process loads within the facility against industry norms and demonstrate savings.

<table>
<tr><td>Process load within the facility</td></tr>
<tr><td>Percentage savings compared to industry norms

For process loads < 25% of TBEC
10% - 1 credit
20% - 2 credits
>30% - 3 credits

For process loads < 50% of TBEC
10% - 2 credit
20% - 4 credits
>30% - 6 credits

For process loads ≥ 50% of TBEC
10% - 3 credit
20% - 6 credits
>30% - 9 credits</td></tr>
</table>
</td>
<td>Up to 9 credits</td>
</tr>
<tr>
<td>IND 1-14 ON-SITE ENERGY GENERATION

Encourage on-site energy generation through renewable energy or energy recovery / regeneration:

For facilities where solar panels are not installed, provide solar panel installation ready roof. Appropriate roof pitch, static loads, mounting system and roof access to be considered.</td>
<td>5 credits for every 1% replacement of electricity (based on total electricity consumption)

OR

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

(Up to 15 credits)

1 credit</td>
</tr>
<tr>
<td>Sub-Total (C):</td>
<td>Sum of GreenRE credits obtained from IND 1-5 to 1-14</td>
</tr>
</table>

PART 1 – ENERGY EFFICIENCY CATEGORY SCORE:	Sub-Total (A) X $\frac{\text{Air-Conditioned Building Floor Area}}{\text{Total Floor Area}}$ + Sub-Total (B) X $\frac{\text{Non Air-Conditioned Building Floor Area}}{\text{Total Floor Area}}$ + Sub-Total (C) Where : Sub-Total (A) = Sum of GreenRE Credits obtained Under Section (A) that is IND 1-1 to 1-2 Sub-Total (B) = Sum of GreenRE Credits obtained Under Section (B) that is IND 1-3 to 1-4 Sub-Total (C) = Sum of GreenRE Credits obtained Under Section (C) that is IND 1-5 to 1-14 If either Section (A) or Section (B) is not applicable, no pro-rating of areas is required for the score computation. Total floor area includes air-conditioned area and non air-conditioned area but excluding car park and common area.

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

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

a) Basin taps and mixers
b) Flushing cistern
c) Shower taps and mixers or showerheads
d) Sink/bib taps and mixers
e) Urinals and urinal flush valve</td><td><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>2 credits</td><td>4 credits</td><td>6 credits</td></tr></table>
Credits can be scored based on the number and water efficiency rating of the fitting type used.

(Up to 6 credits)</td></tr>
<tr><td><u>IND 2-2 WATER USAGE AND LEAK DETECTION</u>

Promote the use of sub-metering and leak detection system for better control and monitoring

(a) Provision of sub-meters for major water uses which includes irrigation, cooling towers etc

(b) Linking all sub-meters to Building Management System (BMS) for leak detection.</td><td>1 credit

1 credit</td></tr>
<tr><td><u>IND 2-3 ALTERNATIVE WATER SOURCES</u>

Use of suitable systems that utilize alternative water sources for non-potable uses: irrigation, washing, water features, toilet flushing, etc (excluding cooling tower make up water) to reduce use of potable water.

Alternative sources can include rainwater, greywater (for toilet flushing only), AHU condensate and wastewater recycling.</td><td>Credits awarded based on % reduction in total potable water usage of the applicable uses

<table><tr><td>> 50 %</td><td>3 credits</td></tr><tr><td>≥ 10 % to 50 %</td><td>2 credits</td></tr><tr><td>< 10 %</td><td>1 credit</td></tr></table>
(Up to 3 credits)</td></tr>
</table>

IND 2-4 IRRIGATION SYSTEM AND LANDSCAPING Reduce potable water consumption for irrigation and landscaping. (a) Use of non-potable water including rainwater for landscape irrigation (b) Use of automatic water efficient irrigation system with rain sensor, soil moisture sensor or equivalent control system. (c) Use of drought tolerant plants that require minimal irrigation.	 1 credit Extent of Coverage: At least 50% of the landscape areas are served by the system 1 credit Extent of Coverage: At least 80% of the landscape areas 1 credit
IND 2-5 WATER CONSUMPTION OF COOLING TOWER Reduce potable water consumption for cooling purpose. (a) Use of cooling tower water treatment system which can achieve 6 or better cycles of concentration at acceptable water quality (b) Use of recycled water from approved sources for cooling purpose	 1 credit 1 credit
PART 2 – WATER EFFICIENCY CATEGORY SCORE:	Sum of GreenRE credits obtained from IND 2-1 to 2-5

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

IND 3-1SUSTAINABLE 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, fly ash) to replace Ordinary Portland Cement (OPC).

(b) Concrete Usage Index (CUI)

Encourage more efficient concrete usage for building components.

Prerequisite Requirement:
Minimum score under IND 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
≤ 0.50	1
≤ 0.45	2
≤0.40	3
≤0.35	4
≤0.30	5

(Up to 5 credits)

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<tr><td>

IND 3-2 SUSTAINABLE PRODUCTS

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

Prerequisite Requirement:
Minimum score under IND 3-1:
GreenRE Gold ≥ 3 credits
GreenRE Platinum ≥ 5 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 use of environmentally friendly product.

(Up to 8 credits)

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</table>

IND 3-3 GREENERY PROVISION

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

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

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

(b) Restoration of trees on site, conserving or relocating of existing trees on site. (at least 20%)

1 credit

(c) Use of compost recycled from horticulture waste.

1 credit

IND 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 that has good track records in the adoption of sustainable, environmental friendly and considerate practices during construction.

1 credit

(c) Building quality is assessed under the Quality Assessment System in Construction (QLASSIC) or Construction Quality Assessment System (CONQUAS).

1 credit

(d) To performs 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 for each firm
(Up to 1 credit)

(f) Project team comprises one Certified GreenRE/Green Mark Manager (GM)

1 credit for certified GRM/GMM

(g) Energy policy, energy targets and regular review with top management's commitment as part of an environmental strategy	1 credit
(h) Targets to improve building water performance against own building water performance baseline should be set. To show intent, measures and implementation strategies of water efficiency improvement plans over the next three years.	1 credit
(i) Provision of facilities or recycling bins for collection and storage of different recyclable waste such as paper, glass, plastic etc.	1 credit
(j) To comply with Cleaner Production Guidelines mandated by the Department of Safety and Health (DOSH) Malaysia.	1 credit
IND 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 train stations or bus stops.	1 credit
(b) Shuttle service for facility employees.	1 credit
(c) Project is accessible from major highway outlets and / or within close proximity to major cargo services (i.e airport, seaport, railway stations). Project to be within 10km of these facilities.	1 credit
(d) Provision of hybrid/electric vehicle charging stations and priority parking lots within the development.	Extent of coverage: Minimum 1 number priority parking bays for every 100 carpark lots. EV chargers – 1 for every 200 parking bays. (Cap at 3) (1 credit)
(e) Provision of covered / sheltered bicycles parking lots (i.e with rack / bar) and adequate shower and changing facilities.	Extent of Coverage : Minimum 10 number and maximum 50 numbers of bicycle parking lots (1 credit)

IND 3-6 STORMWATER MANAGEMENT Encourage the treatment of stormwater runoff through provision of infiltration or design features before discharge to public drains. Provision of infiltration features or design features for new development and redevelopment in accordance with MSMA.	Reduce post development stormwater peak discharge rate and quantity from exceeding pre-development peak discharge rate and quantity: 5 - 15% - 1 credit 16 - 25% - 2 credits > 25% - 3 credits (Up to 3 credits)
IND 3-7 REFRIGERANTS Reduce the potential damage to the ozone layer and the increase in global warming through the release of ozone depleting substances and greenhouse gases. (a) Refrigerants with ozone depleting potential (ODP) of zero **OR** with global warming potential (GWP) of less than 100. (b) Use of refrigerant leak detection system at critical areas of plant rooms containing chillers and other equipment with refrigerants.	 1 credit 1 credit
PART 3–ENVIRONMENTAL PROTECTION CATEGORY SCORE:	Sum of GreenRE credits obtained from IND 3-1 to 3-7

<table>
<tr><th>Part 4 – Indoor Environmental Quality</th><th>GreenRE Credits</th></tr>
<tr><td>

IND 4-1 THERMAL COMFORT

For office areas:
Air-conditioning system is designed to allow for cooling load variations due to fluctuations in ambient air temperature to ensure consistent indoor conditions for thermal comfort.

Indoor temperature between 23°C to 26°C
Relative Humidity between 50% to 70%

Note: Additional 0.5 credit will be awarded for room temperature and humidity displays in all applicable areas.

and / or

For process areas:
To ensure thermal comfort is maintained at the following levels:

<table>
<tr><th>PMV Range</th><th>PPD</th></tr>
<tr><td>-0.5<PMV<+0.5</td><td><10</td></tr>
</table>

</td><td>

0.5 credit

0.5 credit

1 credit

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

IND 4-2 NOISE LEVEL

For office and process areas:
Demonstrate acoustic performance of internal partitions as follows:

<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>

and / or

For process areas:
To make efforts to reduce noise pollution to external environment. Building / plant envelope is designed to reduce noise by NR20dBA in standard operation.

</td><td>

1 credit

1 credit

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

IND 4-3 INDOOR AIR POLLUTANTS Minimise VOCs, mainly from inside sources to promote a healthy indoor environment. a) Use of low volatile organic compounds (VOC) paints certified under local/international certification body. b) Use adhesives certified under local/international certification body for composite wood products.	Extent of Coverage: A at least 90% of the internal wall areas 1 credit 1 credit
IND 4-4 INDOOR AIR QUALITY (IAQ) MANAGEMENT Ensure that building ventilation systems are designed and installed to provide acceptable IAQ under normal operating hours. a) Provision of filtration media and differential pressure monitoring equipment in Air Handling Units (AHUs). b) Implement effective IAQ management plan to ensure that building ventilation systems are clean and free from residuals left over from construction activities.	1 credit 1 credit
IND 4-5 EXTERNAL VIEWS To show that >50% of occupied spaces have a view of out facility within working heights (i.e 1.2m – 1.7m from floor level).	1 credit
IND 4-6 QUALITY OF ARTIFICIAL LIGHTING Improve workplace lighting quality by avoiding low frequency flicker associated with fluorescent lighting with the use of high frequency ballasts in the fluorescent luminaries. Use of driver with output frequency < 200Hz and < 30% flicker for LED lighting.	Extent of Coverage: At least 90% of all applicable areas that are served by fluorescent luminaries 1 credit 1 credit
Part 4 – INDOOR ENVIRONMENTAL QUALITY CATEGORY SCORE:	Sum of GreenRE credits obtained from IND 4-1 to 4-6

Part 5 – Other Green Features	GreenRE Credits
IND 5-1 GREEN FEATURES & INNOVATIONS Encourage the use of green features which are innovative and have positive environmental impact. Examples: • Pneumatic waste collection system • Dual chute system • Self-cleaning façade system • Infiltration trenches • Integrated storm water retention/treatment into landscaping • Heat recovery systems (at least 10% of required capacity) • Etc	2 credit for high impact item 1 credit for medium impact item 0.5 credit for low impact item (Up to 9 credits)
PART 5 – OTHER GREEN FEATURES CATEGORY SCORE:	Sum of GreenRE credits obtained from IND 5-1

Part 6- Carbon Footprint of Development	GreenRE Credits
IND 6-1 CARBON FOOTPRINT OF DEVELOPMENT Recognise the carbon emission 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 IND 6-1

GreenRE Score (Industrial Facilities)

GreenRE Score (IND) = ∑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 of Development)]

Where :
Category Score for Part 1≥ 30 credits and
∑Category score for Part 2 to Part 6 ≥ 20 credits