DESIGN REFERENCE GUIDE

New Data Centre

Version 1.1

March 2023

Contents

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 New Data Centre (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.

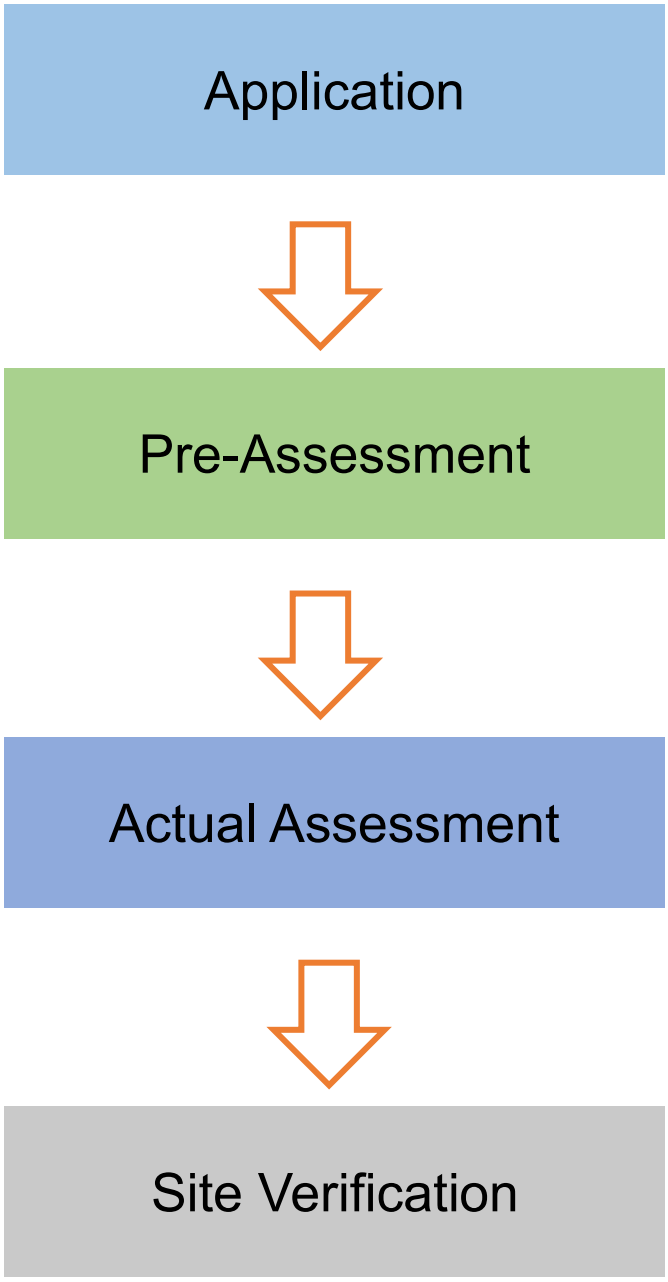
This Guideline is not intended to abridge safety, health, environmental or related requirements contained in other applicable laws, codes or policies administered by relevant authorities. Where there is a conflict between a requirement of this Guideline and such other regulations affecting the design,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

3. Revision Log

Revision	Description	Date Effective
1.0	Issued as Pilot	1st July 2020
1.0	Revised Version of Implementation	1st January 2021
1.1	Issued for Implementation	March 2023

4. GreenRE Assessment Stages

The GreenRE New Data Centre 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 New Data Centre Rating System

Overview:

The GreenRE New Data Centre criteria consist of five (5) environmental impact categories namely:

(a) Part 1 – Energy Efficiency: This category focuses on the approach that can be used in the New Data Centre and public amenities to optimise the energy efficiency of the New Data Centre.

(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 – Sustainable Construction & Management: 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 lighting quality.

(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 operational and embodied carbon impact assessment aligned to Green House Gas (GHG) Protocol standards.

These environment impact categories are broadly classified under two main grouping 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 35 credits must be obtained from this group to be eligible for certification.

Other Green Requirements consist of (b) Part 2–Water Efficiency; (c) Part 3 – Sustainable Construction & Management; (d) Part 4 – Indoor Environmental Quality; (e) Part 5 – Other Green Features. A minimum of 10 credits must be obtained from this grouping to be eligible for certification.

The maximum GreenRE score achievable for a project is capped at 100 credits. This rating tool is to be read in conjunction with NRB v3.1 and ENRB v3.1

To achieve GreenRE Award

Pre-requisite & Mandatory Requirements
All relevant pre-requisite requirements for the specific GreenRE Rating are to be complied with

Energy Related Requirements
Minimum 35 credits

+

Other Green Requirements
Minimum 10 credits

Elective Requirement for Energy Improvement
(Combination of the following items to meet 35 credits)

Part 1 – Energy Efficiency
NDC 1-1 Overall Energy Efficiency
NDC 1-2 Systems Energy Efficiency
- Cooling System
- Electrical System
- IT Equipment

NDC 1-3 Energy Efficiency and Performance Verification
NDC 1-4 Data Centre Design and Energy Management
NDC 1-5 Energy Efficient Features and Innovations
NDC 1-6 Renewable Energy

Elective Requirement for Other Areas
(Combination of the following items to meet 10 credits)

Part 2 - Water Efficiency
NDC 2-1 Water Efficient Design
NDC 2-2 Alternative Water Sources
NDC 2-3 Cooling Tower Water Use

Part 3 – Sustainable Construction & Management
NDC 3-1 Refrigerants and Fire Suppressants
NDC 3-2 Sustainable Construction
NDC 3-3 Sustainable Products
NDC 3-4 Sustainability Policy
NDC 3-5 Environmental Management Practice

Part 4 - Indoor Environmental Quality
NDC 4-1 Indoor Air Quality Performance
NDC 4-2 Lighting Quality and Management
NDC 4-3 Thermal Comfort and Noise Level

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

Part 6 – Carbon Emission Development
NDC 6-1 Carbon Emission Development

Credit Allocation:

	Category	Credits Allocation
	(I) Energy Related Requirements	
Minimum 35 credits	**Part 1: Energy Efficiency**	
	NDC 1-1 Overall Energy Efficiency - PUE improvements over Reference Model	 25
	NDC 1-2 Systems Energy Efficiency - Cooling System (including Air Management System) - Electrical System - IT Equipment	 14 9 8
	NDC 1-3 Energy Efficiency and Performance Verification - Commissioning of Energy Systems - Measurement and Verification Plan - Energy Metering and Reporting of PUE	 4 3 3
	NDC 1-4 Data Centre Design and Energy Management - Data Centre Planning and Design - Data Centre Operations and Energy Management	 5 5
	NDC 1-5 Energy Efficient Features and Innovations	8
	NDC 1-6 Renewable Energy	5
	Category Score for Part 1 – Energy Efficiency	**89**
	(II) Other Green Requirements	
Minimum 10 credits	**Part 2: Water Efficiency**	
	NDC 2-1 Water Efficient Design	3
	NDC 2-2 Alternative Water Sources	3
	NDC 2-3 Cooling Tower Water Use	6
	Category Score for Part 2 – Water Efficiency	**12**
	Part 3: Sustainable Construction & Management	
	NDC 3-1 Refrigerants and Fire Suppressants	4
	NDC 3-2 Sustainable Construction	10
	NDC 3-3 Sustainable Products	6
	NDC 3-4 Sustainable Policy	3
	NDC 3-5 Environmental Management Practice	7
	Category Score for Part 3 – Sustainable Construction & Management	**30**
	Part 4: Indoor Environmental Quality	
	NDC 4-1 Indoor Air Quality Performance	2
	NDC 4-2 Lighting Quality and Management	2
	NDC 4-3 Thermal Comfort and Noise Level	2
	Category Score for Part 4: Indoor Environmental Quality	**6**
	Part 5: Other Green Features	
	NDC 5-1 Green Features & Innovations	10
	Category Score for Part 5: Other Green Features	**10**
	Part 6: Carbon Emission of Development	3
	NDC 6-1 Carbon Emission of Development	**3**
	Category Score for Part 2 to Part 6 – Other Green Requirements	**61**
	GreenRE New Data Centre Building Score:	**150 (MAX)**

6. GreenRE New Data Centre System Scoring

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

7. GreenRE New Data Centre Rating System Criteria

Pre-requisite

PART 1 - ENERGY EFFICIENCY

1. OVERALL ENERGY EFFICIENCY

GreenRE Rating	Minimum credits
GreenRE Bronze	35 credits
GreenRE Silver	42 credits
GreenRE Gold	50 credits
GreenRE Platinum	60 credits

2. MAXIMUM POWER USAGE EFFECTIVENESS (PUE)

GreenRE Rating	PUE at 25% IT Load
GreenRE Bronze	1.7
GreenRE Silver	1.6
GreenRE Gold	1.55
GreenRE Platinum	1.50

Note :

1) PUE is a metric that illustrates data center efficiency using the total annual facility energy divided by total annual IT equipment energy. The IT equipment energy shall be measured at PDU output.

2) PUE performance of the data center shall be determined using energy modelling software at the 25%, 50%, 70% and 100% of IT load for Gold and Platinum Rating.

3. MINIMUM SYSTEMS' EFFICIENCY

Prescribed system efficiency of cooling system to be as follows:

(i) For Data Centre using Water Cooled Chilled-Water Plant:

GreenRE Rating	Peak Data Centre Cooling Load (RT)	
	< 500	≥ 500
	Efficiency(1) (kW/RT)	
Bronze	0.85	0.75
Silver	0.80	0.70
Gold	0.75	0.68
Platinum	0.70	0.65

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

GreenRE Rating	Peak Data Centre Cooling Load (RT)	
	<500	≥ 500
	Efficiency[1] (kW/RT)	
Bronze	1.10	1.00
Silver	1.00	Not applicable [2]
Gold	0.85	
Platinum	0.78	

4. ENERGY MODELLING

For Gold and Platinum projects, use a computer simulation model to assess the energy performance of the proposed data centre facility and systems (Proposed DC Model) to achieve the most effective energy efficient design. Details and submission requirements on energy modelling can be found in Appendix A of this Guideline.

GreenRE Gold - PUE 1.55 and below (at 25% IT Load)
GreenRE Platinum - PUE 1.50 and below (at 25% IT Load)

Note:

(1) The performance of the overall cooling system for the data centre shall be based on the efficiency at full installed design capacity (N) plus any additional capacity that is required to maintain continuous availability of the service during operation (e.g. N+1). Performance data shall be backed by the manufacturer's test reports, commissioning information or obtained from the energy model. They will also be subject to verification under section NDC 1-3.

(2) For data centres with peak cooling load of more than 500 RT, the use of air cooled central chilled-water plant or other unitary air-conditioners are not applicable for 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. Data centres that are designed with air-cooled systems and for higher GreenRE rating will be assessed on a case by case basis.

5. ENERGY MONITORING

(i) 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 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 M&V instrumentation.

- Location and installation of the measuring devices to meet the manufacturer's recommendation.
- Data acquisition system shall be able to record and store values up to at least 3 decimal places.
- All data logging with capability to trend at 1-minute 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°C over entire measurement or

calibration range. All thermo- wells shall be installed in a manner that ensures that the sensors can be in direct contact with fluid flow. Provisions shall be made for each temperature measurement location to have two spare thermo-wells located at both side of the temperature sensor for verification of measurement accuracy.

- 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.

(ii) The data centre shall be equipped at a minimum with energy metering to provide total facility power and energy usage and total IT equipment power and energy usage on a historical basis, in order to determine instantaneous and average PUE data. The number and type of meters that are required to be installed shall be determined by the data centre design, but at the minimum shall be 1½% percent accuracy, full-scale and provided to meter all forms of energy to the data centre, (electricity, natural gas, steam, chilled water, one-pass cooling, etc.) and at the output of the UPS or PDUs, if this is the source of power that serves the IT equipment.

Note:
Where a particular section is not applicable to the data centre assessed, the actual score awarded will be normalised with respect to the total maximum score less the score of the non-applicable section.

Part 1 – Energy Efficiency	GreenRE credits

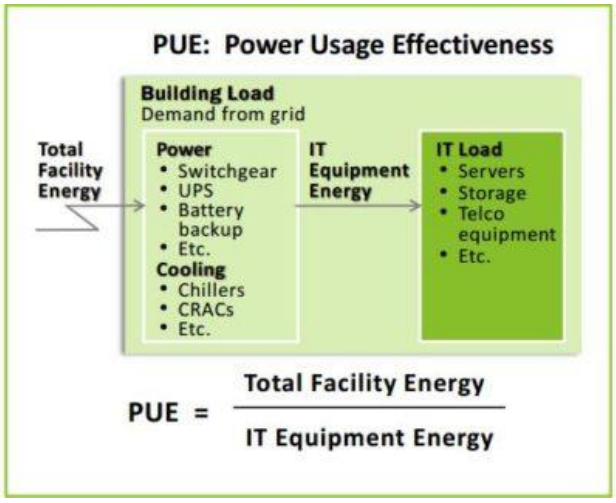
NDC 1-1 OVERALL ENERGY EFFICIENCY

The **PUE** value is defined as the total energy used by a data centre divided by the energy used by IT equipment in that data centre. The total energy used by the data centre shall be taken at the point where the facility is metered. The IT equipment load shall be based on PDU output [PUE Cat. 2]. The PUE categories listed are in accordance with MCMC MTSFB TC G004:2015 – *Technical Code of Specification of Green Data Centres.*

Compute PUE at various load points, 25%, 50%, 75% and 100% of the IT load under Malaysia climatic conditions.

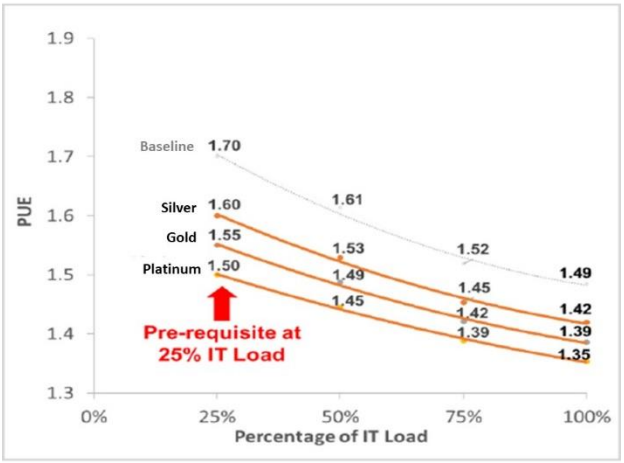
As data centres often operate at part load, the design of data centre and cooling system should aim to achieve good efficiency at part load.

	PUE at 25% IT Load
Baseline	1.7



This PUE will also need to be verified in relation with section 1-3 on Energy Efficiency and Performance Verification. For verification purposes, if UPS output data is not available, the closest direct measured power data will be used and a fixed PDU loss will be applied based on industry norms for such equipment.

Refer to Annex A for Energy Modelling Guideline



PUE Reference Curve

Up 25 Points based on PUE results obtained

PUE Scoring Methodology:

PUE at 25% IT load is used for base point calculation; However, if PUEs at 50% or 75% cannot meet the reference PUE curve of respective ratings, points will be deducted, i.e.

Base Point = 1.4 * (Percentage Improvement at 25% IT load from Baseline PUE)

Final Point = Point scored x [1- (20 x highest % deviation from the reference PUE curve at 50% or 75% IT load)]*

Note: The PUE Deviation Percentage shall be capped at 2%.
For project with PUE<1.4, there are maximum another 3 points available in Part 5-1(d)

NDC 1-2 SYSTEMS ENERGY EFFICIENCY

Overall Data Centre Energy Efficiency must be corroborated by the component systems efficiency in order to identify areas of improvement in the data centre operations.

(i) 1-2-1 Cooling System

Encourage the use of high efficiency cooling system both in terms of equipment efficiency and system configuration, to minimize the energy consumption.

The performance of the overall cooling system for the data centre shall be based on the efficiency at full installed design capacity (N) plus any additional capacity that is required to maintain continuous availability of the service during operation (e.g. N+1).

The systems to be considered are as follows:

(a) Water-Cooled Chilled-Water Plant, comprising:

a) Water-Cooled Chiller
b) Chilled water pump
c) Condenser water pump
d) Cooling tower or Heat Rejection Unit

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

Note:
Stricter minimum performance applies for Silver and higher ratings (see pre-requisite requirements)

(a) Water-Cooled Chilled-Water Plant

Peak data centre cooling load < 500 RT

7 credits for meeting the prescribed chilled-water plant efficiency of 0.85 kW/ton

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

Credits scored = 7 + (0.15 x %improvement)

Peak data centre cooling load ≥ 500 RT

7 credits for meeting the prescribed chilled-water plant efficiency of 0.75 kW/ton

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

Credits scored = 7 + (0.175 x % improvement)

(up to 10 credits)

(b) Air cooled Chilled-Water Plant/ Unitary Air-Conditioners (DX CRAC Units):

Air-cooled Chilled-Water plant:

- Air-Cooled Chiller
- Chilled Water Pump

Unitary Air-Conditioners:

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

Baseline Prerequisite Requirements	Peak Cooling Load	
	< 500 RT	≥ 500 RT
Minimum water-cooled central chilled-water plant efficiency	1.1 kW/RT	1.0 kW/RT

Note:
Stricter minimum performance applies for Silver and higher ratings (see pre-requisite requirements)

(c) Using chilled water from a central facility (e.g. district cooling system or central chilled water plant not operated solely to serve the data centre)

For data centres using district cooling system, data from the central plant will be used for the computation of the cooling system performance.

Note:
Combination of system types
Where there is a combination of system types, the computation of the credits awarded will be pro-rated based on the actual cooling capacity supplied by each system type, or by the operating hours, if the different systems are not operating at the same time**.**

(d) Air Management System:

Computer Room Air-Conditioning Units (CRACs) and Computer Room Air-Handling Units (CRAHs)

Baseline – Fan power limitation in AC system

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

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

Peak data centre cooling load < 500 RT

7credits for meeting the prescribed air-conditioning system efficiency of 1.1 kW/ton

0.1 credits for every percentage improvement in the air-conditioning system efficiency better than 1.00 kW/ton

Credits scored = 7 + (0.1 x % improvement)

Peak data centre cooling load ≥ 500 RT

7 credits for meeting the prescribed air-conditioning system efficiency of 1.0 kW/ton

0.125 credits for every percentage improvement in the air-conditioning system efficiency over the baseline

Credits scored = 7+ (0.125 x % improvement)

(Up to 10 credits)

(c) Using chilled water from a central facility

Credits in accordance with above based on central plant data. If no data is available, 4 credits will be applied.

(d) Air Management System

0.1 credit for every percentage improvement in the air distribution system efficiency over the baseline

(Up to 4 credits)

(ii) 1-2-2 Electrical System

To have the most efficient electrical power supply system providing the required level of redundancy while maintaining high load factors.

Building transformer loss value shall be based on measuring the loss across the building transformers that is supporting the data centre operation and comply with requirements in MS-1525:2019.

Provision of energy efficient UPS (uninterrupted power supply)

1 credit

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 2 credits)
The IT power chain efficiency includes transmission lines, switchgear, UPSs and PDUs serving the IT equipment. Efficiencies higher than the baseline (minimum) efficiency, as shown in the table below, depending on the UPS load factor, will qualify for additional points. Values between the UPS Load Factors indicated in the table will be linearly interpolated. UPS Load Factor / Minimum IT Power Chain Efficiency 25 % / 73 % 33 % / 78 % 50 % / 83 % 66 % / 85 % 75 % / 86 % 100 % / 88 % The UPS Load Factor shall be determined as: UPS Load Factor = Total UPS Output / Total Installed UPS Capacity (N) The IT Power Chain Efficiency shall be determined from a separate calculator to be provided, based on switchgear, UPS and PDU selection and their system configuration.	4 credits for achieving minimum efficiency 0.5 credits for every 2% improvement in efficiency over the minimum. (Up to 6 credits)
(iii) 1-2-3 IT Equipment To have policies that require the procurement and use of the most efficient ICT equipment which meet the demand, while providing the required level of redundancy.	
(i) ICT equipment, including servers, storage devices and network systems, that are Energy STAR or equivalent rated, where available.	2 credits
(ii) Power control of ICT equipment. Low power modes, Power capping (minimum 25% of the equipment enabled).	2 credits

(iii) Software control technologies, such as virtualization and optimizing algorithms or dynamic control of equipment for minimizing energy utilisation. (iv) Monitoring of ICT or Server Equipment Utilisation.	2 credits 2 credits Note: The section NDC 1-2-3 is applicable only to data centres that have operational control over the ICT equipment.
NDC 1-3 ENERGY EFFICIENCY AND PERFORMANCE VERIFICATION **(i) 1-3-1 Commissioning of Energy Systems** To verify that the data centre's energy related systems are installed, calibrated and perform according to the owner's project requirements, basis of design, construction documents and that they meet the minimum requirements of the Green Mark criteria. Commissioning shall be carried out at multiple load points (33%, 66% and 100%) and under normal utility operations, maintenance operations and failure conditions. The commissioning shall include verification of the Power Use Effectiveness (PUE) according to the design criteria at partial and full load conditions. **(ii) 1-3-2 Measurement and Verification Plan** The purpose of a measurement and verification plan is to have the ability to reconcile the actual data centre energy consumption over time with the design performance. Develop and implement a measurement and verification (M&V) plan. The M&V period must cover at least 1 year of post-construction occupancy. Using the partial (33%, 66%) and full load design projections and commissioning results, compare actual operating conditions to the plan, and provide a narrative to summarize performance, explaining where results vary from plan and including average hourly PUE. Provide a process for corrective action if the results of the M&V plan indicate that energy savings are not being achieved.	4 credits 3 credits

(iii) 1-3-3 Energy Metering and Reporting of PUE Data centre PUE metric from all energy sources should be measured and trended over time; so that the data centre owner and/or operator can verify that the energy related systems are performing according to the basis of design. The data centre shall, at a minimum, be equipped with energy metering to provide total facility power and energy usage and total IT equipment power and energy usage on a historical basis, in order to determine instantaneous and average PUE data. Besides PUE determination, the data centre shall be equipped with energy metering to provide power and energy usage for the facility's power transformation and distribution systems, cooling systems and any on-site generation and trending of these metrics on a historical basis.	3 credits
NDC 1-4 DATA CENTRE DESIGN AND ENERGY MANAGEMENT (i) 1-4-1 Data Centre Planning and Design Demonstrate that the data centre planning and design: (i) Maintain balance between efficiency & resilience of data centre using design analysis of the operating model to balance cost & efficiency with resilience. (ii) Promote scalable expansion by building up capacity in a modular approach to deployment in order to improve efficiency and ability to respond to business requirements (ii) 1-4-2 Data Centre Operations and Energy Management Have policies that promote continuity of information to ensure that energy-efficient operating strategies are maintained; and provide a foundation for training and system analysis. Management commitment towards obtaining ISO 50001 certification, including intent, measures and implementation strategies of energy efficiency improvement plans to achieve energy target set over the next three years.	3 credits 2 credits 2 credits 3 credits

NDC 1-5 ENERGY EFFICIENT FEATURES AND INNOVATIONS Encourage the use of innovative energy efficient equipment, system or design features. To qualify, the features must achieve significant, measurable improvement of energy performance in one of the following areas: (a) Innovative cooling systems or features (including free air-cooling, direct liquid cooling and two-phase systems, etc.) (b) Innovative power supply, back-up power or UPS systems (c) IT operations, maintenance or system upgrade strategies not covered by Section NDC 1-2-3 (d) Radical changes in data centre design, operations or systems not covered in any section above.	2 credits for each innovation that demonstrate the following: • The intent of the proposed innovation • The additional energy benefits delivered • The proposed requirements for compliance • The proposed performance metrics to demonstrate compliance and the approaches (strategies) used to meet the requirements (Up to 8 credits)
NDC 1-6 RENEWABLE ENERGY Encourage the use of renewable energy to offset facility energy demands. (a) Solar feasibility study – to assess the data centre's potential and viability to harness and leverage on solar energy and photovoltaics solution(s) adoption. (b) Solar ready roof - Appropriate roof pitch, static loads, mounting system and roof access to be considered. (c) Adoption of renewable energy – Incorporation of renewable energy to reduce building's energy consumption from grid and corresponding carbon emission.	1 credit 1 credit 1 credit for every 0.1% replacement of total building energy consumption with renewable energy or 1 credit for every 25% of roof area used for solar panels (up to 3 credits)
PART 1 – ENERGY EFFICIENCY CATEGORY SCORE:	Sum of GreenRE credits obtained from NDC 1-1 to 1-6: Maximum 89 Credits

Part 2 - Water Efficiency	GreenRE credits
NDC 2-1 WATER EFFICIENT DESIGN (a) Provide private-metering and potable water leak detection system for better control and monitoring, such as: (i) To monitor the water consumption on monthly basis (ii) Provision of private-meters for major water uses (e.g. cooling towers) (iii) Linking all private-meters to the Building Management System (BMS) for leak Detection (b) To specify the use of water efficient fittings under Water Efficiency Product Labelling Scheme (WEPLS) or equivalent for all applicable water fittings.	2 credits 1 credit
NDC 2-2 ALTERNATIVE WATER SOURCES Use of suitable systems that utilize alternative water sources for **non-potable uses**: cooling tower make up water, irrigation, washing, water features, toilet flushing, etc. to reduce use of potable water. Alternative sources can include rainwater, greywater (for toilet flushing only), condensate harvesting from the cooling system and recycled water from approved sources.	Credits awarded based on calculated % reduction in potable water usage of the applicable uses > 50 % - 3 credits < 10 % to 50 % - 2 credits < 10 % - 1 credit (Up to 3 credits)
NDC 2-3 COOLING TOWER WATER USE Calculate percentage savings over baseline annual consumption. The baseline consumption is calculated based on the following: (a) Evaporation rate of 1% water flow rate for each 7 Kelvin of water temperature range, (b) Drift loss of 0.002% water flow rate for counter-flow towers and 0.005% water flow rate for cross-flow towers, and (c) Use of cooling tower water treatment system which can achieve 7 or better cycles of concentration of acceptable water quality	Credits awarded based % saving over baseline. > 50 % - 6 credits > 30 % - 4 credits (up to 6 credits) Note: Section NDC 2-3 is applicable only to data centres using water-cooled systems
PART 2– WATER EFFICIENCY CATEGORY SCORE:	Sum of GreenRE credits obtained from NDC 2-1 to 2-3: Maximum 12 Credits

<table>
<tr><th>Part 3 – Sustainable Construction & Management</th><th>GreenRE credits</th></tr>
<tr><td><u>NDC 3-1 REFRIGERANTS AND FIRE SUPPRESSANTS</u>

To reduce global warming and damage to the ozone layer by minimising the release of greenhouse gases and ozone depleting substances.

(a) Use Refrigerants with ozone depletion potential (ODP) of zero or with global warming potential (GWP) of less than 100.

(b) Refrigerant leak detection monitoring system at critical areas of plant rooms containing chillers and other equipments with refrigerants.

(c) In server rooms, use of Fire Suppressants with zero ODP or GWP of less than 100.

(d) In UPS and Battery rooms, use of Fire Suppressants with zero ODP or GWP of less than 100.</td><td>

1 credit

1 credit

1 credit

1 credit</td></tr>
<tr><td><u>NDC 3-2 SUSTAINABLE CONSTRUCTION</u>

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 designs with efficient use of concrete for building components.</td><td>

<table><tr><th>% Replacement of OPC by approved industrial by-products</th><th>Credits 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>
(Up to 5 credits)

<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>
(Up to 5 credits)

Note: The section NDC 3-2 is applicable only to standalone data centres</td></tr>
</table>

<table>
<tr>
<td><u>NDC 3-3 SUSTAINABLE PRODUCTS</u>

Encourage the use of building components / products certified by an approved certification body.

Recycled components / products with third party verification.</td>
<td>
<table>
<tr><th>Extent of use of environmentally friendly product</th><th>Weightage for Credit Allocation</th></tr>
<tr><td>Low Impact</td><td>0.5</td></tr>
<tr><td>Medium impact</td><td>1</td></tr>
<tr><td>High Impact</td><td>2</td></tr>
</table>

Credits scored will be based on the extent of use of environmentally friendly product.

(Up to 6 credits)</td>
</tr>
<tr>
<td><u>NDC 3-4 SUSTAINABILITY POLICY</u>

<u>3-4-1 Sustainable Purchasing</u>

Establish a policy to promote the procurement and use of environmentally friendly products that are certified by local certification bodies.

<u>3-4-2 Waste Management</u>

(a) Establish a policy to promote and encourage waste minimization

(b) Establish a policy to promote waste sorting, collecting, quantifying, monitoring and recycling of a large range of waste generated in-house. Provide facilities or recycling bins for collection and storage of different recyclable waste such as:
1. IT related waste such as, electronic equipment
2. Plastic waste
3. Metal waste
4. Paper waste</td>
<td>1 credit

1 credit

1 credit</td>
</tr>
<tr>
<td><u>NDC 3-5 ENVIRONMENTAL MANAGEMENT PRACTICE</u>

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

(a) Implement effective environmentally friendly programmes including monitoring and setting targets to minimise energy use, water use and construction waste.</td>
<td>1 credit</td>
</tr>
</table>

(b) Main builder that has good track records in the adoption of sustainable, environmentally friendly and considerate practices during construction.	1 credit
(c) Building quality is assessed under the Quality Assessment System in Construction (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 for each firm (Up to 1 credit)
(f) Project team comprises one Certified GreenRE Manager / Greenmark Accredited Professional (GMAP)	1 credit for certified GRM/GMM
PART 3 – SUSTAINABLE CONSTRUCTION & MANAGEMENT CATEGORY SCORE:	Sum of GreenRE credits obtained from NDC 3-1 to 3-4: Maximum 30 Credits

Part 4 – Indoor Environmental Quality	GreenRE credits
NDC 4-1 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
NDC 4-2 LIGHTING QUALITY AND MANAGEMENT To encourage good lighting design to promote productivity and occupant comfort. Improve 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
NDC 4-3 THERMAL COMFORT AND NOISE LEVEL (a) In all areas specify comfort level to comply with the following: • Supply air temperature not less than 23°C • Relative Humidity between 30% to 60% (b) All areas are designed to achieve ambient internal noise level as specified: • 55 dB (6am – 10pm) L_{Aeq} • 45 dB (10pm – 6am) L_{Aeq}	1 credit 1 credit
PART 4– INDOOR ENVIRONMENTAL QUALITY CATEGORY SCORE:	Sum of GreenRE credits obtained from NDC 4-1 to 4-3: Maximum 6 Credits

Part 5 – Other Green Features	GreenRE credits
NDC 5-1 GREEN FEATURES AND INNOVATIONS To encourage the use of other green features which are innovative or/and have positive environmental impact. Features must achieve significant, measurable environmental performance in the data centre operations, maintenance or management not covered in Part 2, 3 and 4 above. Examples: (a) Computational fluid dynamics (CFD) simulation to analyse and improve air management inside data halls (b) Building Information Modelling (BIM) based design such as 4D, 5D, 6D (c) Purchase green power generated locally for a minimum contract period of 10 years. (0.5 credits for every 1% replacement) (d) PUE less than 1.4 at 25% IT load – refer to PUE calculation formula (e) Thermal mapping of racks to identify areas of overcooling and undercooling	Credits awarded for each feature based on impact and demonstration of the following: • The intent of the proposed innovation • The additional environmental benefits delivered • The proposed requirements for • Compliance • The proposed performance metrics to demonstrate compliance and the • approaches (strategies) used to meet the requirements (Up to 10 credits) 2 credits 1 credit each up to 10 credits 3 credits 1 credit
PART 5 – OTHER GREEN FEATURES CATEGORY SCORE:	Sum of GreenRE credits obtained from NDC 5-1: Maximum 10 Credits

Part 6- Carbon Footprint of Development	GreenRE Credits
NDC 6-1 CARBON FOOTPRINT OF DEVELOPMENT To calculate Scope 1,2 and 3 emissions in accordance with established Green House Gas (GHG) Protocol aligned frameworks. For new buildings, this will primarily entail direct and indirect operational emissions (Scope 1,2) and embodied carbon from construction and materials used. (Scope 3).	3 credits
PART 6- CARBON FOOTPRINT OF DEVELOPMENT **CATEGORY SCORE:**	Sum of GreenRE credits obtained from NDC 6-1: Maximum 3 Credits

GreenRE Score (New Data Centre)

GreenRE Score (NDC) = ∑Category score [(Part 1-Energy Efficiency) +
(Part 2-Water Efficiency) +
(Part 3-Sustainable Construction & Management) +
(Part 4-Indoor Environmental Quality) +
(Part 5-Other Green Features) +
(Part 6-Carbon Emission of Development)]

Where:
Category Score for Part 1≥ 35 credits and
∑Category score for Part 2 to Part 6 ≥ 10 credits

Appendix A
DC ENERGY MODELING METHODOLOGY AND REQUIREMENTS

Energy Modelling Guideline

The simulation shall be conducted in accordance with the Design Reference Guide Non -Residential Building Appendix A: Energy Modelling Methodology and Requirements, where applicable.

The energy performance of a Data Centre Facility shall take into consideration data centres' unique design such as N+1 or 2N design. Energy modelling shall be used to assess PUE and system efficiency in multiple loads, i.e. IT load at 25% 50%, 75% and 100%. A separate calculator or software shall be used to estimate the electrical losses in the power supply chain (transformers, switchgear, UPSs, PDUs and electrical cables.) under various load conditions - 25%, 50%, 75% and 100% IT load. These losses shall then be included as internal loads, dissipated as heat in the thermal zone.

The energy performance improvements may come from facility infrastructure design, selection of equipment, their capacities and part load characteristics and how they are operated. The designer may use the opportunity to determine the optimal operating configuration of equipment and systems in terms of energy performance but must commit to the selection in the submission. The system configurations must consider the redundant equipment and sequencing arrangements that enable the spare equipment capacity to be on "hot" standby, i.e. running together with base capacity. Separate zones and schedules shall be modelled based on spaces with different temperature, e.g. raise floor, data hall and ceiling return.

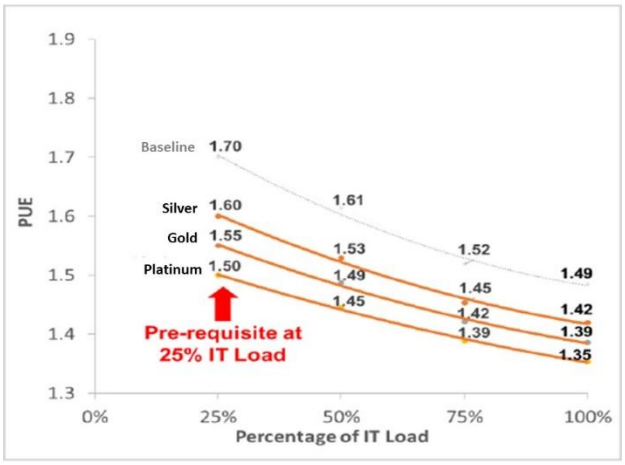
Appendix B

PUE POINT SCORING – WORKING EXAMPLE

Case No.1

Design PUE of Data Centre A

IT Load	25%	50%	75%	100%
Design PUE	1.55	1.48	1.41	1.39



Target GreenRE rating is Gold, hence the reference curve for Gold should apply.

Final Point = Base Point *(1 – (20 x PUE Deviation Percentage))

Where PUE Deviation Percentage refers to percentage deviation of the PUE at 50% and 75% IT load from the reference PUE curve, whichever is higher. The PUE Deviation Percentage shall be capped at 2%. If the PUE at 50% and 75% IT load are better than the PUE Reference for the specific Green Mark rating, then the PUE Deviation Percentage is zero.

Base Point (at 25% IT load) $= 1.4 \times \frac{1.7-1.55}{1.7} \times 100 = \ 12.3$

As the PUE at 50% and 75% is better (and lower than) the PUE Reference for Gold, the PUE Deviation Percentage is zero.

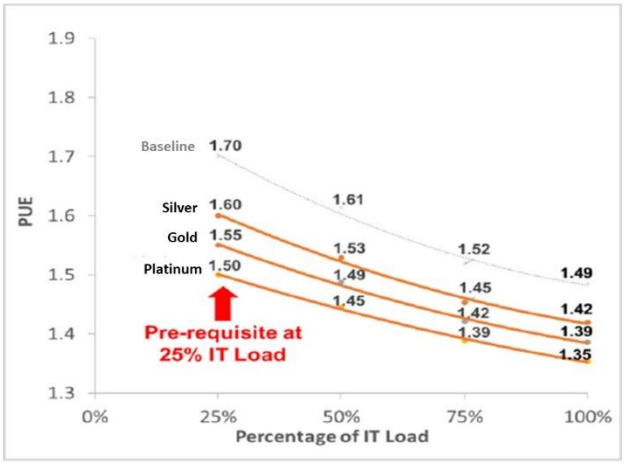
Final Point = 12.3

IT Load	25%	50%	75%
Reference PUE Curve	1.55 (Gold)	1.49	1.42
Data Centre A Design PUE	1.55	1.48	1.41
PUE Deviation Percentage	N.A		
PUE Deviation Percentage to be applied (cap at 2%)			

Case No.2

Design PUE of Data Centre B

IT Load	25%	50%	75%	100%
Design PUE	1.47	1.46	1.41	1.32



Target GreenRE rating is Platinum, hence the reference curve for Platinum should apply.

Final Point = Base Point *(1 – (20 x PUE Deviation Percentage))

Where PUE Deviation Percentage refers to percentage deviation of the PUE at 50% and 75% IT load from the reference PUE curve, whichever is higher. The PUE Deviation Percentage shall be capped at 2%. If the PUE at 50% and 75% IT load are better than the PUE Reference for the specific Green Mark rating, then the PUE Deviation Percentage is zero.

Base Point (at 25% IT load) $= 1.4 \times \frac{1.7-1.47}{1.7} \times 100 = \ 18.9$

Final Point $= 1.4 \times 1 - (20 \times 1.44\%)) = 13.5$

Compare the percentage improvement of PUE at various load points at 50% and 75% IT load, reference to Platinum reference curve.

IT Load	25%	50%	75%
Reference PUE Curve	1.5 (Platinum)	1.45	1.39
Data Centre A Design PUE	1.47	1.46	1.41
PUE Deviation Percentage	N.A	$\frac{1.45-1.46}{1.45} \times 100 = -0.69\%$	$\frac{1.39-1.41}{1.39} \times 100 = -1.44\%$
PUE Deviation Percentage to be applied (cap at 2%)	1.44 % (Higher deviation of 50% and 75% IT load)		