GMDC: 2024

BCA-IMDA Green Mark for Data Centres

BETA VERSION

To achieve GREEN MARK Certification

Prerequisite Requirement
All relevant prerequisite requirements for the specific Green Mark Rating are to be complied with

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Section 1 - Energy Efficiency (EE)

EE 1 Power Usage Effectiveness (PUE)

EE 2 Cooling System Efficiency

EE 3 Air Management

EE 4 IT Power Chain Efficiency

EE 5 Hot Aisle/ Cold Aisle Containment

EE 6 Renewable Energy

Section 2 – Carbon (CN)

CN 1 Sustainable Design and Construction

CN 2 Sustainable Products and Materials

CN 3 Energy Efficient IT Equipment

CN 4 SS 564 Certification

CN 5 Greenhouse Gas (GHG) Emissions
     Monitoring and Tracking

Section 3 – Resilience (RE)

RE 1 Project Team

RE 2 Refrigerant and Fire Suppressant

RE 3 Reduction in Water Consumption of
     Cooling Towers

RE 4 Water Efficient Fittings

RE 5 Water Usage Effectiveness (WUE)

Section 4 – Health and Wellbeing (HW)

HW 1 Active Furnishing

HW 2 Air Quality and Comfort

HW 3 Biophilic Design

HW 4 Restorative Spaces

Section 5 – Intelligence (IN)

IN 1 Integration

IN 2 Asset Information Model

IN 3 Responsive

Section 6 – Maintenance (MT)

MT 1 Architectural

MT 2 Mechanical

MT 3 Electrical

Scorecard

GM Criteria		Point Allocations	
		New DC	Existing DC
Section 1 – Energy Efficiency (EE)			
EE 1	Power Usage Effectiveness (PUE)	20	
EE 2	Cooling System Efficiency	10	
EE 3	Air Management	3	
EE 4	IT Power Chain Efficiency	4	
EE 5	Hot Aisle/ Cold Aisle Containment	2	
EE 6	Renewable Energy	1	
	Score for Section 1 – Energy Efficiency	**40**	
Section 2 – Carbon (CN)			
CN 1	Sustainable Design and Construction	2	0
CN 2	Sustainable Products and Materials	1	1
CN 3	Energy Efficient IT Equipment	3	3
CN 4	SS 564 Certification	2	2
CN 5	Greenhouse Gas (GHG) Emissions Monitoring and Tracking	0	2
	Score for Section 2 – Carbon	**8**	
Section 3 – Resilience (RE)			
RE 1	Project Team	1	
RE 2	Refrigerant and Fire Suppressant	2	
RE 3	Reduction in Water Consumption of Cooling Towers	1	
RE 4	Water Efficient Fittings	1	
RE 5	Water Usage Effectiveness (WUE)	1	
	Score for Section 3 – Resilience	**6**	
Section 4 – Health and Wellbeing (HW)			
HW 1	Active Furnishing	0.5	
HW 2	Air Quality and Comfort	1.25	
HW 3	Biophilic Design	1	
HW 4	Restorative Spaces	0.25	
	Score for Section 4 – Health and Wellbeing	**3**	
Section 5 – Intelligence (IN)			
IN 1	Integration	4.5	3.5
IN 2	Asset Information Model	1.5	2
IN 3	Responsive	3	3.5
	Score for Section 5 – Intelligence	**9**	
Section 6 – Maintenance (MT)			
MT 1	Architectural	1	
MT 2	Mechanical	4.5	
MT 3	Electrical	3.5	
	Score for Section 6 – Maintenance	**9**	
	Total Green Mark Score available	**75**	

Prerequisite Requirements

Green Mark Rating	Green Mark Score
Green Mark Platinum	50
Green Mark Gold^{PLUS}	40

Prerequisite Requirements for Data Centres

P.1 POWER USAGE EFFECTIVENESS (PUE) FOR NEW DATA CENTRES

Green Mark Rating	Maximum PUE at 25% IT Load
Green Mark Gold^{PLUS}	1.46
Green Mark Platinum	1.39

Note:

1) PUE is a metric that illustrates data centre energy efficiency using the total annual facility energy divided by total annual IT equipment energy. The IT equipment energy shall be measured at Power Distribution Unit (PDU) output [PUE category 2]. Please refer to SS 564 for details on the PUE metric and the measurement categories.

2) PUE performance of new data centres shall be determined using energy modelling software at the 25%, 50%, 75% and 100% of IT load and for existing DCs, PUE performance data for past 12 months shall be submitted.

MAXIMUM OPERATING PUE FOR EXISTING DATA CENTRES

Minimum operating PUE shall refer to the PUE (chart 1) at the corresponding IT load for the respective Green Mark rating.
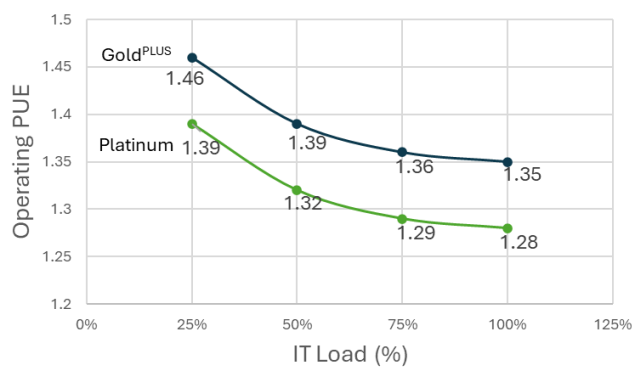

Chart 1

P.2 COOLING SYSTEM EFFICIENCY

Green Mark Rating	Total Cooling System Efficiency (TSE)[1] (kW/RT)	Air-side Efficiency[2] (kW/RT)
Green Mark Gold^{PLUS}	0.74	0.18
Green Mark Platinum	0.68	0.16

1   Total Cooling System Efficiency (TSE) (kW/RT) shall include both the water side and air side systems, irrespective of types of cooling systems and IT loads.
2   Air-side Efficiency (kW/RT) is only applicable for DCs with purchased cooling from District Cooling System (DCS).

The prescribed maximum efficiency figure in the table above shall be complied with at any IT load between 25% and 100%.

For the purpose of energy modelling for DCS with purchased cooling from DCS, the default chiller plant efficiency of 0.67 kW/RT shall be applied for DCs with purchased cooling from DCS.

P.3 PERMANENT MEASUREMENT & VERIFICATION (M&V) FOR COOLING SYSTEM OPERATING EFFICIENCY

Permanent measuring instruments for monitoring of cooling system operating efficiency shall be provided. The installed instrumentation shall have the capability to calculate the resultant operating system efficiency (i.e. kW/RT) within 5% of its true value and in accordance with SS 591: 2021 - Code of practice for long term measurement of central chilled water system energy efficiency. Each measurement system shall include the sensor(s), any signal conditioning, the data acquisition system and wiring connecting these components.
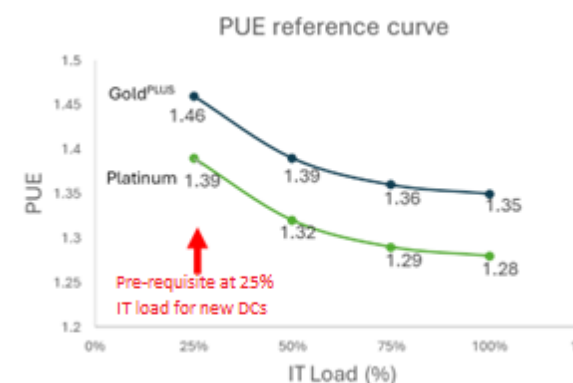
- Location and installation of the measuring devices to meet the manufacturer's recommendation; location of measuring devices should be within reach to facilitate site maintenance and verification.

- All data logging with capability to trend at 1-minute sampling time interval, and recorded to the 3rd decimal digit.

- Computation and display of water-side and air-side efficiency.

- Magnetic in-line flow meter, with 1% uncertainty and capable of electronic in-situ verification to within ±2% of its original factory calibration. If installation of magnetic in-line meters is not possible, ultrasonic flow meters may be used.

- 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 the entire measurement range. Provisions shall be made for each temperature measurement location to have test plugs or additional thermo-wells located before and after each temperature sensor for verification of measurement accuracy. All thermo-wells are recommended to be installed in a manner that ensures the sensors can be in direct contact with the fluid flow. There shall be valid justification if direct immersion of the temperature sensor(s) is/are not possible. Such projects will be assessed on a case-by-case basis.

- Dedicated power meters of accuracy Class 1 or better and metering current transformers, where applicable, of Class 1 or better, are to be provided for each of the following groups of equipment: chillers, chilled water pumps, condenser water pumps, cooling towers fans and air side equipment.

- A heat balance substantiating test for the water-cooled chilled-water system is to be computed in accordance to SS 591 for verification of the accuracy of the M&V instrumentation. The heat balance shall be computed over the entire normal operating hours with more than 80% of the computed heat balance within ± 5% over a 1-week period.

P.4 ENERGY METERING AND REAL-TIME REPORTING OF PUE

- All energy related to PUE calculation shall be measured and trended over time; the data centre owners and/or operators shall verify that the energy related systems perform according to design.

- The data centre shall, at a minimum, be equipped with energy metering to provide total facility energy and total IT equipment energy at PDU output, in order to provide real-time display and data collection of PUE and computation of annual average PUE.

- All energy sources serving the data centre shall be measured, including but not limited to electricity, natural gas, steam and chilled water. Class 1 or better power meters and its current transformers, where applicable, shall be used to measure electricity.

Section 1 – Energy Efficiency

Section 1 - Energy Efficiency (EE)	Green Mark Points (40 Points)	
	New	**Existing**

EE 1 Power Usage Effectiveness (PUE)

(a) New Data Centres

Use a computer simulation to assess the energy performance of the proposed Data Centre (DC) to achieve the most efficient design.

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

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

The PUE shall be verified in accordance with the requirement of commissioning of energy systems as specified under ANSI/ASHRAE/IES Standard 90.1 commissioning requirements for building controls and the building envelop. Commissioning shall be carried out at multiple part loads (25%, 50%, 75% and 100% of IT load) and under normal utility operations, maintenance and failure conditions. The commissioning shall include verification of the PUE according to design.

Refer to Annex A for Energy Modelling Guideline.

(b) Existing Data Centres

The DC shall provide the operating PUE and operating IT load using 12 months of trend-logged data.

Operating PUE =

$$\frac{Annual\ facility\ energy\ consumption\ (kWh)}{Annual\ IT\ energy\ consumption\ (kWh)}$$

Total facility energy should include all energy types used by the DC, including utility supply, district chilled water, on-site generated renewable energy, and other relevant sources.

IT energy should be measured at the PDU output. PUE3 measured at IT equipment input is also acceptable, provided that the metering accuracy complies with established standards.

Scoring Methodology

PUE reference curve

(a) For DCs able to achieve Gold^{plus} PUE curve, when $PUE_{Platinum} < PUE \leqslant PUE_{Gold}{}^{PLUS}$:

   Points scored = 10 + 71 x $(PUE_{Gold}{}^{PLUS} - PUE)$

(b) For DCs able to achieve Platinum curve, when $PUE \leqslant PUE_{Platinum}$:

   Points scored = 15 + 27 x $(PUE_{Platinum} - PUE)$

New DCs: PUE refers to design PUE at 25% IT load. For points scoring, respective values of $PUE_{Gold}{}^{PLUS}$ and $PUE_{Platinum}$ at 25% IT load shall be used as provided in the PUE reference curve above.

Existing DCs: PUE refers to operating PUE at the current IT load. For points scoring, respective values of $PUE_{Gold}{}^{PLUS}$ and $PUE_{Platinum}$ shall be interpolated based on data points provided in the PUE reference curve above.

(Up to 20 points for section EE1)

EE 2 Cooling System Efficiency		
To encourage the use of high efficiency cooling system in equipment efficiency and system configuration to minimize the energy consumption.		
Total cooling System Efficiency (TSE) (kW/RT) shall include both the water-side and air-side system. It shall include all DC ACMV equipment, humidity control equipment, office aircon, etc.	Points scored = 3 + 33 * (0.74 – Design TSE)	Points scored = 3 + 33 * (0.74 – Operating TSE)
Design TSE for New DCs shall be taken as the worst-case TSE value achieved at 25%, 50% and 75% of the design IT load.	Points scored = 3 + 100 * (0.18 – Design Air-side Efficiency)	Points scored = 3 + 100 * (0.18 – Operating Air-side Efficiency)
For DCs with purchased cooling from District Cooling System (DCS), air-side efficiency (kW/RT) is required. Design air-side efficiency for New DCs shall be taken as the worst-case air-side efficiency value achieved at 25%, 50% and 75% of the design IT load.	(Up to 10 points for section EE2)	(Up to 10 points for section EE2)

EE 3 Air Management		
To encourage good air management with low bypass and recirculation.		
a) New DCs use Computational Fluid Dynamics (CFD) simulation to analyse and improve the air management inside data halls.	1.5 points	n.a.
b) Existing DCs should have a Return Temperature Index (RTI), as defined in SS564, as close to 100% as possible.		
(i) Range between 70% and 130% Or (ii) Range between 80% and 120% Or (iii) Range between 90% and 110%	n.a.	0.5 point 1 point 1.5 points
c) To encourage the operation of DC at higher Supply Air Temperature (SAT) by following the methodology specified under **SS 697:2023 "Deployment and operation of data centre IT equipment under tropical climate"**. (i) 24°C ≤ SAT< 25°C (ii) 25°C ≤ SAT< 26°C (iii) 26°C ≤ SAT< 27°C (iv) SAT ≥ 27°C SAT refers to the temperature of the air leaving the aircon unit. For new DCs, all data halls must meet the requirement, and for existing DCs, at least 90% of data halls must comply with this requirement. *Note: 100% liquid cooled DC will be awarded full 3 points. For hybrid cooling topologies, points will be prorated based on IT load.*	0.25 point 0.5 point 1 point 1.5 points	

EE 4 IT Power Chain Efficiency To achieve the most efficient electrical power supply system while providing the required level of redundancy. IT Power Chain Efficiency shall include components such as transformers, transmission lines, switchgears, UPSs and PDUs serving the IT equipment.	1 point for achieving IT power chain efficiency of 85% at 25% IT load. Points scored = 0.3 x (E - 85%) E refers to the design IT power chain efficiency at 25% IT load (Up to 4 points)	1 point for achieving IT power chain efficiency of 85% at operating IT load. Points scored = 0.3 x (E - 85%) E refers to the operating IT power chain efficiency (Up to 4 points)
EE 5 Hot Aisle / Cold Aisle Containment Implement effective and complete physical separation of the hot air (IT equipment outlet) from the cold air (IT equipment inlet) to eliminate hot and cold air mixing, thus reducing energy consumption, e.g. full aisle containment with blanking plates at empty IT cabinet spaces.	2 points	
EE 6 Renewable Energy To promote on-site renewable energy generation in order to reduce reliance on grid energy and decrease carbon emissions.	0.25 points for every 0.01% replacement of total building energy (based on building energy consumption at 25% IT load) (Up to 1 point)	0.5 points for every 0.01% replacement of total building energy (Up to 1 point)

Section 2 – Carbon

Section 2 – Carbon (CN)	Green Mark Points (8 points)	
	New	**Existing**
CN 1 Sustainable Design and Construction Use of sustainable construction materials and methods to reduce environmental impacts of the construction phase. a) Promote scalable expansion by building up capacity in a modular approach to improve energy efficiency.	0.5 point	n.a.

b) Use of Low Carbon Concrete certified by SGBC or equivalent local certification bodies (using CEM II – V cements under SS EN 197-1) for ≥ 80% of applicable superstructure works by volume:
  a. at least SGBP 2 ticks or equivalent
  b. at least SGBP 3 ticks or equivalent
  c. at least SGBP 4 ticks or equivalent
	0.2 point
	0.3 point
	0.5 point
		n.a.

c) Replacement of coarse and fine aggregates for structural concrete applications [by mass of Crushed Concrete Aggregate (CCA), Wash Copper Slag (WCS), granite fines (GF)] must meet both minimum requirements in terms of extent of usage and replacement levels as shown in the table below: 	Minimum Requirement	CCA*	WCS	GF
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Extent of usage	≥ 1.5% x GFA	≥ 0.75% x GFA	≥ 1.5% x GFA
Replacement amount (%)	≥ 20%	≥ 10%	≥ 50% | *Crushed concrete aggregate (CCA), referred to in current standards, was previously called recycled concrete aggregate (RCA)	0.25 point for fine/coarse aggregate replacement; 0.5 point for both coarse and fine aggregate replacement	n.a.
d) Existing structures are demolished with an enhanced demolition protocol, where a recovery rate of ≥ 40% crushed concrete waste from the demolished building is sent to approved recyclers with proper facilities	0.5 point	n.a.
CN 2 Sustainable products and materials a) Green Mechanical, Electrical and Plumbing (MEP) To encourage use of Mechanical and Electrical (M&E) products and building services where ≥ 60%* by cost of the MEP systems are SGBP certified or equivalent administered by local certification bodies. Examples of green products include: • Chillers • Auto-tube cleansing system • Pumps • Transformers	0.5 point	

(The coverage of ≥ 60% by cost should include at least 3 types of Green MEP Products)* b) Green Materials To encourage the use of building components/products certified by SGBP or an approved local certification body. Points will be awarded based on the weightage and the extent of the coverage and impact (i.e. weightage x extent of coverage and impact). <table><tr><td>Very Good</td><td>Excellent</td><td>Leader</td></tr><tr><td>0.3</td><td>0.4</td><td>0.5</td></tr></table> <table><tr><td colspan="2">Factor Based on Extent of Coverage and Impact of the Material</td></tr><tr><td>High Impact</td><td>0.5</td></tr><tr><td>Low Impact</td><td>0.25</td></tr></table> *Note: High impact refers to ≥ 60% of usage; Low impact refers to < 60% usage of applicable areas*	0.5 point
CN 3 Energy Efficient IT Equipment All new/renewed customer agreements and IT equipment procurement policy (where applicable) shall include requirements that mandate the use of energy efficient IT equipment defined as follows: 1. IT equipment must have a valid certificate under US Energy Star or equivalent certification scheme. In cases where Energy Star or equivalent certification is not available, individual compute server equipment's active state efficiency score obtained using Standard Performance Evaluation Corporation (SPEC)'s Server Efficiency Rating Tool (SERT) ver. 2.0 and above shall be provided to show that the equipment is as energy efficient as that specified by Energy Star or equivalent certification. 2. IT equipment shall be able to operate at Class A2 conditions as defined by ASHRAE Environment Classes for Data Centres. (i) 50% ≤ Coverage of IT equipment < 70% (ii) 70% ≤ Coverage of IT equipment < 85% (iii) Coverage of IT equipment ≥ 85%	 1 point 2 points 3 points
CN 4 SS 564 Certification To obtain SS 564 certification which assists organizations in establishing and maintaining a management system focused on energy efficiency and environmental stewardship.	2 points

CN 5 Greenhouse Gas (GHG) Emissions Monitoring and Tracking (a) Scope 1 GHG emission (direct emission) and Scope 2 GHG emission (indirect emission). (b) Scope 3 GHG emission (indirect emission) for at least 2 relevant categories.	n.a.	1 point for scope 1 & 2 2 points for scope 1, 2 & 3

Section 3 – Resilience

Section 3 – Resilience (RE)	Green Mark Points (6 points)	
	New	**Existing**
RE 1 Project Team The appointment of environmental specialists at building design, construction, operation and retrofit stages to drive and coordinate the environmental design approach. a) Accredited professionals GM AP / GM AAP GM AP(FM) / GM AAP(FM)[1] Certified FM Expert (CFME)[2] – Tiers 1 and 2 b) Firms certified under Singapore Green Building Services (SGBS)[2] certification scheme, and/or Certified FM Company (CFMC)[3] accreditation scheme [1] https://gmap.sgbc.online/public/about [2] https://www.sifma.org.sg/certified-facilities-management-expert-cfme [3] https://www.sgbc.sg/sgbc-certifications/sgbs- certification [4] https://www.sifma.org.sg/CFMC_Accreditation	0.25 point for GMAP/GMAP(FM)/ CFME (Tiers 1 and 2) 0.5 point for GMAAP/GMAAP(FM) (Up to 0.5 point) 0.25 point per firm (Up to 0.5 point)	
RE 2 Refrigerant and Fire Suppressant To encourage responsible use of refrigerants and fire suppressants, minimising their environmental impact. Points will be awarded based on the Ozone Depleting Potential (ODP) and Global Warming Potential (GWP) for the following (ODP=0 and GWP<10): (a) Refrigerants (b) Fire Suppressant in the whole data centre *Note: To be awarded any points, all refrigerants and fire suppressants used throughout the data centre must comply with these criteria.*	1 point 1 point	

RE 3 Reduction in Water Consumption of Cooling Towers
 	
a) Use of a cooling tower water treatment system which can achieve
 	
    7 or better cycles of concentration (COC) with acceptable water quality when utilising PW
 	
    OR
 	
    10 or better cycles of concentration (COC) with acceptable water quality when utilising NW
	0.5 point
	
	0.5 point	

b) Use of alternate water for cooling tower makeup water such as rainwater, AHU condensate water, NEWater, etc. **Note**: *DCs are to provide cooling tower water conductivity sensors for real-time COC trending and monitoring.*	
RE 4 Water Efficient Fittings To encourage the use of efficient water fittings under PUB's Water Efficient Labelling Scheme (WELS). Use of minimum WELS 3-ticks rating for all water fittings	1 point
RE 5 Water Usage Effectiveness (WUE) WUE is a metric that measures the efficiency of water usage in data centres. To encourage water use efficiency in data centres, points will be awarded for WUE less than 2.2m³/MWh/year. WUE (m³/MWh/year) = $\dfrac{\text{Annual Water Consumption (m}^3)}{\text{Annual IT energy (MWh)}}$ i) $2.0 < \text{WUE} \leq 2.2$ ii) $\text{WUE} \leq 2.0$	0.5 point 1 point (Up to 1 point)

Section 4 – Health and Wellbeing

Section 4 – Health and Wellbeing (HW)	Green Mark Points (3 Points)	
	New	**Existing**
HW 1 Active Furnishing Provision of active furnishing to discourage sedentary behaviour (e.g. standing tables and height-adjustable desk), decentralised common areas, standing meeting rooms etc.	0.5 point (at least 100% of all workstations)	
HW 2 Air Quality and Comfort **a) Occupant Comfort** (i) Use of hybrid cooling system (elevated temperature with increased air speed) that can meet PMV +/- 0.5	0.25 point	
(ii) Periodic (Post) Occupancy Evaluations At least once every 3 years	0.25 point	
(iii) IAQ Surveillance Audit By an accredited laboratory once every 3 years	0.25 point	
b) Clean Air (i) UVGI system for air disinfection	0.25 point	
(ii) Air filtration with permanent provision of ePM1 ≥75% (ISO 16890) [or alternatively at least MERV 14A (ASHRAE 52.2 Appendix J)] media filters for occupied space	0.25 point	
HW 3 – Biophilic Design Direct connection to plants, water, light or nature views; Indirect connection via natural materials, patterns, art; Placement of natural elements along common circulation routes, shared seating areas, workstations (i) Fixed indoor planting distributed at key common areas. >10% of common area (by floor Area) to have fixed indoor planting, and/or ponds.	0.5 point	
(ii) Placement of natural elements, and use of mixed textures in key common areas such as atria, entrance lobbies, shared seating areas, and key circulation routes.	0.5 point	
HW 4 Restorative Spaces Healthy environments should be designed with a range of spaces catering for a broad spectrum of human activities that are suitably adaptable for collaborating, resting and relaxing, or community bonding. The provision of such spaces especially in a working environment help reduce stress, provide places of focus and refuge for occupants. Designated indoor and/or outdoor space for restorative practices (<u>minimum 16m2 per space</u>, and large enough for meditation/yoga or just quiet respite) which are accessible for all building occupants.	0.25 point	

<u>Note:</u> HW1-3 will only apply to normally occupied areas, such as support offices and Network Operation Centre (NOC). It will not be required in normally unoccupied areas such as plantrooms, data halls (unless workstations are included within these spaces)

Section 5 - Intelligence

Section 5 – Intelligence (IN)	Green Mark Points (9 Points)	
	New	**Existing**
IN 1 – Integration a) Digital Life Cycle Use Integrated Digital Delivery (IDD) solution(s) to develop <u>Project Information Model (PIM)</u> with adequate level of information needed to facilitate integrated and digitalised design, construction, operation and retrofit process. PIM shall be sufficiently developed and detailed for purposes of co-ordination, environmental simulations, statutory submissions, tender and construction documentation as well as forming the basis for conversion into Asset Information Models (AIM).		
(I) PIM (BIM) developed in accordance with Singapore Model Content Requirements (MCR).	0.5 point	N.A
(II) Use of spatial model co-ordination platform based on PIM for spatial analysis including:	0.75 point	N.A
a. Identifying system clashes through an automatic model checking tool.		
b. Spatial analysis for effective construction, maintenance and future alteration or replacement.	0.75 point	N.A
(III) Digital building commissioning, performance and defect co-ordination platform based on PIM to track, co-ordinate and manage the commissioning of systems and the tracking of defects and their rectification.	1 point	1 point for re-commissioning or retro commissioning
References: • *[ISO 19650–1](#) Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 1: Concepts and principles.* • *[ISO 19650-2](#) Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 2: Delivery phase of the assets.* • *[Model Content Requirements (MCR)](#) stipulates the information requirements for Building Information Modelling (BIM) by building typology as part of project information deliverables according to project delivery stages.*		
b) **Performance dashboard** to monitor the different aspects of building assets' performance and operations from a single dashboard:		
i) Operational dashboard: sets of measures used to guide facility operations such as energy & water efficiency and work order status.	0.5 point	1 point
ii) Managerial dashboard: sets of metrics which may use data from multiple operational systems such as asset health	0.5 point	1 point
c) Data Accessibility and Security - information stored in the digital platform(s) can be accessed by facilities teams in a secured manner to facilitate operation and maintenance activities from anywhere and anytime.	0.5 point	0.5 point

IN 2 – Asset Information Model a) Physical and virtual asset information tagging system that allows for tracking of maintenance work, repairs, refurbishments or upgrades, replacement, decommissioning, risk assessments, and performance evaluations of the physical asset to be captured.	1 point	1 point
b) Demonstrate accountable data ethics practices that identifies the various opportunities for the collection, analysis, and use of data, organised around 4 principles: • Governance and Transparency • Management of Personal Data • Care of Personal Data • Individuals' Rights	0.5 point	1 point
IN3 Responsive Real time asset monitoring and optimisation (i) Adaptive Air-Conditioning Mechanical Ventilation (ACMV) control system (water-side) – continuously monitor, analyse, and modify Building Management System (BMS) control settings to optimise energy usage of ACMV (water-side) system	1 point	1 point
(ii) Adaptive ACMV control system (air-side) – continuously monitor, analyse, and modify BMS control settings to optimise energy usage of ACMV (air-side) system	1 point	1 point
(iii) Adaptive lighting monitoring & control system – continuously monitor and control the lighting within specific areas based on inputs such as motion, daylight levels, or space temperature to reduce energy usage	0.5 point	0.5 point
(iv) Tenant energy monitoring and optimisation – continuously monitor, benchmark, and report tenant energy consumption to optimise the energy consumption.	0.5 point	1 point

Section 6 – Maintainability (MT)

Section 6 – Maintainability (MT)	Green Mark Points (9 Points)	
	New	**Existing**
MT 1 Architectural Access for maintenance of façade Ensure entire façade is accessible for maintenance *Note:* - *100% of the façade must be accessible.* - *Façade: including wall, cladding (stone, tile, metal, and glazing), openings, structural members, railings, façade features (sun-shading devices), and M&E systems (façade lighting, media walls, solar panels [BIPV])* - *Sole use of rope access is deemed unacceptable since maintenance comprises regular cleaning, minor repair & replacement, and inspection; all of which cannot be undertaken by rope access.* - *Access for façade maintenance, if accessible from within the building, must not be via tenanted/leased out spaces.*	1 point	
MT 2 Mechanical 2.1 Chiller Plant 2.1.1 Access to cooling towers to facilitate maintenance Provide permanent sleeve to mount davit arm for all cooling towers and hand over of 1 davit arm for each cooling tower model to building owner	0.5 point	

2.1.2   Reduce risk of fouling issue and improve condenser water quality
 	
    a. Provide microprocessor based, automatic water quality monitoring and control system linked to BMS.
 	
        The critical parameters including conductivity, temperature, pH value, hardness, salinity, oxidation reduction potential (ORP) and total dissolved solids (TSS) must be monitored by BMS.
	0.5 point	

b. Provide auto-tube cleaning for water cooled chillers.	0.5 point	
c. Provide basin sweeper system and side stream separator to remove coarse to fine particles and silt deposit in the cooling tower basin. *Note: The basin sweeper system shall be provided for each cooling tower.*	1 point	

2.2	Fire Protection System	
2.2.1	Provide flexibility for maintenance and testing of sprinkler system	
a.	Locate the flow switch drain valve in rooms with floor trap (i.e. toilet, AHU room etc.).	0.5 point
b.	Provide smart features such as the automatic flow switch testing system to automate the functional test for the fire sprinkler system.	0.5 point
2.2.1	Reduce risk of damage and periodic replacement of fire-rated boards due to exposure to high humidity and water.	
a.	Specify the use of weatherproof fire-rated materials for fire protection services such as wet/dry riser and hydrant pipes etc.	0.5 point
b.	Specify the use of weatherproof fire-rated materials for mechanical ventilation services.	0.5 point
MT 3 Electrical		
3.1	Power distribution	
3.1.1	Reduce risk of water Ingress into electrical room	
a.	Electrical room must be raised by minimum 100 mm against the outside passageway. *(OR)*	0.5 point
b.	Provide minimum 100 mm plinth for floor mounted electrical switchboard.	
3.1.2	Reduce risk of failure of main LT switchboard due to overheating	
a.	Install heat sensor in the main LT switchboard to alert any abnormal rise in temperature with audible/visual alarm.	0.5 point
b.	Integrate sensor to building BMS system for online monitoring of temperature data.	0.5 point

3.2 Lightning Protection System Reduce risk of damage of air termination tape at roof parapet wall due to operation of façade maintenance systems such as gondola Avoid damage to the lightning protection system by proper design and installation of facade maintenance system	0.5 point	
3.3 Vertical Transportation a) Provide access to roof level for equipment replacement and maintenance such as chiller plant and pumps	0.5 point	
b) Reduce lift downtime and enhance reliability by providing lift predictive maintenance. *Note: Monitor key parameters such as vibration, acceleration, levelling, door jams, gaps, noise, and jerk etc.*	0.5 point	
3.4 CCTV Camera a) Provide access to cameras located at heights (≥3 m) i.e. foldable poles/arms	0.25 point	
b) Provide surge arrestor to all outdoor cameras	0.25 point	

ANNEX A

<u>Energy Modelling Guideline</u>

The simulation shall be conducted in accordance with the <u>Green Mark 2021 Energy Modelling Technical Guide</u>, where applicable.

The energy performance of a **Data Centre Facility** shall consider the unique design features such as N+1 or 2N redundancy. Energy modelling shall be used to assess PUE and system efficiency at multiple IT loads: 25%, 50%, 75%, and 100%.

A separate calculator or software shall be used to estimate 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.

Energy performance improvements may result from facility infrastructure design, equipment selection, capacities, part-load characteristics, and operational strategies. Designers may use this opportunity to determine optimal operating configurations for equipment and systems in terms of energy performance but must commit to their selections in the submission.

System configurations must consider redundant equipment and sequencing arrangements that enable 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 temperatures, e.g., raised floor, data hall, and ceiling return.