



BCA GREEN MARK

# GM EDC: 2019

**BCA-IMDA Green Mark for Existing Data Centres**

**To achieve GREEN MARK Award**



**Prerequisite Requirement**

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



**Section 1 – Energy Efficiency**

- 1.1 Power Usage Effectiveness (PUE)
- 1.2 Cooling System Efficiency
- 1.3 Air Management
- 1.4 IT Power Chain Efficiency
- 1.5 Hot Aisle / Cold Aisle Containment
- 1.6 Renewable Energy

**Section 2 – Water Efficiency**

- 2.1 Water Usage Effectiveness (WUE)
- 2.2 Reduction in Water Consumption of Cooling Towers
- 2.3 Water Monitoring and Leak Detection
- 2.4 Alternative Water Sources
- 2.5 Water Efficient Fittings

**Section 3 – Sustainable Operation & Management**

- 3.1 Refrigerants and Fire Suppressants
- 3.2 Green Products and Materials
- 3.3 Sustainable Operation
- 3.4 Environmental Credentials of Project Team
- 3.5 Data Centre Operation and Energy Management
- 3.6 Waste Management

**Section 4 – Smart and Healthy Building**

- 4.1 Indoor Air Quality Performance
- 4.2 Lighting Quality and Management
- 4.3 Thermal Comfort and Noise
- 4.4 Data Centre Infrastructure Management

**Section 5 – Advanced Green Effort**

- 5.1 Other Green Features & Innovations

**BCA-IMDA Green Mark for Existing Data Centres EDC: 2019**

<b>GM Criteria</b>		<b>Point Allocations</b>
<b>Section 1 – ENERGY EFFICIENCY</b>		
1.1	Power Usage Effectiveness (PUE)	25
1.2	Cooling System Efficiency	20
1.3	Air Management	4
1.4	IT Power Chain Efficiency	7
1.5	Hot Aisle / Cold Aisle Containment	2
1.6	Renewable Energy	4
<b>Score for Section 1 – Energy Efficiency</b>		<b>62</b>
<b>Section 2 – WATER EFFICIENCY</b>		
2.1	Water Usage Effectiveness (WUE)	1
2.2	Reduction in water Consumption of Cooling Towers	2
2.3	Water Monitoring and Leak Detection	3
2.4	Alternative Water Sources	1
2.5	Water Efficient Fittings	1
<b>Score for Section 2 – Water Efficiency</b>		<b>8</b>
<b>Section 3 – SUSTAINABLE OPERATION &amp; MANAGEMENT</b>		
3.1	Refrigerants and Fire Suppressants	3
3.2	Green Products and Materials	4
3.3	Sustainable Operation	6
3.4	Environmental Credentials of Project Team	1
3.5	Data Centre Operation and Energy Management	3
3.6	Waste Management	3
<b>Score for Section 3 – Sustainable operation &amp; Management</b>		<b>20</b>
<b>Section 4 – SMART AND HEALTHY BUILDING</b>		
4.1	Indoor Air Quality Performance	2
4.2	Lighting Quality and Management	1
4.3	Thermal Comfort and Noise	1
4.4	Data Centre Infrastructure Management	6
<b>Score for Section 4 – Smart and Healthy Building</b>		<b>10</b>
<b>Section 5 – ADVANCED GREEN EFFORT</b>		
5.1	Other Green Features & Innovations	10
<b>Score for Section 5 – Advanced Green Effort</b>		<b>10</b>
<b>Total Green Mark Score available</b>		<b>110</b>

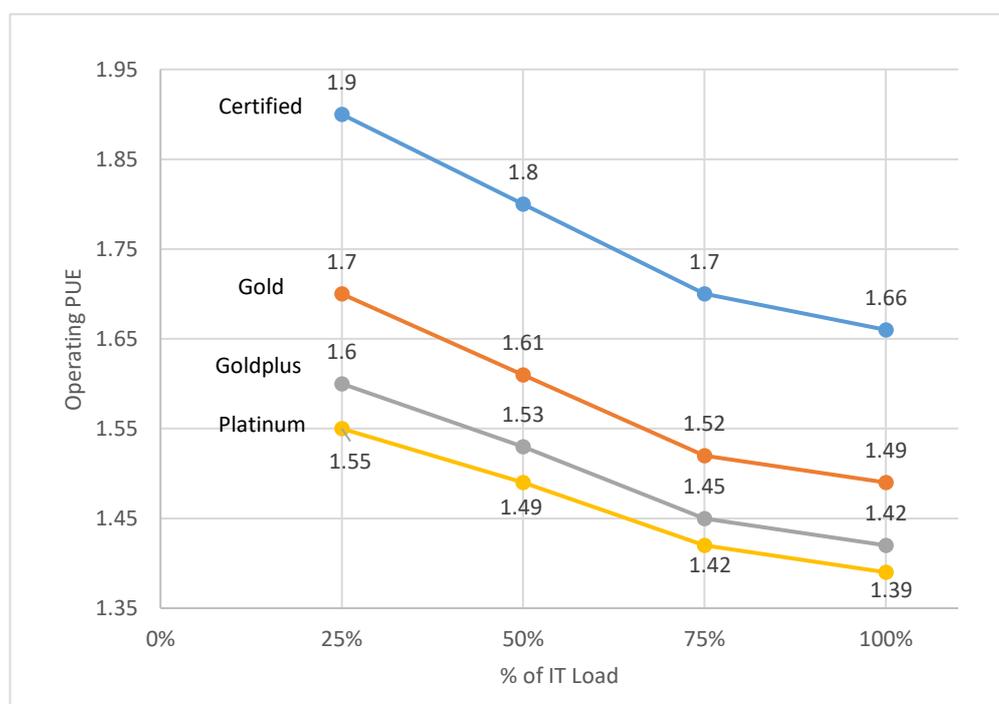
### Green Mark Award Ratings and Prerequisite Requirements

Green Mark Rating	Green Mark Score
Green Mark Platinum	70 and above
Green Mark Gold <sup>PLUS</sup>	60 to <70
Green Mark Gold	>50 to <60
Green Mark Certified	Compliance with all pre-requisite requirements

#### Prerequisite Requirements for Existing Data Centre Criteria

##### P.1 MINIMUM OPERATING POWER USAGE EFFECTIVENESS

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



**Chart 1**

Note:

- 1) Power Usage Effective (PUE) is a metric that illustrates data centre efficiency using the total annual facility energy divided by total annual IT equipment energy. The IT equipment energy shall be measured at PDU output [PUE category 2]. Where energy consumption at PDU output is unavailable, IT equipment energy shall be measured at UPS output [PUE category 1] and apply 3% electrical loss for PUE category 2 calculation. Please refer to SS 564 for details on PUE metric and the measurement categories.
- 2) PUE for the past 12 months shall be submitted

## P.2 COOLING SYSTEM MINIMUM OPERATING EFFICIENCY

### Option 1: Total Cooling Efficiency (water + air)

(i) For Data Centres using Water Cooled Cooling System:

Green Mark Rating	Cooling Load (RT)	
	< 500	≥ 500
	Efficiency <sup>(1)</sup> (kW/RT)	
Certified	1.07	1
Gold	1	0.95
Gold <sup>PLUS</sup>	0.9	0.85
Platinum	0.83	0.8

(ii) For Data Centres using Air Cooled Cooling System:

Green Mark Rating	Cooling Load (RT)	
	< 500	≥ 500
	Efficiency <sup>(1)</sup> (kW/RT)	
Certified	1.15	1.08
Gold	1.05	Not applicable <sup>(2)</sup>
Gold <sup>PLUS</sup>	0.9	
Platinum	0.83	

### Option 2: Cooling System Efficiency (excluding air-side system)

(i) For Data Centres using Water Cooled Cooling System:

Green Mark Rating	Cooling Load (RT)	
	< 500	≥ 500
	Efficiency <sup>(1)</sup> (kW/RT)	
Certified	0.8	0.75
Gold	0.75	0.7
Gold <sup>PLUS</sup>	0.67	0.62
Platinum	0.63	0.6

(ii) For Data Centres using Air Cooled Cooling System:

Green Mark Rating	Cooling Load (RT)	
	< 500	≥ 500
	Efficiency <sup>(1)</sup> (kW/RT)	
Certified	0.9	0.83
Gold	0.8	Not applicable <sup>(2)</sup>
Gold <sup>PLUS</sup>	0.67	
Platinum	0.63	

Note:

- 1) Performance of the system shall be subject to measurement and verification.

- 2) In general, for data centres with cooling load of more than 500 RT, the use of air cooled cooling system is not applicable for higher Green Mark ratings. However, if the system efficiency of the air cooled cooling system is comparable with the stipulated efficiency of water cooled cooling system, it will be assessed on a case-by-case basis.
- 3) For data centres with purchased cooling, the efficiency of the cooling system shall be provided for assessment and verification. If the efficiency of the cooling plant is not available, the default plant efficiency of 0.8 kW/RT shall be applied. *Please refer to [GM NRB: 2015 Technical Guide 2.1 \(c\)](#) on DCS baseline efficiency.*

### **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: 2013 - 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  $\pm 2\%$  of its original factory calibration. If installation of magnetic in-line meters is not possible, ultrasonic flow meters may be used
- Temperature sensors shall be provided for chilled water and condenser water loop and shall have an end-to-end measurement uncertainty not exceeding  $\pm 0.05^\circ\text{C}$  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/Chiller 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  $\pm 5\%$  over a 1-week period

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

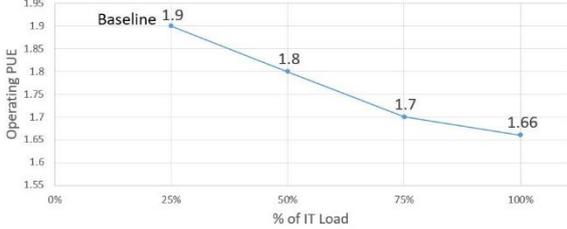
- (i) All forms of energy related to PUE calculation shall be measured and trended over time. The data centre owners and/or operators shall verify that the energy related systems are performing according to design intent.
- (ii) The data centre shall be equipped with energy metering to provide total facility energy, total IT equipment energy, in order to provide real-time display and data collection of PUE, and compute the annual average PUE.
- (iii) All sources of energy serving the data centre shall be measured, including but not limited to electricity, natural gas, steam and chilled water. Power meters, Class 1 or better shall be used to measure electricity.

#### **P.5 INDOOR AIR QUALITY (IAQ) SURVEILLANCE AUDIT FOR OCCUPIED AREA**

To conduct an IAQ surveillance audit once every 3 years. The audit shall be conducted by an accredited laboratory under Singapore Accreditation Council with respect to the recommended IAQ parameters and acceptable limits stated in Table 1 of SS 554 : 2016 Code of Practice for Indoor Air Quality for Air-Conditioned Buildings or in Annex E of NEA's Guidelines for Good Indoor Air Quality in Office Premises.

#### **P.6 DISPLAY GREEN MARK CREDENTIAL**

To display the Green Mark Decal or Plaque at prominent location.

Section 1 - Energy Efficiency	Green Mark Points (62 Points)																
<p><b>1.1 Power Usage Effectiveness (PUE)</b></p> <p>The data centre shall provide the operating PUE and Operating IT load using 12 months of trend-logged data.</p> $\text{Operating PUE} = \frac{\text{Annual facility energy consumption (kWh)}}{\text{Annual ICT energy consumption (kWh)}}$ <p>Total facility energy should include all kinds of energy used by data centre, including utility supply, district chilled water, renewable energy, etc.</p> <p>ICT energy should be measured at PDU output.</p>	<p><b>Green Mark Points (62 Points)</b></p> <p>Baseline PUE:</p>  <table border="1"> <caption>Operating PUE vs % of IT Load</caption> <thead> <tr> <th>% of IT Load</th> <th>Operating PUE</th> </tr> </thead> <tbody> <tr> <td>25%</td> <td>1.9</td> </tr> <tr> <td>50%</td> <td>1.8</td> </tr> <tr> <td>75%</td> <td>1.7</td> </tr> <tr> <td>100%</td> <td>1.66</td> </tr> </tbody> </table> <p><b>PUE Scoring Methodology:</b></p> <p>Point scored = 1.2 x (Percentage improvement at operating IT load from baseline PUE)</p> <p>(Up to 25 points)</p> <p><i>Refer to Annex A for examples.</i></p>	% of IT Load	Operating PUE	25%	1.9	50%	1.8	75%	1.7	100%	1.66						
% of IT Load	Operating PUE																
25%	1.9																
50%	1.8																
75%	1.7																
100%	1.66																
<p><b>1.2 Cooling System Efficiency</b></p> <p>To encourage the use of efficient cooling system to minimize the energy consumption.</p> <p><b>Option 1: Total Cooling Efficiency</b></p> <p>The total cooling system efficiency (kW/RT) shall include both the water-side and air-side system.</p> <p><b>(a) Water-cooled Cooling System</b></p> <table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="2">Cooling load</th> </tr> <tr> <th>&lt; 500 RT</th> <th>≥ 500 RT</th> </tr> </thead> <tbody> <tr> <td><b>Baseline (kW/RT)</b></td> <td>1.07</td> <td>1</td> </tr> </tbody> </table> <p><i>*Note 1): Water-cooled Cooling system includes Water-cooled package unit.</i>  <i>*Note 2): For data centres with purchased cooling, the efficiency of the cooling system shall be available and for verification. If the efficiency of the chilled water plant is not available, the default plant efficiency is 0.8 kW/RT.</i></p> <p><b>(b) Air-cooled Cooling System:</b></p> <table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="2">Cooling load</th> </tr> <tr> <th>&lt; 500 RT</th> <th>≥ 500 RT</th> </tr> </thead> <tbody> <tr> <td><b>Baseline (kW/RT)</b></td> <td>1.15</td> <td>1.08</td> </tr> </tbody> </table> <p><i>*Note: Where there is a combination of different system types points score will be pro-rated based on the weighted cooling capacity supplied by the respective system</i></p>		Cooling load		< 500 RT	≥ 500 RT	<b>Baseline (kW/RT)</b>	1.07	1		Cooling load		< 500 RT	≥ 500 RT	<b>Baseline (kW/RT)</b>	1.15	1.08	<p><b>Option 1: Total Cooling Efficiency</b></p> <p>Point scored = 0.67 x (% improvement)</p> <p>Point scored = 0.57 x (% improvement)</p> <p>(Up to 20 points)</p>
		Cooling load															
	< 500 RT	≥ 500 RT															
<b>Baseline (kW/RT)</b>	1.07	1															
	Cooling load																
	< 500 RT	≥ 500 RT															
<b>Baseline (kW/RT)</b>	1.15	1.08															

<b><u>Option 2: System efficiency (excluding air-side system)</u></b>	<b><u>Option 2: System efficiency (excluding air-side system)</u></b>																		
<p>(a) Water-cooled Cooling System:</p> <table border="1"> <thead> <tr> <th></th> <th colspan="2">Cooling load</th> </tr> <tr> <th></th> <th>&lt; 500 RT</th> <th>≥ 500 RT</th> </tr> </thead> <tbody> <tr> <td><b>Baseline (kW/RT)</b></td> <td>0.82</td> <td>0.75</td> </tr> </tbody> </table> <p>(b) Air-cooled Cooling System:</p> <table border="1"> <thead> <tr> <th></th> <th colspan="2">Cooling load</th> </tr> <tr> <th></th> <th>&lt; 500 RT</th> <th>≥ 500 RT</th> </tr> </thead> <tbody> <tr> <td><b>Baseline (kW/RT)</b></td> <td>0.9</td> <td>0.83</td> </tr> </tbody> </table> <p>(c) Air Distribution System</p> <p>Air distribution operating system efficiency baseline is 0.25kW/RT</p>		Cooling load			< 500 RT	≥ 500 RT	<b>Baseline (kW/RT)</b>	0.82	0.75		Cooling load			< 500 RT	≥ 500 RT	<b>Baseline (kW/RT)</b>	0.9	0.83	<p>Point scored = 0.49 x (% improvement)</p> <p>Point scored = 0.41 x (% improvement) (Up to 15 points)</p> <p>Point scored = 0.18 x (% improvement) (Up to 5 points)</p>
	Cooling load																		
	< 500 RT	≥ 500 RT																	
<b>Baseline (kW/RT)</b>	0.82	0.75																	
	Cooling load																		
	< 500 RT	≥ 500 RT																	
<b>Baseline (kW/RT)</b>	0.9	0.83																	
<p><b>1.3 Air Management</b></p> <p>(a) To encourage good air management with low bypass and recirculation, the data centre should have a Return Temperature Index (RTI), as defined in SS564, as close to 100% as possible.</p> <p>(i) Range between 70% and 130%; <b>Or</b>                      (ii) Range between 80% and 120%; <b>Or</b>                      (iii) Range between 90% and 110%</p> <p>(b) To encourage the operation of data centre at higher supply air temperature within the recommended envelope in ASHRAE 2011 Thermal Guidelines for Data Centres.</p>	<p>1 point 1.5 points 2 points</p> <p>2 points for supply air temperature ≥ 24 °C</p>																		
<p><b>1.4 IT Power Chain Efficiency</b></p> <p>The IT power chain efficiency should include the components such as transformers, transmission lines, switchgears, UPSs and PDUs serving the IT equipment.</p>	<p>3 points for achieving IT power chain efficiency of 80%</p> <p>Point scored = 0.32 x (% improvement from baseline of 80%) (Up to 4 points)</p> <p><b>(Up to 7 points for section 1.4)</b></p>																		

<p><b>1.5 Hot Aisle/ Cold Aisle Containment</b></p> <p>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.</p>	<p>2 points</p>
<p><b>1.6 Renewable Energy</b></p> <p><b>(a) Solar Energy Feasibility Study</b></p> <p>To assess the data centre’s potential and viability to harness and leverage on solar energy and photovoltaics solution(s) adoption.</p> <p><b>(b) Solar Ready Roof</b></p> <p>To encourage the adoption of photovoltaic, roof design should be ready for future photovoltaic installation, such as Structural, Electrical and Spatial readiness</p> <p><b>(c) Adoption of Renewable Energy</b></p> <p>To encourage on-site generation of renewable energy to reduce the building’s energy consumption from the grid and carbon emissions.</p>	<p>0.5 point</p> <p>0.5 point each</p> <p>1 point for every 0.01% replacement of total energy (Up to 2 points for section 1.6(c))</p> <p><b>(Up to 4 point for section 1.6)</b></p>

Section 2 - Water Efficiency	Green Mark Points (8 Points)
<p><b>2.1 Water Usage Effectiveness (WUE)</b></p> <p>Provide permanent water meters to monitor and track the water consumption. To calculate the following:</p> <ul style="list-style-type: none"> <li>• WUE; <b>and</b></li> <li>• m<sup>3</sup>/RTh</li> </ul> <p>Note1: <math display="block">WUE (m^3/MWh/year) = \frac{\text{Annual Water Consumption (m}^3\text{)}}{\text{Annual IT energy (MWh)}}</math></p> <p>Note2: <math display="block">m^3/RTh = \frac{\text{Annual Cooling Tower Make up Water Consumption (m}^3\text{)}}{\text{Building's annual cooling consumption (RTh)}}</math></p>	<p>1 point</p>
<p><b>2.2 Reduction in Water Consumption of Cooling Towers</b></p> <p>(a) Use of a cooling tower water treatment system, which can achieve 7 or better cycles of concentration (COC) with acceptable water quality.</p> <p>(b) Use of alternate water for cooling tower make-up water such as rainwater, AHU condensate water, NEWater, etc.</p>	<p>1 point</p> <p>1 point</p>
<p><b>2.3 Water Monitoring and Leak Detection</b></p> <p>Provide private meters and water leak detection system for better control and monitoring of water consumption.</p> <p>(a) Private meters to measure the water consumption at the cooling tower make-up water tank.</p> <p>(b) Smart remote metering system with alert features for leak detection and monitoring purposes.</p> <p>(c) Display metered data, trending of water consumption and relevant parameters.</p>	<p>1 point</p> <p>1 point</p> <p>1 point</p>

<p><b>2.4 Alternative Water Sources</b></p> <p>Utilize alternative water sources for <b>non-potable uses</b>, such as irrigation, washing, water features and toilet flushing to reduce use of potable water.</p> <p><i>*Note: Non-potable uses exclude cooling tower make-up water.</i></p>	<table border="1"> <thead> <tr> <th>Percentage (%) Reduction of Potable Water Consumption</th> <th>Points</th> </tr> </thead> <tbody> <tr> <td>&lt;50%</td> <td>0.5</td> </tr> <tr> <td>≥50%</td> <td>1</td> </tr> </tbody> </table>	Percentage (%) Reduction of Potable Water Consumption	Points	<50%	0.5	≥50%	1
Percentage (%) Reduction of Potable Water Consumption	Points						
<50%	0.5						
≥50%	1						
<p><b>2.5 Water Efficient Fittings</b></p> <p>To encourage the use of efficient water fittings under PUB's Water Efficient Labelling Scheme (WELS).</p> <p>(a) PUB Water-Efficient Building Certificate for the facility</p> <p><b>OR</b></p> <p>(b) Use minimum 2-tick MWELS water fittings and 3-tick MWELS fittings for basin taps</p>	<p>1 point</p> <p>OR</p> <p>1 point</p>						

Section 3 - Sustainable Operation & Management	Green Mark Points (20 Points)																								
<p><b>3.1 Refrigerants and Fire Suppressants</b></p> <p>To encourage the responsible use of refrigerants/suppressants and to minimise the impact on the environment.</p> <p>Points will be awarded based on the Ozone Depleting Potential (ODP) and Global Warming Potential (GWP) for the following:</p> <p>(a) Refrigerant</p> <p>(b) Fire Suppressant in server, UPS and Battery rooms</p> <p>(c) Refrigerant Leak Detection System</p> <p>An automated refrigerant leak detection system should be installed with detection points at critical areas in the plant room(s) housing the chillers and/or other equipment that contain refrigerants.</p> <p>(d) Refrigerant Management System</p> <p>A refrigerant management procedure or strategies are in place on proper handling of refrigerants during storage and top-up, maintaining of the log sheets, tracking and reducing the refrigerant consumption as well as avoiding leakages.</p>	<table border="1"> <thead> <tr> <th>ODP and GWP of Refrigerant/Fire Suppressant</th> <th>Point(s)</th> </tr> </thead> <tbody> <tr> <td>ODP=0 OR GWP&lt;100</td> <td>0.5</td> </tr> <tr> <td>ODP=0 AND GWP&lt;750</td> <td>0.75</td> </tr> <tr> <td>ODP=0 AND GWP&lt;10</td> <td>1</td> </tr> </tbody> </table> <p>Up to 1 point</p> <p>Up to 1 point</p> <p>0.5 point</p> <p>0.5 point</p>	ODP and GWP of Refrigerant/Fire Suppressant	Point(s)	ODP=0 OR GWP<100	0.5	ODP=0 AND GWP<750	0.75	ODP=0 AND GWP<10	1																
ODP and GWP of Refrigerant/Fire Suppressant	Point(s)																								
ODP=0 OR GWP<100	0.5																								
ODP=0 AND GWP<750	0.75																								
ODP=0 AND GWP<10	1																								
<p><b>3.2 Green Products and Materials</b></p> <p>(a) Green Products</p> <p>To encourage use of building services and mechanical and electrical (M&amp;E) products certified by an approved local certification body.</p> <p>Examples of green products include:</p> <ul style="list-style-type: none"> <li>• Chillers</li> <li>• Auto-tube cleansing system</li> <li>• Pumps</li> <li>• Transformers</li> <li>• ICT equipment with Energy Star rated</li> </ul> <p>(b) Green Materials</p> <p>To encourage the use of building component/products certified by an approved local certification body.</p>	<table border="1"> <thead> <tr> <th colspan="4">Point per Green Product</th> </tr> <tr> <th>Good</th> <th>Very Good</th> <th>Excellent</th> <th>Leader</th> </tr> </thead> <tbody> <tr> <td>0.25</td> <td>0.5</td> <td>0.75</td> <td>1.0</td> </tr> </tbody> </table> <p>(Up to 2 points)</p> <table border="1"> <thead> <tr> <th colspan="4">Weightage Based on Extent of Environmental Friendliness of Material</th> </tr> <tr> <th>Good</th> <th>Very Good</th> <th>Excellent</th> <th>Leader</th> </tr> </thead> <tbody> <tr> <td>0.25</td> <td>0.5</td> <td>0.75</td> <td>1.0</td> </tr> </tbody> </table>	Point per Green Product				Good	Very Good	Excellent	Leader	0.25	0.5	0.75	1.0	Weightage Based on Extent of Environmental Friendliness of Material				Good	Very Good	Excellent	Leader	0.25	0.5	0.75	1.0
Point per Green Product																									
Good	Very Good	Excellent	Leader																						
0.25	0.5	0.75	1.0																						
Weightage Based on Extent of Environmental Friendliness of Material																									
Good	Very Good	Excellent	Leader																						
0.25	0.5	0.75	1.0																						

<p>Points will be awarded based on the weightage and the extent of the coverage and impact (i.e. weightage * extent of coverage and impact).</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr style="background-color: #92d050;"> <th colspan="2" style="text-align: center; padding: 5px;">Factor Based on Extent of Coverage and Impact of the Material</th> </tr> <tr> <td style="text-align: center; padding: 5px;">High Impact</td> <td style="text-align: center; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; padding: 5px;">Low Impact</td> <td style="text-align: center; padding: 5px;">0.5</td> </tr> </table> <p style="text-align: center;">(Up to 2 points)</p> <p>Note: High impact refers to ≥50% of usage; low impact refers to &lt;50% usage of applicable areas</p>	Factor Based on Extent of Coverage and Impact of the Material		High Impact	1	Low Impact	0.5
Factor Based on Extent of Coverage and Impact of the Material							
High Impact	1						
Low Impact	0.5						
<p><b>3.3 Sustainable Operation</b></p> <p>(a) Sustainability procurement Policy</p> <p>Promote the procurement and use of environmentally friendly products that are certified by local certification bodies. Adoption of sustainable and environmental-friendly practices in the operation and maintenance of the facility.</p> <p>(b) Adoption of an Energy Performance Contract (EPC) from firms accredited by SGBC or equivalent to achieve measurable performance outcomes for the following:</p> <p>i) Energy Performance Contract for retrofitting:</p> <ul style="list-style-type: none"> <li>• Centralised chilled-water system with guaranteed efficiency of 0.62 kW/RT or better</li> <li>• Air distribution system with guaranteed efficiency of 0.2 kW/RT or better</li> </ul> <p>ii) Energy Performance Contract for maintenance with a minimum period of 3 years:</p> <ul style="list-style-type: none"> <li>• Centralised chilled-water system with guaranteed efficiency of 0.62 kW/RT or better</li> <li>• Air distribution system with guaranteed efficiency of 0.2 kW/RT or better</li> </ul> <p>(c) System Handover and Documentation</p> <p>To maintain proper and updated system verification and handover documents of retrofitted building systems, including description of systems' operation and controls, testing and commissioning reports, as-built drawings, technical and training manuals and user guides.</p>	<p style="text-align: right;">1 point</p>						

<p><b>3.4 Environmental Credentials of Project Team</b></p> <p>To recognise green professionals with specialised green credentials who can effectively operate and/or guide the FM team towards sustainable management and operation.</p> <p>Applicable to in-house building and facility management team or external consultants with the following credentials:</p> <p>(a) Green Mark Accredited Professional (Facilities Management) [GMAP(FM)];</p> <p>(b) Green Mark Advanced Accredited Professional (Facilities Management) [GMAAP(FM)];</p> <p>(c) Singapore Certified Energy Manager (SCEM)</p>	<p>0.5 point</p> <p>1 point</p> <p>1 point</p> <p><b>(Up to 1 point for section 3.4)</b></p>
<p><b>3.5 Data Centre Operation and Energy Management</b></p> <p>Management system in line with SS 564 - including intent, measures and implementation strategies to achieve energy target set over the next three years.</p> <p><b>Or</b></p> <p>Obtain SS 564 certification</p>	<p>1 point</p> <p><b>Or</b></p> <p>3 points</p>
<p><b>3.6 Waste Management</b></p> <p>(a) Environmental Waste Management Plan</p> <p>An effective and holistic management plan can facilitate better environmental performance during operation and promote waste minimisation.</p> <p>(b) Recycling Facilities</p> <p>Provide facilities or recycling bins for collection and storage of different recyclable waste such as:</p> <p>(i) IT related waste such as electronic equipment</p> <p>(ii) Other general waste such as plastic, paper or metal waste.</p>	<p>1 point</p> <p>0.5 point</p> <p>0.5 point</p>

<p>(c) Waste Monitoring</p> <p>To encourage the following waste collection practices for continuous improvement on waste reduction:</p> <ul style="list-style-type: none"><li>(i) Quantify and monitor the waste disposed</li><li>(ii) Quantify and monitor the waste recycled</li></ul>	<p>0.5 point</p> <p>0.5 point</p>
--	-----------------------------------

Section 4 – Smart and Healthy Building	Green Mark Points (10 Points)
<p><b>4.1 Indoor Air Quality Performance</b></p> <p>To promote a healthy indoor environment for <b>occupied areas</b>:</p> <p>(a) Demand Control Ventilation</p> <p>Use of demand control ventilation strategies with dedicated outdoor system, such as provision of carbon dioxide (CO<sub>2</sub>) sensors or equivalent devices, to regulate the quantity of fresh air supplied to the building's occupied air-conditioned spaces</p> <p>(b) In occupied areas (such as offices, meeting rooms, etc.)</p> <p>Provision of at least Minimum Efficiency Rating Value (MERV) 6 or equivalent filters for outdoor air filtration all the time, and at least MERV 14 or equivalent filters when the outdoor pollution level is in the unhealthy range in accordance with Ministry of Health's guidelines.</p> <p>OR</p> <p>Permanent provision of MERV14 or equivalent filters to all Dedicated Outdoor Air System (DOAS) units (e.g. pre-cooling AHUs) for effective removal of harmful pollutants from the building's ventilation system</p> <p>(c) Indoor Air Quality (IAQ) Surveillance Audit</p> <p>To conduct an IAQ surveillance audit once every 3 years. The audit shall be conducted by an accredited laboratory under Singapore Accreditation Council with respect to the recommended IAQ parameters and acceptable limits stated in Table 1 of <i>SS 554 : 2016 Code of Practice for Indoor Air Quality for Air-Conditioned Buildings</i> or in Annex E of NEA's <i>Guidelines for Good Indoor Air Quality in Office Premises</i>.</p>	<p>0.5 point</p> <p>0.5 point</p> <p>OR</p> <p>1 point</p> <p>0.5 point</p> <p><b>(Up to 2 points for section 4.1)</b></p>
<p><b>4.2 Lighting Quality and Control</b></p> <p>To encourage good lighting quality and to improve occupant comfort in workplaces.</p> <p>(a) For occupied spaces such as offices, meeting rooms, etc.</p> <ul style="list-style-type: none"> <li>The measured indoor lighting levels should comply with the recommended illuminance (average lux level) stated in <i>SS 531 : 2006 Code of Practice for Lighting of Work Places Part 1 – Indoor Lighting</i> or <i>CP 38 : 1999</i></li> </ul>	<p>0.5 point</p>



display or web-based and mobile applications.	
(b) Power control of ICT equipment, power capping.	1 point
(c) Software control technologies, such as virtualization and optimizing algorithms or dynamic control of equipment to minimize energy utilisation.	1 point
(d) Monitoring ICT or server equipment utilisation.	1 point
	<b>(Up to 6 points for section 4.4)</b>

Section 5 – Advanced Green Effort	Green Mark Points (10 Points)
<p><b>5.1 Other Green Features and Innovations</b></p> <p>To encourage the use of innovative equipment, system or design features.</p> <p>To qualify, the features must achieve significant, measurable improvement of energy performance in the following areas:</p> <p>(a) Innovative cooling systems including free air-cooling, direct liquid cooling etc.</p> <p>(b) Innovative power supply, back-up power or UPS systems, etc.</p> <p>(c) IT operations, maintenance or system upgrading strategies enabling energy reduction and not covered by any other sections</p> <p>(d) Purchase green power generated locally from licenced retailers for a minimum contract period of 10 years</p> <p>(e) Thermal mapping and monitoring of the racks in server rooms</p> <p>(f) Integration and Analytics such as Whole system optimisation using a network of HVAC equipment</p> <p>(g) Provision of Persistent Bio-cumulative and Toxic (PBT) free lamps <math>\geq</math> 90% of the lamps in the facility.</p> <p>(h) Operating PUE better than platinum PUE curve, refer to Section 1.1 for PUE scoring formula</p> <p>(i) Provision of cooling tower water conductivity sensors for real-time COC trending and monitoring</p>	<p>2 points</p> <p>2 points</p> <p>2 points</p> <p>0.5 point for every 1% replacement (Up to 10 points for section 5.1(d))</p> <p>1 point</p> <p>1 point</p> <p>1 point</p> <p>Up to 3 points</p> <p>1 point</p>

## PUE Point Scoring – Working Example

### Example 1:

#### a) *Pre-requisite Requirement*

Operating PUE of Data Centre A.

<b>IT load</b>	<b>60%</b>
Operating PUE	1.70

PUE - Pre-requisite requirement

GM Ratings	IT Load				
	25%	50%	60% (Interpolated)	75%	100%
Certified	1.90	1.80	1.76	1.70	1.66
Gold	1.70	1.61	1.57	1.52	1.49
Gold <sup>PLUS</sup>	1.6	1.53	1.50	1.45	1.42
Platinum	1.55	1.49	1.46	1.42	1.39

Based on the PUE values interpolated at 60% IT load, the DC A meets the pre-requisite requirement of **Green Mark Certified** only, requiring PUE of 1.76 or better.

#### b) *Point Score*

Baseline PUE:

	IT Load				
	25%	50%	60% (Interpolated)	75%	100%
<b>Baseline (PUE)</b>	1.90	1.80	1.76	1.70	1.66

Baseline PUE at 60% IT load = 1.76

$$\begin{aligned}
 \text{Point scored} &= 1.2 \times (\text{Percentage improvement at operating IT load from baseline PUE}) \\
 &= 1.2 \times ((1.76-1.70)/1.76) \times 100 \\
 &= \mathbf{4.1 \text{ points}}
 \end{aligned}$$

**Example 2:**

**a) Pre-requisite Requirement**

Operating PUE of Data Centre B.

<b>IT load</b>	<b>50%</b>
<b>Operating PUE (IT equipment energy measured at UPS output)</b>	1.56

Apply 3% losses from [IT load]<sub>at UPS output</sub> to [IT load]<sub>at PDU output</sub>

$$\begin{aligned} \text{PUE Category 2:} &= 1.56 / (1 - 3\%) \\ &= 1.61 \end{aligned}$$

The DC meets the pre-requisite requirement of **Green Mark Gold**, requiring minimum PUE of 1.61 at 50% IT load

PUE - Pre-requisite requirement

GM Ratings	IT Load			
	25%	50%	75%	100%
Certified	1.90	1.80	1.70	1.66
Gold	1.70	<b>1.61</b>	1.52	1.49
Gold <sup>PLUS</sup>	1.6	1.53	1.45	1.42
Platinum	1.55	1.49	1.42	1.39

**b) Point Score**

Baseline PUE:

	IT Load			
	25%	50%	75%	100%
<b>Baseline (PUE)</b>	1.90	1.80	1.70	1.66

PUE baseline at 50% IT load = 1.80

$$\begin{aligned} \text{Point scored} &= 1.2 \times (\text{Percentage improvement at operating IT load from baseline PUE}) \\ &= 1.2 \times [(1.8 - 1.61)/1.8] \times 100 \\ &= \mathbf{12.7 \text{ points}} \end{aligned}$$