MCMC MTSFB TC G004:2024

TECHNICAL CODE

SPECIFICATION FOR GREEN DATA CENTRES - FIRST REVISION

Developed by

Registered by

Registered date:

Development of technical codes

The Communications and Multimedia Act 1998 (Laws of Malaysia Act 588) (‘the Act’) provides for a Technical Standards Forum designated under section 184 of the Act or the Malaysian Communications and Multimedia Commission (‘the Commission’) to prepare a technical code. The technical code prepared pursuant to section 185 of the Act shall consist of, at least, the requirements for network interoperability and the promotion of safety of network facilities.

Section 96 of the Act also provides for the Commission to determine a technical code in accordance with section 55 of the Act if the technical code is not developed under an applicable provision of the Act and it is unlikely to be developed by the Technical Standards Forum within a reasonable time.

In exercise of the power conferred by section 184 of the Act, the Commission has designated the Malaysian Technical Standards Forum Bhd (‘MTSFB’) as a Technical Standards Forum which is obligated, among others, to prepare the technical code under section 185 of the Act.

A technical code prepared in accordance with section 185 shall not be effective until it is registered by the Commission pursuant to section 95 of the Act.

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Committee representation

This technical code was developed by the Green ICT, Environment & Climate Change Working Group of the Malaysian Technical Standards Forum Bhd (MTSFB), which consists of representatives from the following organisations:

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Huawei Technologies (Malaysia) Sdn Bhd

Maxis Broadband Sdn Bhd

UCSI Education Sdn Bhd

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Foreword

This technical code for Specification for Green Data Centres ('Technical Code') was developed pursuant to Section 185 of the Communications and Multimedia Act 1998 (Laws of Malaysia Act 588) by the Green ICT, Environment & Climate Change Working Group of the Malaysian Technical Standards Forum Bhd (MTSFB).

Major modifications include:

a) Addition of overview of green data centres clause for foundational context.

b) Addition of terms and definitions clause for a shared vocabulary.

c) Addition of renewable energy integration clause for deployment strategies and recommendations, including those for Photovoltaic (PV) systems.

d) Addition of indoor and outdoor modular data centres clause for efficiency and flexibility.

e) Addition of efficient battery selection and deployment clause, including lithium battery specifications and safety.

f) Addition of new annex on deployment of green data centre concepts in Malaysia case studies.

g) Update the Power Usage Effectiveness (PUE) classification, Supply Air Temperature (SAT) and Uninterruptible Power Supply (UPS) system efficiency for revised guidance and best practices.

h) Update the requirement for competency and training section to emphasize the importance of skilled personnel.

i) Update the governance and regulatory section to outline the benefits of certification and provide a framework.

j) Update the guidance on automation and reporting to highlight its role in energy saving.

This Technical Code cancels and replaces the MCMC MTSFB TC G004:2015, Specification for Green Data Centres.

This Technical Code shall continue to be valid and effective from the date of its registration until it is replaced or revoked.

SPECIFICATION FOR GREEN DATA CENTRES

0. Introduction

Malaysia's commitment to a sustainable future is underscored by the National Energy Transition Roadmap (NETR). This ambitious plan outlines a path toward a low-carbon, net-zero emissions energy system by 2050. Data centres represent a critical component in this transition, with their energy consumption making them a prime target for efficiency initiatives. This revised Technical Code for Green Data Centres directly supports the NETR by providing essential guidance for reducing data centre energy consumption and minimizing their environmental impact, incorporating the latest technologies, and aligning with relevant global standards for energy efficiency and sustainability.

This Technical Code is vital in providing a framework for private, government and commercial data centres to optimize their energy practices. While certification is voluntary, it positions organisations to reduce operating costs, lessen their carbon footprint and enhance their competitiveness within the Malaysian data centre industry. Furthermore, it aligns with growing global trends in prioritising sustainability and mitigates the risks of greenwashing. As environmental regulations become increasingly stringent worldwide, this Technical Code will establish Malaysia as a leader in proactive environmental stewardship.

Businesses, government and society gain numerous benefits from adopting this Technical Code. Businesses experience cost savings, enhanced customer satisfaction and the potential for new markets and increased market share. The government benefits from alignment with global sustainability initiatives and expert guidance. For society, this Technical Code contributes to an improved quality of life in various aspects.

1. Scope

This Technical Code provides the minimum requirements for green data centres for the purpose of establishing policies, systems, and processes to improve the energy efficiency of data centres and at the same time reducing the carbon footprint of the industry.

This Technical Code also outlines the best practices that data centres should adopt in achieving a sustainable industry.

This Technical Code covers all private and public data centres operating in Malaysia, either private or commercial. Within a data centre, the following areas are covered namely environmental conditions, energy management, air management, cooling management, IT equipment and lighting, power chain management, space management, information management, governance and guidelines.

2. Normative references

The following normative references are indispensable for the application of this Technical Code. For dated references, only the edition cited applies. For undated references, the latest edition of the normative references (including any amendments) applies.

ISO 50001, *Energy Management System*

EN 50600, *Information technology - Data centre facilities and infrastructures*

ISO/IEC 22237-2, *Information technology - Data centre facilities and infrastructures Part2: Building construction*

Recommendation ITU-T L.1300, *Best practices for green data centres*

Recommendation ITU-T L.1303, *Functional requirements and framework of green data centre energy-saving management system*

Recommendation ITU-T L.1320, *Energy efficiency measurement and metrics for telecommunication equipment and data centres*

ANSI/TIA/EIA-942, *Telecommunications Infrastructure Standard for Data Centers*

SS 564-1, *Sustainable data centres*

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Technical Committee (TC) 9.9*, Thermal Guidelines for Data Processing Environments – Expanded Data Center Classes and Usage Guidance*

ENERGY STAR®, *Program Requirements Product Specification for Computer Servers, Eligibility Criteria, Version 2.0*
www.energystar.gov/specifications

Green IT Promotion Council, *New Data Center Energy Efficiency Evaluation Index DPPE (Datacenter Performance per Energy) Measurement Guidelines, Version 2.05*

Green Technology and Water Malaysia and the Green Computing Initiative*, The Green Data Centre: Achieving the True Potential of Sustainable Computing*

Lawrence Berkeley National Laboratory, *Self-benchmarking Guide for Data Center Infrastructure: Metrics, Benchmarks, Actions*

NFPA 855, *Standard for the Installation of Stationary Energy Storage Systems*

Uptime Institute, *Tier Classification System*
https://uptimeinstitute.com/tiers

WP49-PUE, *A Comprehensive Examination of the Metric Version 6, Green Grid*

3. Abbreviations

For the purposes of this Technical Code, the following abbreviations apply.

AI	Artificial intelligence
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
BIPV	Building-Integrated Photovoltaics
CRAC	Computer Room Air Conditioning
CRAH	Computer Room Air Handling
DB	Distribution Board
DX	Direct Expansion
EC	Electronically commutated
EnMS	Energy Management System
EnPI	Energy Performance Indicator

ESG	Environmental, Social, and Governance
GDC	Green Data Centre
GDCMS	Green Data Centre Malaysia Standards
HSSD	High Sensitivity Smoke Detection
HT	High Tension
HVAC	Heating, Ventilation and Air Conditioning
ICT	Information and Communications Technology
IMDC	Indoor Modular Data Centres
IT	Information Technology
KVM	Kernel based Virtual Machine
MPPT	Maximum Power Point Tracking
MSB	Main Switch Board
NETR	National Energy Transition Roadmap
PDU	Power Distribution Unit
PUE	Power Usage Effectiveness
RHR	Relative Humidity Range
RoHS	Restriction of Hazardous Substances
SAT	Supply Air Temperature
SDG	Sustainable Development Goals
SLA	Service Level Agreement
SSB	Sub-Switch Board
STS	Static Transfer Systems
TCO	Total cost of ownership
ULF	UPS Load Factor
UPS	Uninterruptible Power Supply
USE	UPS System Efficiency
VESDA	Very Early Smoke Detection Apparatus
VRLA	Valve Regulated Lead-Acid
VSD	Variable Speed Drives
VSS	Video Surveillance System

4. Terms and definitions

For the purposes of this Technical Code, the following terms and definitions apply.

4.1 Environmental, Social, and Governance (ESG)

Factors used to evaluate the sustainability and ethical practices of a company or organisation.

4.2 Energy Management System (EnMS)

A systematic framework to manage and continuously improve energy performance within an organisation.

4.3 Fault tolerant

The ability of a system to continue operating without significant disruption despite the failure of one or more components.

4.4 Measurements

Measurements are indicators of a system's performance that can be observed, individually or jointly, while executing scenarios. These are directly measurable and can be collected automatically.

4.5 Outages

Periods of time when a system or service is unavailable due to planned maintenance or unexpected disruptions.

4.6 Power Usage Effectiveness (PUE)

A metric measuring the total energy used by a data centre divided by the energy used by Information Technology (IT) equipment. A PUE of 1.0 is ideal, indicating all energy is used directly by IT equipment.

4.7 Redundancy

The inclusion of duplicate critical components or systems to ensure continued operation in the event of a single failure.

4.8 Relative Humidity Range (RHR)

A measurement which covers the range of the IT equipment inlet air humidity set points.

4.9 Supply Air Temperature (SAT)

The temperature of the air being delivered to the IT equipment in a data centre.

4.10 Sustainable Development Goals (SDG)

A comprehensive set of global goals established by the United Nations to address environmental, social, and economic challenges.

4.11 Tier level ratings

A classification system established by the Uptime Institute to categorise data centre reliability and availability.

4.12 Uninterruptible Power Supply (UPS) System Efficiency (USE)

A metric that measures the efficiency of an Uninterruptible Power Supply (UPS) system. It is calculated as the ratio of the output power from the UPS to the input power. A higher USE percentage indicates a more efficient UPS system with less energy lost to internal operating components.

4.13 Uptime availability

The percentage of time a system or service is operational and available for use.

5. Overview of green data centre

A green data centre begins with strategic site selection, prioritising locations that offer access to renewable energy and climatic conditions favorable for natural cooling. Site selection should rigorously evaluate risks from natural hazards (e.g., flooding, seismic activity) and address long-term security requirements. The building design emphasises energy efficiency through aspects like orientation, insulation, and the potential to leverage natural ventilation and daylight. Core infrastructure, including power and cooling systems, is optimised for maximum efficiency. This involves high-efficiency UPS systems, strategic power distribution, and prioritising free air cooling whenever possible. Green data centres integrate renewable energy sources, such as on-site solar or wind power, or utilize energy procurement from clean energy providers, to reduce reliance on traditional grid power and its carbon footprint. Operations and maintenance practices focus on continuous monitoring, proactive maintenance, virtualization, and ongoing optimization to ensure the data centre maintains its energy efficiency and sustainability goals over time.

Figure 1 visually depicts the core elements of a green data centre, as described above. Refer to the figure for a complementary illustration of these components.

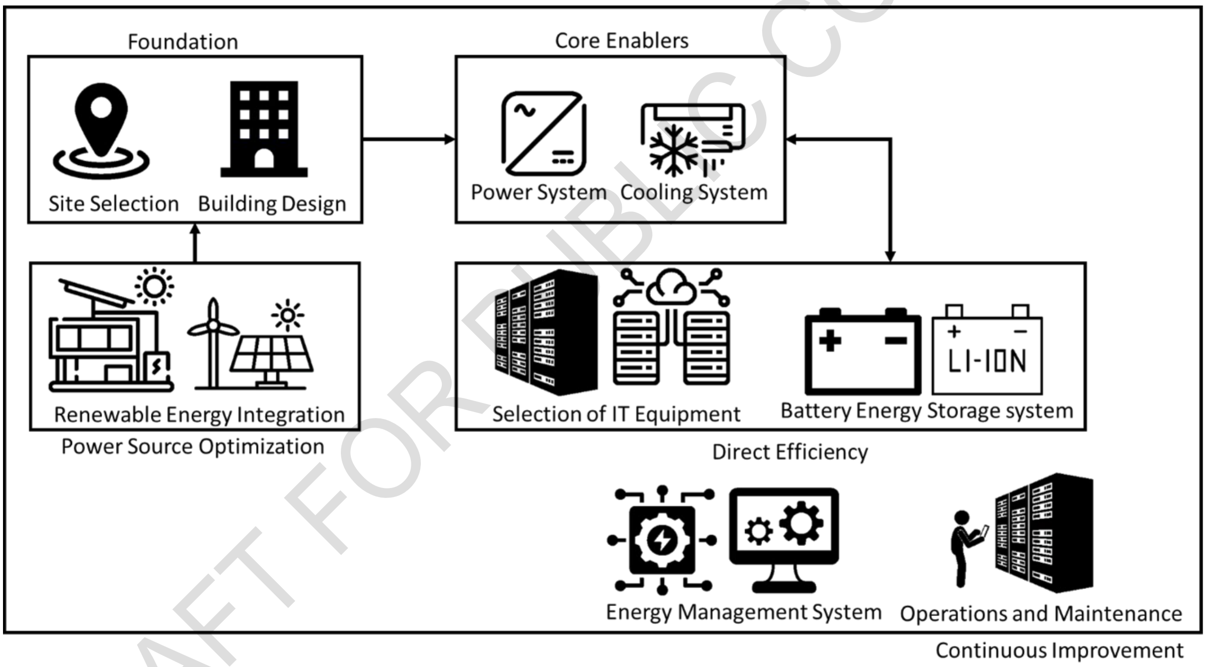


Figure 1. Overview of Green Data Centre

To achieve green data centre status, the selection of power systems, cooling strategies, renewable energy integration, battery energy storage, high efficiency equipment and energy monitoring systems must align with the requirements and expectations of the targeted Uptime Institute tier level. This ensures that the data centre maintains the desired level of reliability and availability while prioritising energy efficiency and sustainable practices.

Frameworks like the Uptime Institute tier ratings provide guidelines for data centre reliability. Other equivalent frameworks may also be used. Table 1 below describe a brief overview of the Uptime Institute's system.

Table 1. Uptime Institute tier ratings for data centre reliability

Tier Level	Description	Expected Availability
Tier I	Basic infrastructure with limited redundancy	99.671%
Tier II	Infrastructure with some redundancy components	99.741%
Tier III	Concurrently maintainable infrastructure for near-continuous operation	99.982%
Tier IV	Fully fault-tolerant infrastructure designed to withstand individual equipment failures and distribution path outages	99.995%

Several energy-efficient technologies and best practices recommended within this Technical Code can support the goals of various reliability frameworks. Carefully consider the desired level of reliability when evaluating and implementing these recommendations to optimise your data centre's energy performance.

The examples of how reliability frameworks influence recommendations are as follows:

a) For Tier II (or equivalent) and above

High-efficiency UPS systems and Power Distribution Units (PDUs) are essential to minimise power losses and increase overall efficiency.

b) For Tier III (or equivalent) and IV

Advanced cooling technologies like liquid cooling or immersion cooling become crucial for managing high-density heat loads and achieving top-tier reliability.

c) For all tiers

i) Integrating renewable energy (solar, wind) and battery storage aligns with green data centre goals and may influence redundancy strategies depending on the targeted Tier level.

ii) Robust energy monitoring systems are critical for tracking PUE and identifying optimization opportunities, but the granularity and capabilities of these systems will scale with the desired Tier level.

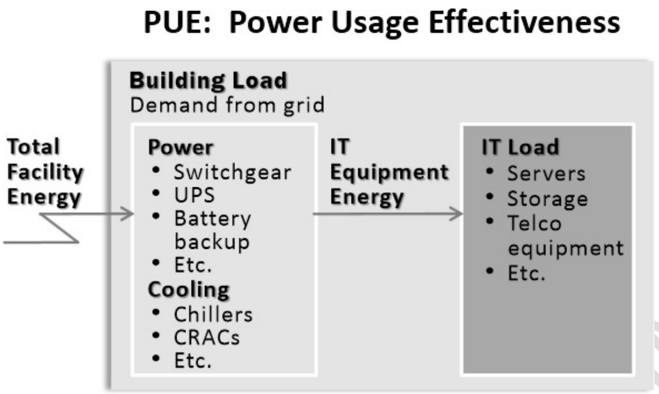
6. Minimum requirements

6.1 Measurements

The following measurements are to be used in benchmarking the minimum requirements of a green data centre.

6.1.1 Power Usage Effectiveness (PUE)

PUE is an efficiency measurement comparing a data centre’s infrastructure to its existing IT load. The initial benchmarking of PUE yields an efficiency score and sets a testing framework for the facility to repeat. The formula for the calculation of PUE is the total facility power divided by the IT equipment power. Total facility power is derived by combining the power for the facility power serving to the data centre (excluding offices, conference rooms, meeting rooms), energy management system, Heating, Ventilation and Air Conditioning (HVAC) and physical security measured at the Main Switch Board (MSB), Sub-switch Board (SSB) or Distribution Board (DB) level. Total IT power is derived by combining the power for compute devices, network devices, IT support systems, storage, telecommunications equipment and miscellaneous devices measured at the PDUs level.



$$PUE = \frac{\text{Total Facility Energy}}{\text{IT Equipment Energy}}$$

Figure 2. PUE measurement description

IT equipment energy includes the energy associated with all of the IT equipment (e.g., computer, storage and network equipment) along with supplemental equipment (e.g., Kernel based Virtual Machine (KVM) switches, monitors and workstations or laptops used to monitor or otherwise control the data centre).

Total facility energy includes all IT equipment energy as described above plus everything that supports the IT equipment using energy, such as power delivery components, including UPS systems, switchgear, generators, PDUs, batteries, and distribution losses external to the IT equipment; cooling system components, such as chillers, cooling towers, pumps, Computer Room Air Handling (CRAH) units, Computer Room Air Conditioning (CRAC) units, and Direct Expansion (DX) air handler units and other miscellaneous component loads, such as data centre lighting.

The IT load is measured at the output of the PDU equipment. The incoming energy is measured from the utility service entrance after the High Tension (HT) transformer that feeds all of the electrical and mechanical equipment used to power, cool, and condition the data centre. Basic monitoring requires, at a minimum, the collection of power measurements once a month; for energy measurements, that frequency is recommended.

The following Table 2 denotes the classification of the derived PUE measurement. The minimum PUE measurement shall be 1.9.

Table 2. Classification of the derived PUE measurement

Minimum	Good	Excellent
1.9	Less than 1.9 and more than 1.5	Less than or equal 1.5

Recommendations for achieving green data centre status with a PUE of 1.5 or Lower.

To qualify for the green data centre designation, facilities should strongly consider the following best practices known for their significant impact on energy efficiency.

a) Energy-efficient IT equipment

   Select servers, storage and networking devices with proven energy efficiency certifications (e.g., ENERGY STAR). Implement power management features and right-size equipment to match workloads, reducing idle power consumption.

b) Optimised cooling systems

   Prioritise free air cooling (direct or indirect) wherever feasible. For high-density environments, consider liquid cooling solutions, such as direct liquid cooling or immersion technology, as these offer superior heat transfer efficiency.

c) Renewable energy integration

   Explore on-site renewable energy sources (solar, wind or geothermal) or procurement agreements with clean energy providers. Integrate energy storage (batteries or thermal storage) to smooth renewable variability and reduce reliance on traditional grid power.

d) Data centre monitoring and management

   Implement robust monitoring systems that track energy use, PUE, and other key performance indicators. Utilise collected data to identify optimisation opportunities, proactively address potential inefficiencies, and drive continuous improvement in power utilisation.

6.1.2 Supply Air Temperature (SAT)

SAT is a measurement that represents the airflow weighted average of the supply air temperature in the data centre. A low supply air temperature indicates the potential for improving a data centre's air management and increase the supply air temperature. Higher supply air temperatures allow HVAC cooling systems to operate more efficiently. The metric is derived by measurement at measuring aisle temperature at 1.5 m above the floor at rack level, establish at least one point for every 3 m to 6 m of aisle or every fourth rack position.

Recommendations for efficient HVAC and Cooling are as follows.

a) Data centre HVAC systems should adopt variable frequency water chillers or magnetic levitation water chillers, which offer superior efficiency compared to traditional water chillers.

b) Fan walls are recommended as terminal air conditioners, as they enable a higher temperature difference between supply and return chilled water, prolonging natural cooling and reducing pump power consumption.

c) Cold or hot aisle containment should be implemented to isolate airflows, preventing cooling capacity loss, and improving overall energy efficiency.

d) Water pumps should utilise high-efficiency motors and feature variable frequency drives to continuously adjust operation based on load changes.

e) The water system design should adopt a large temperature difference (typically 6 °C to 8 °C) between water inlet and outlet.

For SAT temperature adjustment, it is proposed to adjust the SAT measurement guideline from 23 °C to 27 °C. This aligns with updated ASHRAE TC 9.9 recommendations, which recognise the potential for energy savings with higher supply air temperatures.

6.1.3 Relative Humidity Range (RHR)

A small relative humidity set point range suggests opportunities to reduce energy use, by reducing the active humidification and dehumidification. Centralised active control of the humidification units reduces conflicting operations between individual units, thereby improving the energy efficiency.

The measurement is derived by establishing a range based on low end IT equipment and high-end IT equipment inlet air relative humidity set point. Measurement is at 1.5 m above the floor at rack level, establish at least one point for every 3 m - 6 m of aisle or every fourth rack position.

The measurement for RHR shall be between 30 % - 60 %.

6.1.4 UPS System Efficiency (USE)

The USE metric is the ratio of the UPS output power to the UPS input power. The UPS efficiency varies depending on its load factor. USE is derived by dividing UPS output power (kW) with UPS input power (kW) and then multiplying by 100.

The measurement equation is:

$$USE = \frac{UPS\ output\ power\ (kW)}{UPS\ input\ power\ (kW)} \times 100$$

The UPS efficiency varies depending on its load factor and therefore the benchmark for this metric depends on the UPS Load Factor (ULF) of the UPS system. The ULF metric is the ratio of the peak load of the UPS to the design value of its capacity. This provides a measure of the UPS system over-sizing and redundancy. The measurement is derived by dividing UPS average load (kW) with UPS peak load capacity (kW).

The efficiency targets and recommendations are as follows.

a) For new and reconstructed data centres, UPS systems with double conversion efficiency exceeding 96 % are essential for maximising energy savings. This recommendation reflects the evolving landscape of data centre technology and prioritises efficient power management. Note that existing data centres may have lower USE levels due to older equipment, but upgrades to higher efficiency systems should be considered when feasible.

b) To optimise efficiency, UPS systems should support energy-saving operation modes (often referred to as "ECO mode"). These modes can achieve efficiencies of 99 % or higher.

c) Hot-swappable critical components (power module, bypass module, control unit, communication cards, etc.) are recommended to minimise downtime during maintenance and mitigate the risk of severe operation breakdowns.

Considerations for ECO mode (or other energy-saving modes) are as follows.

a) When possible, select UPS systems that support active harmonic compensation during energy-saving modes to ensure compatibility with power grid requirements.

b) Prioritise UPS systems offering seamless transitions (0 ms transfer time) between energy-saving and double conversion modes for maximum reliability.

6.1.5 Renewable energy integration

To effectively address rising energy costs and reduce carbon emissions, data centres should actively integrate renewable energy sources into their power strategies. Key technologies include:

a) New renewable energies include, fuel cell and hydrogen energy, which are based on new physical power and new substances.

b) Renewable energies include solar thermal energy, solar photovoltaic energy, biomass, wind power, tidal power, hydropower and geothermal power generation.

Data centres can calculate the efficiency of various renewable energy power equipment using the following formulas. These methods and concepts are outlined in section 9.1.10 of ITU-T L.1300 and sections 5, 5.1, 5.1.3, and 5.1.3.3 of ITU-T L.1320.

6.1.5.1 Renewable energy deployment strategies

Innovative approaches to integrating renewable energy technologies into the building design itself offer both energy-saving and aesthetic benefits. Two prominent strategies are:

a) Building-Integrated Photovoltaics (BIPV): BIPV seamlessly integrates Photovoltaics (PV) modules into the building envelope, serving as both a power source and a functional building element (e.g., shading, insulation). BIPV can significantly contribute to reducing a data centre's carbon footprint.

b) Rooftop solar: On data centre campuses, deploying PV arrays on rooftops offers a practical way to utilize solar energy. While solar energy generation may not offset the data centre's entire energy demand, it provides a valuable supplement to traditional power sources.

6.1.5.2 Recommendations for PV systems

When designing and implementing PV systems for data centres, these best practices will maximise efficiency and reliability.

a) High-efficiency components: Prioritise high-efficiency photovoltaic panels and string inverters (98.50 % efficiency or higher) for maximum energy yield and reduced carbon emissions.

b) Fault tolerance: PV systems should be designed with fault isolation mechanisms to ensure continuous operation of unaffected modules when failures occur.

c) Maximum Power Point Tracking (MPPT): String inverters must incorporate real-time MPPT functionality to optimize energy efficiency under varying solar conditions.

6.1.6 Indoor Modular Data Centre (IMDC)

Indoor Modular Data Centres (IMDCs) employ a highly integrated modular design, incorporating power distribution, cooling, enclosures, wiring, and monitoring into self-contained units. This design isolates hot and cold airflows, preventing cooling loss and enabling precision cooling. Figure 3 illustrates the traditional solutions and modular data centre.

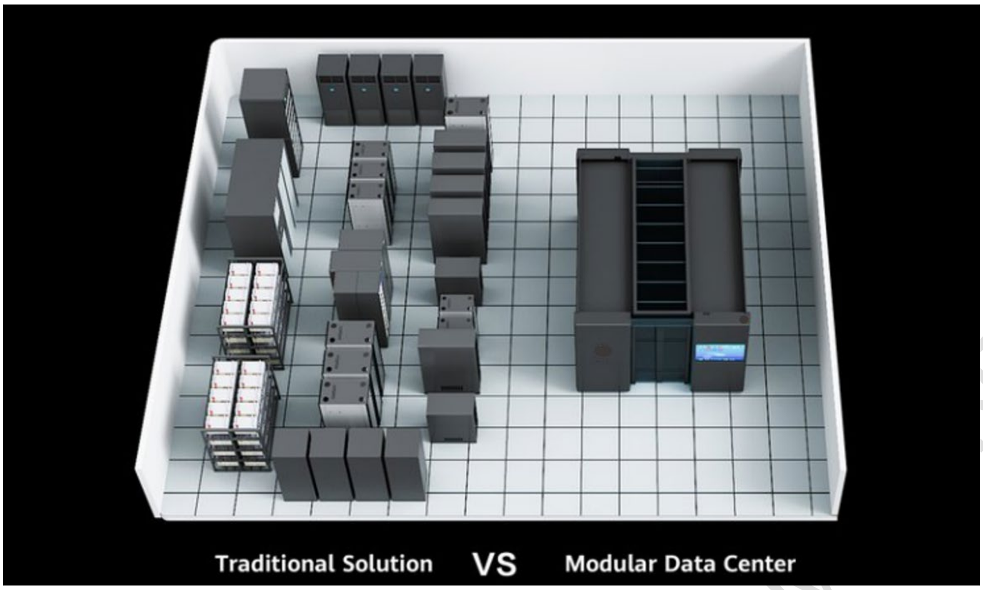


Figure 3. Traditional solution versus modular data centre

The recommended components for the modular data centre are listed in Table 3 below.

Table 3. Type of components for modular data centre

Type of components	List of components
Typical IMDC components	Containment structure (cabinets, ceiling, doors)
	Information And Communications Technology (ICT) equipment enclosures
	Electrical subsystem (including optional UPS)
	Intelligent or standard rack PDUs
	Grounding system
	Electrical and telecommunication pathways
	Mechanical subsystems (cooling, if needed)
	Interior lighting
	Fire detection and alarm system
	Monitoring system
Optional components	Flooring
	Static Transfer Systems (STS) switches (for single-corded equipment)
	Access control (e.g., biometric)
	Video Surveillance System (VSS)
	Fire suppression system
	Pressure relief damper (if fire suppression is present)
	Very Early Smoke Detection System (High Sensitivity Smoke Detection (HSSD), Very Early Smoke Detection Apparatus (VESDA), etc.)

6.1.6.1 Resilience classifications

Data centres can consider aligning their resilience classification system with frameworks like ANSI/TIA/EIA-942, EN 50600, ISO/IEC 22237-2 or similar frameworks. These frameworks offer a structured approach to categorising data centres based on their redundancy and fault tolerance. The levels of the Rated system are typically as follows:

a) Rated-1: Basic minimal redundancy.

   Systems are vulnerable to disruptions. Equipment is N-Capacity without additional components. No redundancy in supply or return paths.

b) Rated-2: Equipment redundancy.

   N+1 capacity for electrical and mechanical equipment. Supply or return path redundancy is not always mandatory. Structured cabling is recommended (point-to-point allowed only between adjacent cabinets).

c) Rated-3: Concurrent maintainable.

   Maintenance can occur without dropping below N-Capacity. Redundant equipment and multiple supply or return paths (one active, one standby is typical). Structured cabling with non-crossing, dual-path routes to each ICT cabinet is recommended.

d) Rated-4: Fault tolerant.

   Can withstand a single fault (equipment or path) at any time without dropping below N-Capacity. Implies Concurrent Maintainability. Structured cabling with non-crossing, dual-path routes to each ICT cabinet is recommended.

6.1.6.2 Outdoor Modular Data Centre (OMDC)

Outdoor modular data centres (OMDCs) leverage prefabrication techniques to integrate cabinets, power distribution, cooling and monitoring systems within standardised container units. These units are assembled on-site, significantly accelerating deployment compared to traditional data centre construction. The details of OMDC are as follows.

a) Sustainability focus

   OMDCs prioritise environmentally responsible practices by:

   i) minimising construction waste; and

   ii) utilising materials with low heavy metal content (e.g., lead, chromium).

b) Structural integrity

   OMDC design is guided by rigorous structural simulations ensuring compliance with building standards and suitability for multi-layer stacking. This delivers a user experience comparable to conventional data centre buildings.

c) Environmental adaptability

   OMDCs are engineered for deployment in diverse climates, withstanding temperatures ranging from -40 °C to 55 °C.

d) Deployment efficiency

OMDCs offer rapid deployment timelines, typically within 12 to 15 months. Design choices impact achievable PUE, and lifecycle carbon emissions are minimised.

e) Important considerations

Due to prefabrication of both building and electromechanical components, flexibility for on-site adjustments is limited. Therefore, thorough equipment room layout planning is crucial during the design phase.

6.1.7 Efficient battery selection and deployment

When selecting batteries for data centre applications, lithium-ion batteries offer distinct advantages over traditional technologies like Valve Regulated Lead-Acid (VRLA) batteries. Key benefits include:

a) High power density: Lithium-Ion batteries deliver more power within a smaller physical footprint, optimising valuable data centre space.

b) Extended lifespan: Lithium-ion batteries offer a longer lifespan compared to VRLA options, often eliminating the need for battery replacement within a typical 10-years operational period. This reduces maintenance costs and minimises disruptions.

c) Simplified Planning: The compact size and longer lifespan of lithium-ion batteries streamline battery deployment planning and simplify location selection within the data centre.

6.1.7.1 Lithium battery specifications

Lithium batteries employed within data centres shall adhere to Restriction of Hazardous Substances (RoHS) guidelines, excluding the 10 substances specified within the directive (lead, mercury, cadmium, etc.).

6.1.7.2 Lithium-ion battery safety

a) Battery composition: For enhanced safety, select lithium-ion batteries with olivine-like crystal structures. These offer superior stability, exhibiting high resistance to fire or explosion even under extreme stress conditions.

b) Fire mitigation: Equip battery packs with dedicated fire extinguishing mechanisms, designed to integrate with room-level fire suppression systems for comprehensive protection.

c) Compartmentalisation: Lithium-ion battery rooms should feature independent compartments to limit the impact of any potential fire events. Each compartment should have a capacity not exceeding 600 kWh. Battery rooms shall include a water spray fire protection system designed in accordance with NFPA 855.

d) Mandatory safety testing: Employed lithium-ion batteries must have successfully undergone and passed the Thermal Runaway Fire Propagation Test as outlined in the UL 9540A standard.

6.2 Policy

6.2.1 Competence and training

The organisation shall ensure that any person(s) working for or on its behalf, related to green data centre implementation and operation are required to obtain appropriate education, training, skills or experience to be competent. The training and certification are required to be recognised by the government. The organisation shall identify and provide training associated with green data centre implementation and operation.

Training encompasses not only technical aspects but also delves into energy management and efficiency to enhance understanding of the significance of sustainable practices. Appropriate records shall be maintained.

6.2.2 Communication and awareness

The organisation shall communicate and ensure that any person(s) working for or on its behalf are aware of the following details.

a) The importance of conformity with the policy procedures and the requirements of the Green Data Centre Malaysia Standards (GDCMS).

b) Their roles, responsibilities and authorities in achieving the requirements of the GDCMS.

c) The benefits of improved green data centre performance.

d) The impact, actual or potential, with respect to green data centre implementation and operation, of their activities and how their activities and behaviour contribute to the achievement of its objectives and targets, and the potential consequences of departure from specified procedures.

The organisation shall establish and implement a process by which any person working for, or on behalf of the organisation can make comments or suggest improvements to the GDCMS. The organisation shall decide whether to communicate externally about its policy, GDCMS performance and shall document its decision. If the decision is to communicate externally, the organisation shall establish and implement a method for this external communication.

6.2.3 Expertise

The organisations are advised to encourage their relevant personnel to obtain locally government recognised certification with regards to green data centre operations.

6.2.4 Design

The organisation shall consider green data centre requirements improvement opportunities and operational control in the design of new, modified and renovated facilities, equipment, systems, space management, location and processes that can have a significant impact on its performance.

The results of the performance evaluation shall be incorporated where appropriate into the specification, design, and procurement activities of the relevant project(s). The results of the design activity shall be recorded.

6.2.5 Governance and regulatory

The organisation shall identify, implement and have access to the applicable legal requirements and other requirements to which the organisation subscribes related to its green data centre implementation and efficiency. The organisation shall determine how these requirements apply to its implementation and efficiency and shall ensure that these legal requirements and other requirements to which it subscribes are considered in establishing, implementing and maintaining the green data centre.

Legal requirements and other requirements shall be reviewed at defined intervals. The organisation shall evaluate compliance with legal requirements and other requirements to which it subscribes related to its green data centre implementation. Records of the results of the evaluations of compliance shall be maintained.

The pursuit of green data centre certification under recognised frameworks by government agency serves as a valuable supplement to existing compliance efforts. Certification programs often provide structured guidance on applicable environmental regulations and evolving best practices. The certification process itself, including audits and performance assessments, can aid the organisation in proactively identifying potential areas of non-conformity and driving continuous improvement. Additionally, achieving certification provides clear documentation of sustainability and efficiency initiatives, supporting internal record-keeping requirements and enhancing compliance efforts.

Benefits of green data centre certification are as follows.

a) Market competitiveness

Certified data centres align with increasing client demand for sustainable solutions. Environmental responsibility is a key differentiator and can attract environmentally conscious clients.

b) Operational cost optimisation

Energy-efficient practices, a core focus of certification programs, directly translate to reduced energy expenditure and long-term operational cost savings.

c) Regulatory readiness

Green data centre certification schemes often incorporate guidance and best practices for aligning with environmental regulations. This allows organisations to proactively meet existing requirements and prepare for potential future regulatory changes.

d) Positive brand perception

Certification reinforces a data centre's commitment to sustainability initiatives, enhancing its reputation within the industry and with potential stakeholders.

Table 4 below proposes a 3-level certification framework, serving as a guide for data centres to strive towards industry-leading best practices in sustainability. This framework outlines ambitious yet achievable targets, recognising different stages of a data centre's green transformation.

Table 4. Level of certification framework

Certification Level	Focus	Criteria
Level 1: Certified energy efficient	Significant energy efficiency improvements	a) PUE of 1.5 or lower b) Implement of recognised energy-saving technologies. c) Documented energy reduction policies.
Level 2: Certified green leader	Exemplary energy efficiency + sustainable practices	a) PUE of 1.3 or lower b) Integration of renewable energy (target of at least 20 % on-site or clean energy procurement) c) Implementation of water-efficient cooling or operations d) Responsible waste management practices (target of at least 50 % waste diversion from landfill)

Table 4. Level of certification framework *(continued)*

Certification Level	Focus	Criteria
Level 3: Certified net-zero champions	Near complete green energy reliance + minimal impact	a) PUE of 1.1 or lower b) Significant on-site renewable energy or clean energy procurement (target of at least 75 %) c) Innovative resource conservation initiatives (e.g., advanced water recycling) d) Zero-waste initiatives (target of at least 90 % waste diversion from landfill)

The organisation shall address actual and potential non-conformities by making corrections, and by taking corrective actions, preventive actions and reviewing its effectiveness. The organisation shall review the organisation's GDCMS to ensure its continuing sustainability, adequacy, and effectiveness. The organisation shall establish and maintain records, as necessary, to demonstrate conformity to the requirements of any applicable international standards.

6.2.6 Purchasing

The organisation shall take into consideration the following criteria when purchasing IT equipment (hardware and software), electrical and mechanical equipment for the implementation and operation of green data centre.

a) The organisation shall establish, implement and maintain a procedure(s) to identify the environmental aspects.

b) The organisation shall determine those aspects that have or can have significant impact(s) on the environment (i.e., significant environmental aspects). The organisation shall document this information and keep it up to date.

c) The organisation shall establish and implement the criteria prior to the purchasing of the IT equipment (hardware and software), electrical and mechanical equipment which are expected to have a significant impact on the organisation's energy performance. The organisation shall define and document the purchasing specifications, as applicable, for effective green data centre implementation and operation.

6.3 Monitoring

Effective monitoring of energy use, environmental parameters and system performance is crucial for sustained energy efficiency and green data centre operations.

6.3.1 Energy metering

The data centre shall install metering equipment capable of measuring the following parameters.

a) The total energy use of the data centre, including all power conditioning, distribution and cooling systems shall track real-time energy consumption of various components within the data centre. The measured energy shall be separate from any non-data centre building loads.

b) The total energy delivered to ICT systems, including power distribution units including other power feeds where non-UPS protected power is delivered to the racks.

c) All relevant data in regularly basic and analyse the data to identify trends and areas of inefficiency.

6.3.2 Energy reports

The organisation shall consistently gather data and reports to ensure comprehensive overview of energy usage towards continuous green developments, which include the following commitment.

a) Energy use of the ICT equipment (server, network and storage) and environmental (temperature and humidity) data shall be reported on an annual basis.

b) Develop a standardised format for energy consumption reports, including key metrics such as total energy usage, energy intensity (energy per unit of computing workload), PUE and carbon footprint.

c) Ensure transparency in reporting by sharing energy performance data with clients, stakeholders, and regulatory bodies as required.

6.3.3 Automation for energy saving

Data centres can significantly improve energy efficiency by implementing automation solutions. These systems analyse complex data, optimise operations and drive continuous improvement of the following key focus area.

a) Intelligent control

   Automation optimises settings for power distribution, cooling and other systems based on factors like IT load and environmental conditions. Algorithms, including Artificial Intelligence (AI)-based models, may be used for these calculations.

b) Predictive optimisation

   Some automation solutions, especially those incorporating AI, build predictive models (including PUE). This enables proactive adjustments for maximum efficiency.

c) Continuous improvement

   Automation systems, particularly those using AI, analyse performance and refine strategies over time, leading to ongoing energy savings.

d) Potential benefits

   Extensive deployment of automation technologies can significantly reduce PUE. For water-cooled chilled water systems, reductions of 8 % to 15 % are achievable.

7. Energy Management System (EnMS)

The organisation shall:

a) establish, document, implement, maintain and improve an Energy Management System (EnMS) in accordance with the requirements of ISO 50001.

b) define and document the scope and boundaries of its EnMS; and

c) determine how it will meet the requirements of ISO 50001 in order to achieve continual improvement of its energy performance and of its EnMS.

8. Green Data Centre Best Practices

The organisation should emulate the recommended best practices as outlined in Annex A which describes recommendations for various components within a data centre comprising of civil and structure, mechanical, electrical, information technology and monitoring and control.

Annex A
(Informative)

Green data centre best practices

Table A1. Civil and structure

Recommendation	Description
CS1. Internal space management within data centre	Provisioning of space based on actual utilised data centre white space (with power & cooling) and not reserved space
	Implement phased approach in capacity provisioning (on demand basis)
CS2. External data centre building	Building facility: Data centre building in accordance to sustainability standards in terms of reduce, reuse, recycling, land or environmental impact and consumption of natural resources in the design and build process
CS3. Operational resilience	Centralised view of resilience across all mechanical and electrical (M&E) and IT components including understanding of all upstream and downstream relationships
	Matching data centre resilience to Service Level Agreement (SLA) between operations and business units
CS4.Lighting	Reduce the energy consumption of lighting equipment
	Utilise occupancy sensors and where lighting technologies are installed use components with a lower energy consumption, greater quality of light, longer lifespan and from recyclable components
CS5.Fire suppression	Utilise an eco-friendly and sustainable fire suppression gas

Table A2. Mechanical

Recommendation	Description
M1. Air flow	Implement hot and cold aisle layout
	Implement containment or enclosures
	Install blanking panels
	Deploy optimally placed diffusers
	Deploy structured cabling.
	Install floor grommets
M2. HVAC	Server inlet temperature adjustments based on ASHRAE guidelines
	Humidity adjustments based on ASHRAE guidelines
	Deploy CRAC or CRAH with Variable Speed Drives (VSD) or Electronically Commutated (EC) fans
	Utilise an eco-friendly and sustainable refrigerant

Table A3. Electrical

Recommendation	Description
E1. Energy management	Scalable power infrastructure (modularity)
	Document and participate in the recycling plans for batteries and other consumables
	Align racks depending on power density
	Use monitoring software data and other tools to implement real time changes (phase balancing, load changes, etc)
	Alternative method of backup power for the data centre based on Total Cost of Ownership (TCO), environmental and sustainability considerations
	Utilise high efficiency UPS

Table A4. Information Technology (IT)

Recommendation	Description
IT1. ICT equipment consolidation	Implement server virtualisation
	Decommissioning of unused servers
	Consolidation of lightly utilised servers
	Better management of data storage
IT2. Green procurement	Procure assets that comply with reducing hazardous substances and are recyclable
	Procure energy efficient equipment that comply with Energy Star or similar standards and metrics
	TCO modelling includes power consumption of the component at the expected or actual utilisation levels
	Cradle to cradle lifecycle view on all M&E and IT equipment - looking at embedded carbon, ease of recycling of the product, etc.
IT3. IT equipment lifecycle extension	Hardware refresh policy set based on TCO model including typical operating cost, capital cost, depreciation costs and value of new technology
	Decommissioning servers based on compute characteristics (e.g., Central Processing Unit (CPU) utilisation, Memory I/O)
	Optimize server configuration based on resource usage
IT4. E-Waste	Reuse policy for assets across the organisation
	E-Waste vendor in place to deal with all data centres equipment aligned to local or national mandatory regulations
	E-Waste strategy in place to promote reselling, recycling, donating and disposal of IT assets based on cost, legislation, ethical and sustainable implications across all data centres
	Supplier and supply chain evaluated for waste management and environmental protection practices
	Supplier and supply chain waste & environmental compliance programs included as part of procurement/sourcing decision process

Table A5. Monitoring and Control

Recommendation	Description
MC1. Monitoring and control	Centralised and automated monitoring system inclusive of all mechanical, electrical and facility systems
	Holistic monitoring capability across the data centre - from source of power to chip performance
	PUE Level measured, plan and actions in place for improvements
	Automated analysis or reporting of data to identify energy saving opportunities
	IT and facilities collaboration on unified energy efficiency goals

Annex B
(informative)

Deployment of green data centre concepts in Malaysia

These case studies demonstrate the widespread applicability of green data centre concepts within Malaysia. Technologies frequently deployed include edge data centre configurations, modular UPS with lithium batteries, centralised monitoring and solar power integration.

Item	Industry Sector	Model	Year
1	Transportation sector	Edge Data Centre Containment System, Modular UPS with Lithium Battery and Centralised Monitoring System.	Since 2019
2	Banking sector	Edge Data Centre Containment System, Modular UPS with Lithium Battery, Centralised Monitoring System and Integrated Power Supply with Solar Energy.	Since 2019
3	Government department	Edge Data Centre Containment System, Modular UPS with Lithium Battery, Centralised Monitoring System and Integrated Power Supply with Solar Energy.	Since 2019
4	Oil & gas sector	Modular UPS with Lithium Battery and Centralised Monitoring System	Since 2019
5	Commercial sector	Edge Data Centre Containment System, Modular UPS with Lithium Battery, Centralised Monitoring System and Integrated Power Supply with Solar Energy.	Since 2019
6	Manufacturing sector	Modular UPS with Lithium Battery, Centralised Monitoring System and Integrated Power Supply with Solar Energy.	Since 2019
7	Semi-conductor sector	Modular UPS with Lithium Battery, Centralised Monitoring System and Integrated Power Supply with Solar Energy.	Since 2019
8	Education sector	Edge Data Centre Containment System, Modular UPS with Lithium Battery, Centralised Monitoring System and Integrated Power Supply with Solar Energy.	Since 2019
9	Smart or intelligent city sector	Edge Data Centre Containment System, Modular UPS with Lithium Battery, Centralised Monitoring System and Integrated Power Supply with Solar Energy.	Since 2019
10	Colocation data centre sector	Edge Data Centre Containment System, Modular UPS with Lithium Battery, Centralised Monitoring System, water-cooled/air-cooled/liquid-cooled Precision A/C unit.	Since 2019

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[1] ANSI/TIA-942, *Telecommunications Infrastructure Standard for Data Centers*

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Acknowledgements

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