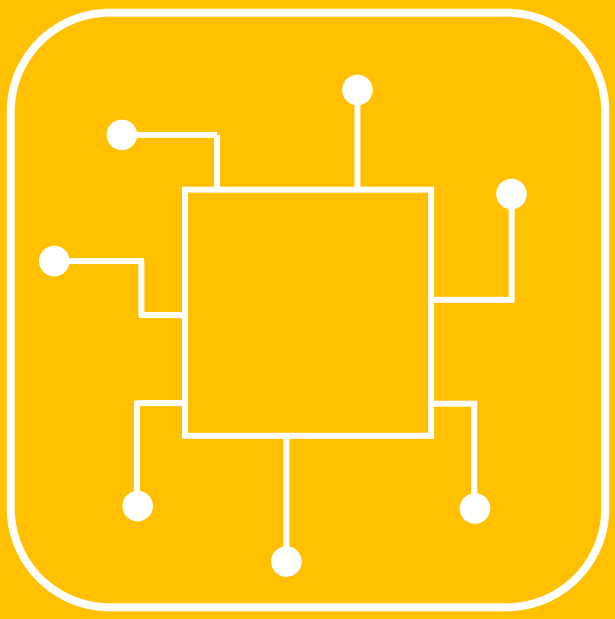

Green Mark 2021

In

Intelligence

Revision Log

Revision	Description	Effective Date
R1	1st Edition	01/11/2021
R1.1	Updates: Introduced prerequisite for IN1.2	31/05/2023
R1.2	Minor updates: Provided an example for Intelligence Innovation	31/05/2023
R2	2nd Edition with updates. - IN1.1 Replaced Singapore CDE Standard with Singapore Model Content Requirements (MCR) and reduce the point to 1 for new development. - IN1.2 Renamed "CDE O&M" into "Good Practices to Facilitate Data Management" as well as revised the criteria for (i) and (ii). - IN2.2 Moved "Digital Twin" as an example in the Innovation section and replaced with "Voluntary Disclosure of Building Energy Performance Data" with the revised criteria. - IN2.3 Moved Data Ethics from IN3 to this sub-section with the revised criteria. - IN3 Revised and added new use cases.	01/01/2024
R2.1	Updates: - IN3.3 Removed the SS554 table to facilitate alignment for future revision of SS554. - Innovation Added more example for innovation.	
R2.2	Minor update: Removed Guidance Notes in IN1.2 (i).	

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IN1 Integrated

A maximum of 5 points can be scored across IN 1 Integrated section.

IN1.1 Digital Life Cycle

Integrated Digital Delivery (IDD) is the use of digital technologies with a Project Information Model (PIM) to integrate work processes and connect stakeholders throughout the design, construction, operation, and retrofitting of the whole building life cycle. Digital life cycle involves the use of PIM to integrate planning, design, construction, retrofit and operational activities with adequate levels of definition of geometry and facility information.

(i) Project Information Model (PIM) developed in accordance with Singapore Model Content Requirements (MCR)

Assessment Criteria

IN1.1 Digital Life Cycle	**New Buildings**	**Existing Buildings**
(i) PIM (BIM) developed in accordance with Singapore Model Content Requirements (MCR).	1 Points	2 Points

The Project Information Model (PIM) should include the standardisation of the model element names, and specification of the element attributes or parameters to allow consistency and clarity in the communication of information between project members.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- PIM Plan (BIM Execution Plan [BEP]) including the requirements for the model content to follow Model Content Requirements (MCR) for project team to deliver.

At Verification stage (New Buildings & Existing Buildings):

- Schedule/report of asset information following Model Content Requirements (MCR).

Guidance Notes

The PIM can be formulated in multiple formats, such as a BIM model with the building and asset geometrical information, or database technologies to store project information. Where two or more formats are used for PIM, specific identifiers shall be used for the shared items to ensure connectivity.

The PIM shall contain the information required by the facility/asset owners to manage their assets. Examples of this information for different building typology can be found in the Model Content Requirements (see Figure 1). The PIM shall also 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).

MCR By Project Typology							
TYPOLOGY	Commercial/Residential						
DATASET (IFC-SG)	All				LEGEND:		
DISCIPLINE	All				Y denotes 'Yes' - input is required.		
MEP SYSTEM	All				O denotes 'Optional' - input if applicable.		
PROPERTY	Conceptual Design	Schematic/ Preliminary Design	Detailed Design/ Final Design	Tender Stage	Construction & Fabrication	As-Built	O&M/ Asset Information Mngt
Accessories & Routing							
Air Admittance Valve							
(for IFC-SG Sandbox Work in Progres, no parameter, just element placement is sufficient)							
Air Valve Chamber							
(for IFC-SG Sandbox Work in Progres, no parameter, just element placement is sufficient)							
Bedding							
BeddingType							
Bulk Water Meter, Private Sub Meter, Gas Meter							
AssetID					Y	Y	Y
Barcode/QRCode				O	Y	Y	O
CarbonFootprint				O	O	O	O
ClassificationSystem					Y	Y	Y
Description				Y	Y	Y	
ElectricalPanelCircuit				O	Y	Y	O

Figure 1: Model Content Requirements for Commercial/Residential building typology

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.*

(ii) Use of spatial model co-ordination platform based on PIM for spatial analysis

Assessment Criteria

IN1.1 Digital Life Cycle		**New Buildings**	**Existing Buildings**
(ii)	Use of spatial model co-ordination platform based on PIM for spatial analysis including:		
	a. Identifying system clashes through an automatic model checking tool.	1 Point	N.A.
	b. Spatial analysis for effective construction, maintenance and future alteration or replacement.	1 Point	N.A.

(a) Identifying system clashes through an automatic model checking tool

The use of BIM clash detection process to model building and facility elements, equipment access and working spaces as “3D volumes” or “reserved box” can help to avoid clashes between different disciplines and to accurately allocate maintenance space for mechanical equipment.

Points shall be awarded for ***clash-checking between different disciplines, modelling equipment access and working space of key mechanical equipment*** (e.g., Chillers, AHU).

(b) Spatial analysis for effective planning, design, construction, maintenance, and future replacement

New development projects should involve the facilities management (FM) team throughout the key design and construction stages to provide insights on space requirements for maintenance and future replacement works.

Points shall be awarded for the ***use of PIM to solve issues in space requirements for maintenance or other space-related issues in the building operation process***.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- BIM Execution Plan (BEP) showing the key spatial provisions made to meet the clash detection requirement.
- Meeting notes, correspondences with facility management team reflecting their involvement and inputs during the meeting sessions.

At Verification stage (New Buildings & Existing Buildings):

- Clash report and/or animation to show the spatial issues from the clashes detected are checked and resolved.
- As-built drawing/model showing the space requirements are fulfilled.

Guidance Notes

An example of how space requirements for equipment access and maintenance work are modelled in BIM can be found in Figure *2*.

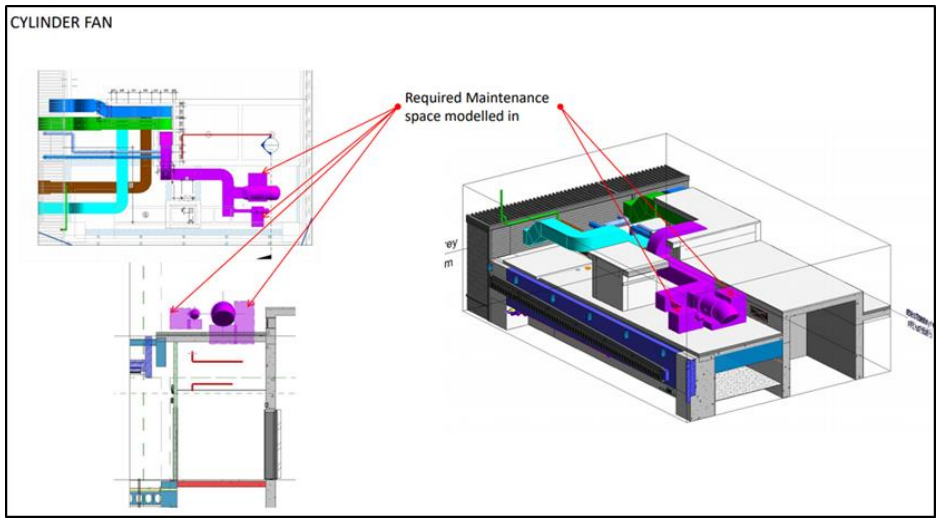

Figure 2: Model Maintenance Space (Image Courtesy of SIT)

The spatial analysis can be performed through visualisation or animation tools as shown in Figure *3* and Figure *4*.

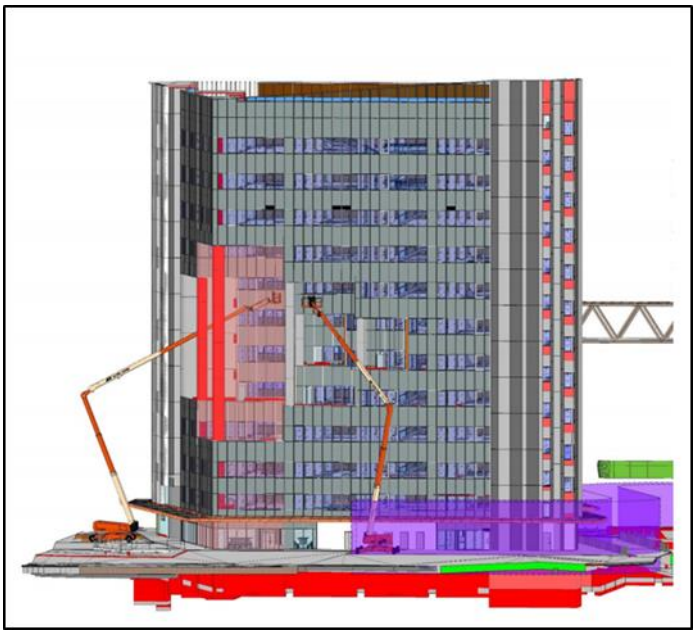

Figure 3: Maintenance Study using Boom Option (Image Courtesy of SIT)

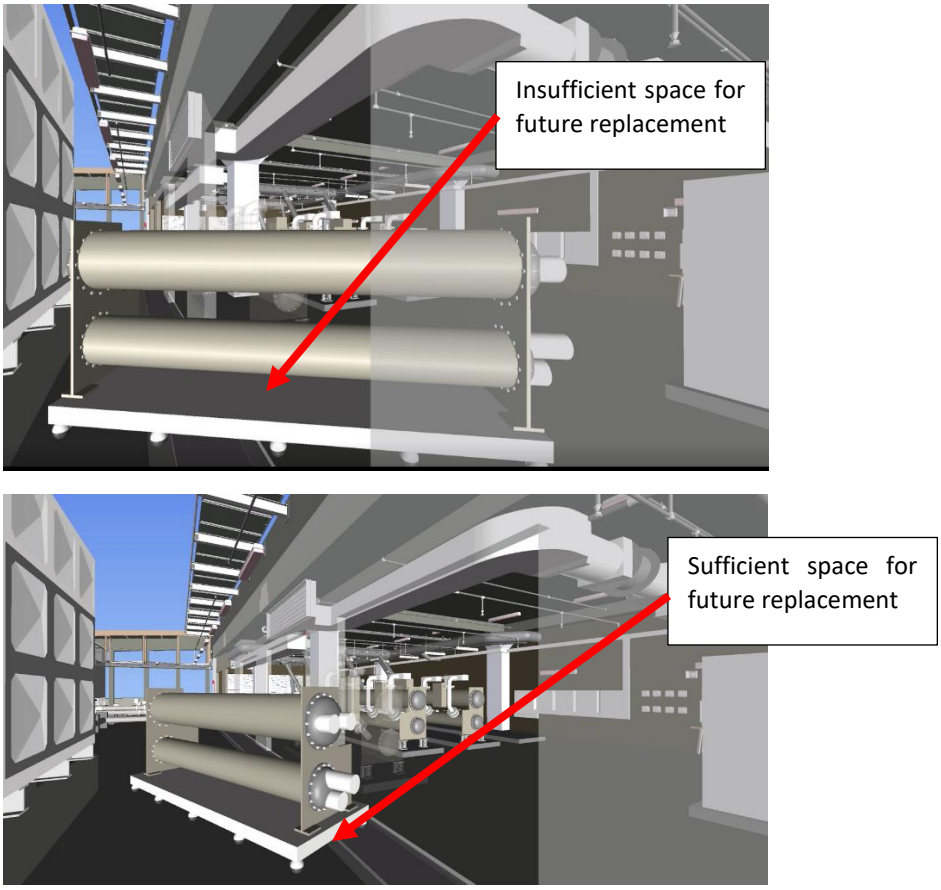

Figure 4: Using Animation to Perform Spatial Analysis for Future Replacement (Image Courtesy of BCA Academy)

(iii) Digital building commissioning, performance and defect co-ordination platform based on PIM

To ensure that the building or assets are operationally ready for handover, a digital platform could be used to manage the commissioning processes as well as track defects and the corresponding rectifications.

Assessment Criteria

IN1.1 Digital Life Cycle		New Buildings	Existing Buildings
(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)

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Tender specifications stating the use of digital platform to track, co-ordinate, and manage the commissioning of systems and tracking of defects and their rectifications.

At Verification stage (New Buildings & Existing Buildings):

- Screenshots and pictures showing the implementation of the platform onsite.
- Activity logs from the digital platform.

Guidance Notes

An example of the digital platform as shown in Figure 5.

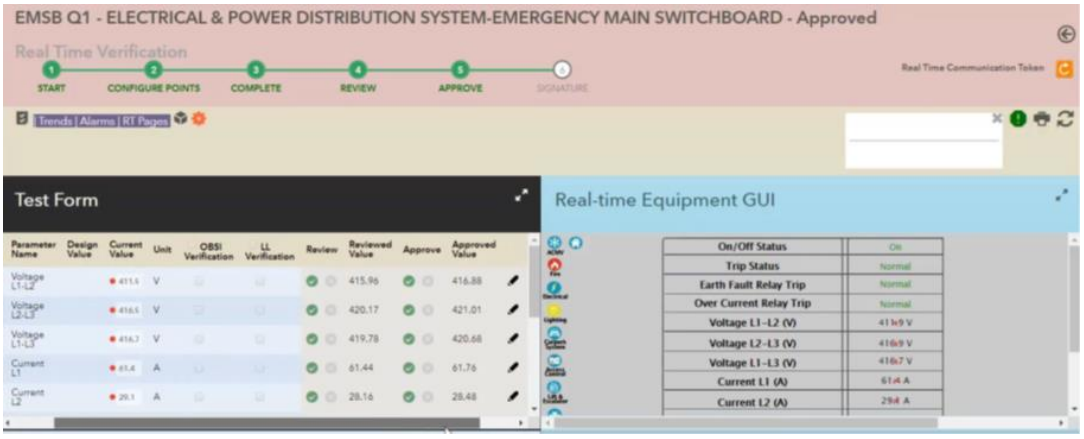

Figure 5: Digital Commissioning (Image Courtesy of Eutech Cybernetics)

IN1.2 Good Practices to Facilitate Data Management

With increasing specialisation and isolation of technologies and processes, systems often operate in silos and result in incoordination that lead to wastage in time, materials and manpower. To address these silos, ***a combination of workflow and information storage solution(s)*** should be established to consolidate multiple systems' data and key information of the asset(s).

Prerequisite
Non-residential projects must score minimum 1 point (for new building) or 2 points (for existing building) from IN1.2 to attain the Intelligence Badge.

(i) Performance Dashboard to monitor building assets' performance and operations

Having a single dashboard reduces the need to switch between screens from different systems. With the increasing amount of operational data collected from multiple systems and facilities, building owner and/or facility manager should combine and simplify the metrics on a single dashboard to gain insight on the building's performance and operations.

Assessment Criteria

IN1.2 Good Practices to Facilitate Data Management	New Buildings	Existing Buildings
(i) Performance dashboard to monitor the different aspect of building assets' performance and operations from a single dashboard:		
a. Operational dashboard: sets of measures used to guide facility operations such as energy & water efficiency and work order status.	0.5 Point	1 Point
b. Managerial dashboard: sets of metrics which may use data from multiple operational systems such as asset health and energy use per occupant.	0.5 Point	1 Point

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Tender specifications stating the adoption of a digital platform with the performance dashboard during the operational stage of the assets (if there is no such platform available).
- Illustrations of the building assets' operational and managerial dashboard of the existing implementation (if the digital platform is already available).

At Verification stage (New Buildings & Existing Buildings):

- Screenshots and photos showing the performance dashboard of the implementation.

Examples of operational and managerial dashboards are shown in Figure 6.

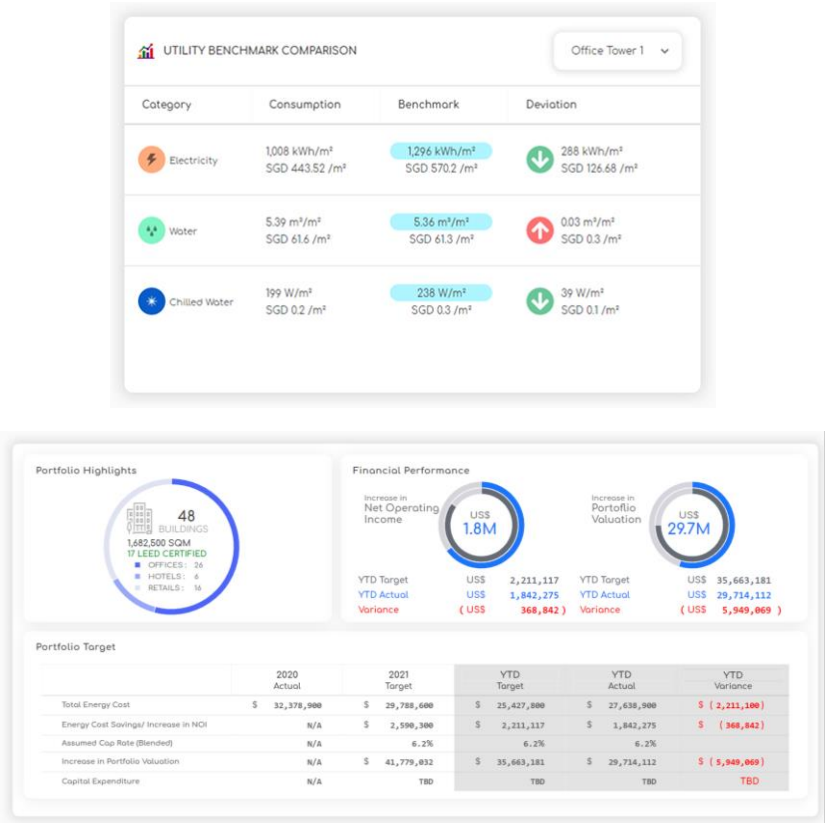

Figure 6: Operational & Managerial Dashboard (Image Courtesy of Eutech Cybernetics)

(ii) Data Management and Integration (Interoperability)

A data management and integration platform enable building owner or facility managers to be better steward of their asset by providing a holistic and fact-based approach for decision making. Building owner/operator is encouraged to adopt platforms with open protocol connectivity such as BACnet Secure, OPC UA, or APIs (REST, HTTPS, MQTT) to all their system/sub-system providers to allow ease of data management and analytics during operational stage of the assets. All FM digital platform(s) shall also support automated and scheduled export of any data set to commonly used file format.

Assessment Criteria

IN1.2 Good Practices to Facilitate Data Management	**New Buildings**	**Existing Buildings**
(ii) Data Management and Integration that: a. Connects and manages asset and facility data, operational data, and real-time equipment data extracted from different sub-systems based on an open protocol such as OPC UA, BACnet Secure, MODBUS, DLMS, or APIs (REST, HTTPS, MQTT). b. Allows data exchange between robots, lifts, and automated doorways.	0.5 Point 0.5 Point	1 Point 1 Point

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- System architecture of the digital platform and its subsystems (see examples in Figure *7*).
- Tender specifications stating the connectivity of various facilities management (FM) systems/sub-systems and data to the digital platform with open protocol.

- Tender specifications requiring the implementation of an interface in the lift and automated doorway controllers to receive commands and provide feedback to a service robot for autonomous operation. Refer to "TR93:2021 on Data exchange between robots, lifts, and automated doorways to enable autonomous operations" for one such set of commands and response.

At Verification stage (New Buildings & Existing Buildings):

- System write-up on the various FM digital solutions which are integrated through the digital platform with open protocol.
- Screenshots and photos showing the implementation.
- Specification and detailed documentation of the lift and automated doorway interface including the set of commands and responses, data frame format, physical connections, and signal levels. The lift and automated doorway interface may be wired, wireless or via discreet I/O such as dry contacts.

Guidance Notes

Figure 7 gives examples of different system architecture of digital platform(s) with open protocol system for each sub-system.

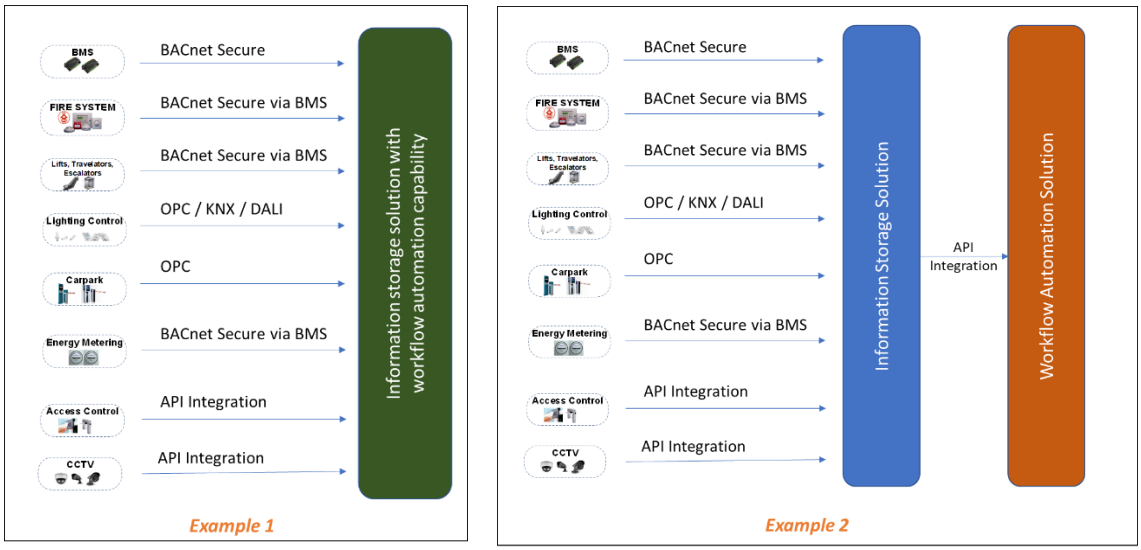

Figure 7: Examples of different system architecture for digital platform(s) with its open protocol systems for each sub-system

References

- SS695:2023 on IoT interoperability concepts, considerations, and best practices.
- TR93:2021 on Data exchange between robots, lifts, and automated doorways to enable autonomous operations.

(iii) Data Accessibility and Security

Integration of asset information can enable an effective way of collaboration, but it also brings increased risk of security breaches with widening access to asset information. It is important to incorporate appropriate security and security minded principles in the service contracts and security requirements of the digital platform(s). Refer to the Cyber Security Agency of Singapore (CSA) website for more information on the Certification and Labelling Schemes.

Assessment Criteria

IN1.2 Good Practices to Facilitate Data Management		New Buildings	Existing Buildings
(iii)	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	1 Point

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Tender specifications stating the requirement of cybersecurity considerations for the digital platform(s).

At Verification stage (New Buildings & Existing Buildings):

- Security certification/accreditation of the digital solution(s) (e.g., Common Criteria).

References

- TR 111:2023 on securing cyber-physical systems for buildings.
- IMDA's Cyber Security Guide Annex C (2022) on Case study for Smart Buildings

IN2 Data Driven

A maximum of 5 points can be scored across IN 2 Data Driven section.

IN2.1 Asset Information Model

The Asset Information Model (AIM) is defined as a federated information model which can include structured information (e.g., geometrical models, schedules, and databases) and unstructured information (e.g., documentation, video clips and sound recordings)[1]. Projects are encouraged to use digital platform(s) to develop an operational up-to-date AIM for purposes of asset tagging, co-ordination, maintenance, etc.

(i) Development and handover of an accurate spatial model of the building or asset

To encourage the generation of digital asset information of the built physical assets and digitally hand over as-built records, manufacturers' specifications & warranties, testing / commissioning reports, and O&M manuals.

Assessment Criteria

IN2.1 Asset Information Model		**New Buildings**	**Existing Buildings**
(i)	Development and handover of an accurate spatial model of the building or asset which is complete, fully up-to-date, and inclusive of renovations that would impact building services or layout alterations.	1 Point	1 Point

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Tender specifications for the AIM including digital handover requirements.

At Verification stage (New Buildings & Existing Buildings):

- Photos / screenshots and documents showing the implementation of digital handover.

(ii) Physical and virtual Asset Information tagging system

Assessment Criteria

IN2.1 Asset Information Model		**New Buildings**	**Existing Buildings**
(ii)	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	2 Points

Assets are to be tagged with a barcode / QR code / RFID. Asset tagging shall at least cover the following systems:

- ACMV system – include Chiller plant, Air distribution (AHU/FCU), Mechanical Ventilation Fans (e.g., Toilet, Carpark and Kitchen exhaust fans) where applicable.
- Electrical System main equipment - include Main HT/LT Switchboard, Sub-board, and Distribution Board.

[1] From ISO 19650-1 (Clause 4.1) and ISO 19650-3 (Clause 5.1.11)

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Tender specifications capturing the asset tagging requirements.

At Verification stage (New Buildings & Existing Buildings):

- Photos / BMS screenshots showing the implementation of asset information tagging.

(iii) Adoption of a common international standard for asset ontology

Asset ontology is an extensible dictionary of terms and concepts in and around buildings, a set of relationships for linking and composing concepts together, and a flexible data model permitting seamless integration of asset ontology with existing tools and databases. Asset Ontology helps to standardise semantic descriptions of the physical, logical, and virtual assets in buildings and the relationships between them.

Assessment Criteria

IN2.1 Asset Information Model		**New Buildings**	**Existing Buildings**
(iii)	Adoption of a common international standard for asset ontology. For example, Brick Schema or Project Haystack.	1 Point	1 Point

The asset ontology shall have the following modelling support:

- ACMV / Sensor systems
- Lighting systems
- Electrical systems
- Plumbing and Sanitary systems
- Fire protection system
- Vertical transportation system
- Security system
- Spatial Information
- Control & operational relationship
- Formal Definitions

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Tender specifications capturing the type of asset Ontology and implementation requirements in terms of completeness, usability, consistency, and future extension.

At Verification stage (New Buildings & Existing Buildings):

- Schematic web structure showing the digital representation of a building that adheres to the Committed Asset Ontology.

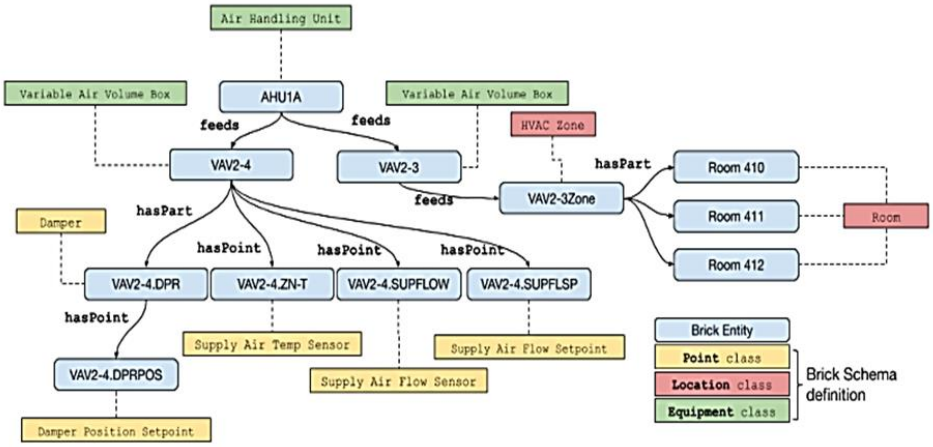

Figure 8: Asset ontology following Brick Schema

References

- ISO 19650-3:2020 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling — Part 3: Operational phase of the assets.
- Project Haystack.
- Brick Schema.

IN2.2 Voluntary Disclosure of Building Energy Performance Data

Projects that voluntarily contribute non-sensitive data pertaining to building energy performance to the Super Low Energy Building (SLEB) Smart Hub[2] can facilitate dynamic energy performance benchmarking and automate Green Mark energy data reporting. This efficient data-sharing process relies on **readily available data**, eliminating the need for additional meters or sensors.

(i) Share basic information

Assessment Criteria

IN2.2 Voluntary Disclosure of Building Energy Performance Data	**New Buildings**	**Existing Buildings**
(i) Create your SLEB Smart Hub user account by following the instructions in the video provided here: https://go.gov.sg/slebregister. Subsequently, become a SLEB Smart Hub member by referring to the step-by-step guide available in the video at this link: https://go.gov.sg/slebmember.	0.5 Point *For Non-Residential buildings only*	0.5 Point *For Non-Residential buildings only*

Documentation Requirements

- The project owner's signed membership application form, along with owner's consent for data sharing, can be conveniently attached to the SLEB Smart Hub membership application page.

[2] Super Low Energy Building (SLEB) Smart Hub (www.sleb.sg) is Singapore's first digital knowledge centre for green buildings in the region, feature-filled with smart analytic tools, datasets, a directory and also the largest green building database in Singapore.

(ii) Share data to SLEB Smart Hub Operation Dashboard

Assessment Criteria

IN2.2 Voluntary Disclosure of Building Energy Performance Data		New Buildings	Existing Buildings
(ii)	Share data to SLEB Smart Hub Operation Dashboard by following the instructions in the video provided here: https://go.gov.sg/sleboperation.	0.5 Point *For Non-Residential buildings only*	0.5 Point *For Non-Residential buildings only*

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- The commitment letter with the data fields to be shared with SLEB Smart Hub.

At Verification stage (New Buildings & Existing Buildings):

- The necessary datasets should be visualized on the SLEB Smart Hub Operation Dashboard. You have the flexibility to share the data either by submitting Excel/CSV files or by transmitting data via APIs to the SLEB Smart Hub. In the case of monthly consumption data, applicants must share a minimum of 12 consecutive months' worth of data.

Guidance Notes

Please refer to the step-by-step user guide for sharing data with the SLEB Smart Hub, available for download at this link. Building operators can utilize our provided User Interface (UI) design template for a consistent visualization of their building's energy performance, in alignment with Green Mark nomenclature. This not only standardizes performance representation but also mitigates the costs of creating a distinct energy information dashboard. Please refer to the specific data requirements and the UI design here.

(iii) Share data to SLEB Smart Hub Energy Performance Dashboard

Assessment Criteria

IN2.2 Voluntary Disclosure of Building Energy Performance Data		New Buildings	Existing Buildings
(iii)	Share data to SLEB Smart Hub Energy Performance Dashboard by following the instructions in the video provided here: https://go.gov.sg/slebenergy.	0.5 Point *For Non-Residential buildings only*	0.5 Point *For Non-Residential buildings only*

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- The commitment letter with the data fields to be shared with SLEB Smart Hub.

At Verification stage (New Buildings & Existing Buildings):

- The necessary datasets should be visualized on the SLEB Smart Hub Energy Performance Dashboard. You can share the data by transmitting data via APIs to the SLEB Smart Hub. In the case of monthly consumption data, applicants must share a minimum of 12 consecutive months' worth of data.

Guidance Notes

Please refer to the step-by-step user guide for sharing data with the SLEB Smart Hub, available for download at this link.

IN2.3 Data Ethics

To ensure data related practices including but not limited to collecting, generating, analysing, and utilising the data are under established protocols to avoid potential adverse impact on people and society. The data ethics policies and processes lay out the set of key principles and processes that guide the ethical collection, processing, analysis, and application of data.

Assessment Criteria

IN2.3 Data Ethics	New Buildings	Existing Buildings
Demonstrate accountable data ethics practices that identifies the various opportunities for the collection, analysis, and use of data, organised around 4 principles: a) Governance and Transparency b) Management of Personal Data c) Care of Personal Data d) Individuals' Rights	2 points	2 points

The project team shall consider the risks that technologies deployed in the building present to the environment, society, and governance. This includes the understanding of data bias, privacy protection and the right to be forgotten.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- The IMDA's Data Protection Trustmark (DPTM) certification (or equivalent).

At Verification stage (New Buildings & Existing Buildings):

- Documentation on policies and processes on the risk and impact assessments (e.g., Data Protection Impact Assessment – DPIA) and the implementation of action plans to address the identified data protection risks.

References

- Data Protection Trustmark Certification
- ISO/IEC 27701:2019 Security techniques — Extension to ISO/IEC 27001 and ISO/IEC 27002 for privacy information management — Requirements and guidelines

IN3 Responsive

A maximum of 5 points can be scored across IN3 Responsive section.

IN3.1 Energy Usage Optimisation

This section rewards facilities that dynamically optimize their energy usage through demand reduction (e.g., cooling load or lighting load in kWh) while maintaining occupants' comfort. Project are encouraged to utilise a network of sensors, data transmission infrastructure, and building management (control) system to facilitate responsive building operations.

(i) Adaptive ACMV control system (Water Side)

Assessment Criteria

IN3.1 Energy Usage Optimisation	**New Buildings**	**Existing Buildings**
(i) Adaptive ACMV control system (Water Side) – continuously monitor, analyse, and modify BMS control settings to optimise energy usage of ACMV (water-side) system while maintaining occupant comfort.	0.5 Point *For Non-Residential buildings only*	0.5 Point *For Non-Residential buildings only*

Points shall be awarded where the key systems, such as the Chiller, Cooling Towers, the Condenser Water Pumps and the Chilled Water Pumps, can:

- Store historical consumption of energy-consuming systems in a database system to facilitate data analytics.
- Store actuator performance (e.g., chilled water valve position), cooling tower fans speed, and pump flow rate, in a database system to facilitate correlation analyses of performance vs energy consumption.
- Provide adequate number of calibrated sensors to gather data relevant to tracking building service performance.
- Combine insights from multiple data sources (e.g., power, temperature, flow rate, pressure, external environmental factors etc) and dynamically finetune set points to achieve energy optimization without compromising service performance.
- Provide a control logic for auto optimisation of systems.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Method statement covering parameters monitored, data trending, action thresholds and system actions.
- Sub-system equipment specification.
- Power meter and sensors specification.
- Single line diagram showing the design location of the power meters and sensors.

At Verification stage (New Buildings & Existing Buildings):

- System description, including monitoring and optimisation capabilities and logic.
- BMS or supervisory control and data acquisition display of meter readings and trends.
- Commissioning report of the sub-metering system.
- Screenshot indicating real-time optimisation effort to reduce energy and maintain quality.

References

- ASHRAE Guideline 36 (2021) provides uniform sequences of operation for HVAC systems that are intended to maximize the systems' energy efficiency and performance, provide control stability, and allow for real-time fault detection and diagnostics.

(ii) Adaptive ACMV control system (Air Side)

Assessment Criteria

IN3.1 Energy Usage Optimisation		New Buildings	Existing Buildings
(ii)	Adaptive ACMV control system (Air Side) – continuously monitor, analyse, and modify BMS control settings to optimise energy usage of ACMV (air side) system while maintaining occupant comfort.	1 Point *For Non-Residential buildings only*	1 Point *For Non-Residential buildings only*

Points shall be awarded where the key systems, such as air distribution system and mechanical ventilation system, can:

- Store historical consumption of energy-consuming systems in a database system to facilitate statistical analyses.
- Store actuator performance (e.g., timeseries data for control valve opening, fan speed etc.) in a database system to facilitate correlation analyses of actuator performance vs energy consumption.
- Provide adequate number of digital quality sensors to gather data relevant to tracking building service performance. For the common case of occupant comfort, both temperature and humidity sensors shall be provisioned.
- Combine insights from multiple data sources (e.g., occupancy data, CO2 concentration data etc) and dynamically finetune actuator commands or set points to achieve energy optimization without compromising service performance. For example, the setpoint is defined as a function of the loads in the room.
- Provide a control logic for auto optimisation of systems.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Method statement covering parameters monitored, data trending, action thresholds and system actions.
- Sub-system equipment specification.
- Power meter and sensors specification.
- Single line diagram showing the location of the power meters and sensors.

At Verification stage (New Buildings & Existing Buildings):

- System description, including monitoring and optimisation capabilities and logic.
- BMS or supervisory control and data acquisition display of meter readings and trends.
- Commissioning report of the sub-metering system.
- Screenshot indicating real-time optimisation effort to reduce energy and maintain quality.

References

- ASHRAE Guideline 36 (2021) provides uniform sequences of operation for HVAC systems that are intended to maximize the systems' energy efficiency and performance, provide control stability, and allow for real-time fault detection and diagnostics.

(iii) Adaptive lighting monitoring & control system

Assessment Criteria

IN3.1 Energy Usage Optimisation		New Buildings	Existing Buildings
(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 while maintaining comfortable user experience.	0.5 Point *For Non-Residential buildings only*	0.5 Point *For Non-Residential buildings only*

Points shall be awarded where the adaptive lighting monitoring and control system can:

- Read and store luminaire sensor bundle data (e.g., motion, daylight levels and temperature) & energy consumption in a database system to facilitate statistical analyses.
- Be integrated with the BMS and/or FM platform such that all the motion, space temperature, energy use and daylight sensor readings from each sensor are available in real time for the BMS and/or FM platform for control use.
- Combine insights from multiple data sources such as environmental and occupancy data (e.g., temperature, daylight level, power utilisation, and occupancy) and dynamically finetune actuator commands to achieve energy optimization without compromising service performance. For example, automatic dimming control of luminaires based on locally measured daylight levels.
- Provide a control logic for auto optimisation of systems.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Method statement covering parameters monitored, data trending, action thresholds and system actions.
- Lightings specification.
- Single line diagram showing the location of the power meters and sensors.

At Verification stage (New Buildings & Existing Buildings):

- System description, including the monitoring and optimisation capabilities and logic.
- Commissioning report of the lightings system.
- Screenshot indicating real-time optimization effort to reduce energy and maintain quality.

(iv) Tenant energy monitoring and optimisation

Alongside CN3.1 Green Lease implementation, this section further details how building owner/landlord can play a more active role to encourage tenants to consume less energy while performing their business activities. This section evaluates how building owner/landlord implement smart solution(s) at tenanted spaces to continuously keep track on energy consumption and implement optimisation strategies to reduce energy consumption.

Assessment Criteria

IN3.1 Energy Usage Optimisation		New Buildings	Existing Buildings
(iv)	Tenant energy monitoring and optimisation – continuously monitor, benchmark, and report tenant energy consumption to optimise the energy consumption.	1 Point *For Non-Residential buildings only*	1 Point *For Non-Residential buildings only*

Points shall be awarded when the building owner/landlord provides smart solution(s) for each tenant with the ability:

- To access the building data from the smart features and capabilities that building owner/landlord has enabled in the tenanted areas. For example, occupancy and environmental data (e.g., temperature, daylight level) from smart lighting system installed in the tenanted spaces should be made available/accessible (e.g., through mobile/web app, API integration etc) to all tenants at any time during occupying the spaces.
- To control/adjust the actuator parameters such as to program the luminaire groups associated with each switch based on the grouping advised by the tenants or to control cooling based on occupancy loading.
- To derive ratio of energy consumption usage by load category such as lighting, Air-Con and any category that is relevant to the business and to identify areas for improvements (e.g., through notification of unusual energy consumption based on trend reporting).
- To benchmark (actual vs targets) the energy usage of the tenanted spaces (e.g., energy consumption per occupants).

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Method statement covering parameters monitored, data trending, action thresholds and system actions.
- Sub-system equipment specification.
- Power meter and sensors specification.
- Single line diagram showing the location of the power meters and sensors.

At Verification stage (New Buildings & Existing Buildings):

- System description, including the monitoring and optimisation capabilities and logic.
- Commissioning report of the sub-metering system.
- Screenshot or real time display on energy consumption breakdown and efficiency tracking of key systems.
- Screenshot indicating real-time optimization effort to reduce energy and maintain quality.

IN3.2 Greenhouse Gas (GHG) Emissions Monitoring and Tracking

This section evaluates building owners on their GHG emission monitoring and tracking system which will help improve the GHG data availability, identify the GHG reduction opportunities and achieve the GHG reduction targets over time.

Associated with CN1.2 2030 Transition Plan, this section will facilitate the net zero transition planning and progression.

Assessment Criteria

IN3.2 Greenhouse Gas (GHG) Emissions Monitoring and Tracking	**New Buildings**	**Existing Buildings**
Point allocation is based on the scopes of GHG monitoring and tracking.		
(i) Scope 1 GHG emission (direct emission) and Scope 2 GHG emission (indirect emission).	0.5 Point	0.5 Point
(ii) Scope 3 GHG emission (indirect emission) for at least 2 relevant categories.	0.5 Point	0.5 Point
	For Non-Residential buildings only	*For Non-Residential buildings only*

To develop a GHG emission monitoring and tracking system which can fulfil following criteria:

- The process of data collection, monitoring and tracking can be automatic or manual.
- Minimally the data collection should be on monthly basis.
- Data review and analysis should be conducted on regular basis. The recommended interval is on quarterly basis.
- GHG reduction targets which could be short, medium- or long term should be established within 3 years after setting up the monitoring and tracking system.
- At least one dedicated personnel should be appointed to oversee the GHG monitoring and tracking system. The personnel can be inhouse staff or external consultant. The personnel is responsible for:
  - Tracking the GHG emission and communicating the performance on regular basis
  - Identifying the GHG reduction opportunities to achieve the reduction targets.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Method statement for collection, monitoring, and tracking of GHG emissions.

At Verification stage (New Buildings & Existing Buildings):

- Screenshots of GHG emission monitoring and tracking system, control logic and data analytics reports.

IN3.3 Health & Comfort – Provision of indoor air quality monitoring system with zonal controls

Indoor environment parameters shall be measured in real time and used for zonal control of the AC and ventilation system to facilitate a healthy indoor environment for building users and occupiers.

Assessment Criteria

IN3.3 Health & Comfort – Provision of indoor air quality monitoring system with zonal controls	**New Buildings**	**Existing Buildings**
Health & Comfort – Provision of indoor air quality monitoring system with zonal controls.	1 Point *For Non-Residential buildings only*	1 Point *For Non-Residential buildings only*

Points shall be awarded when the air-conditioning / mechanical ventilation system can be controlled with real time measurement of the indoor environment parameters, including temperature, relative humidity, CO2, formaldehyde (or TVOC), and PM2.5 for all occupied spaces. For projects where the system does not cover all occupied spaces, points awarded shall be prorated basing on percentage area of coverage.

The minimum number of sampling points and the sample position shall follow SS554 (Code of Practice for Indoor Air Quality for Air-Conditioned Buildings) or equivalent.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Method statement covering parameters monitored, data trending, action thresholds and system actions.
- Sensor specification and design location.

At Verification stage (New Buildings & Existing Buildings):

- BMS or supervisory control and data acquisition display of meter readings.
- Calibration report of the environmental sensors.
- Screenshot or real time display on indoor environmental parameters, and system actions.

Guidance Notes

As the occupant density may occasionally change, wireless IoT sensors are preferred instead of wired so that the IoT sensors can be easily moved when the design of the space changes (e.g., by partitioning the spaces). For project that deploys occupancy sensors, occupant density data can also be used to adjust the location of the IAQ sensors periodically which can be a good demonstration on how the 2 sets of data can be correlated.

References

- SS554:2021 Code of practice for indoor air quality for air-conditioned buildings.

IN3.4 Space Optimisation

Space optimisation is a strategic approach to make the most efficient and effective use of physical spaces while also contributing to cost savings and operational efficiency. The objective of space optimisation is to enhance space functionality and occupant/FM personnel productivity while minimising waste and inefficiency.

Assessment Criteria

IN3.4 Space optimisation	New Buildings	Existing Buildings
To continuously monitor, track, and report space utilisation in order to empower building owner and/or FM team to optimise space functionality/utilisation and occupant/FM personnel productivity.	1 Point *For Non-Residential buildings only*	1 Point *For Non-Residential buildings only*

Points shall be awarded in the utilisation of digital solution capable in:

- Collecting real-time data on occupancy levels and pattern which may include information on peak usage times, areas with high/low occupancy rates, and frequency of space utilisation.
- Identifying underutilised spaces so that building owner and/or FM team can make informed decisions about how to repurpose or optimise them to better meet their needs.
- Enabling dynamic space allocation. For example, if a meeting room is unoccupied, the system can release the room reservation and make it for others to use.
- Analysing the data collected from the occupancy sensors to make evidence-based decisions such as adjusting operating hours, reallocating spaces, or adjusting FM services (e.g., prioritise cleaning tasks).

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Method statement for occupancy and space monitoring, and its integration into systems for spatial optimisation, including:
    - Data analysis and logging.
    - Identification of underutilised space, allowing for investigations.
    - System controls (FM system, room booking and allocation systems).
- Sensor specification.

At Verification stage (New Buildings & Existing Buildings):

- Screenshots of spatial optimisation system, control logic and data analytics reports.
- Calibration report of the environmental sensors.

IN3.5 User Experience

(i) User feedback

A digital user feedback platform should be made available for building occupants or residents to provide the feedback anytime on the occupants or residents experience where building operators can also easily collate and analyse the feedback to gather insights on the expectation of the desired indoor/outdoor environment.

Assessment Criteria

IN3.5 User Experience	New Buildings	Existing Buildings
(i) User feedback: proactive collection and use of data using a digital user feedback platform to understand, track and manage the occupants or residents experience within the building: • User patterns. • Comfort (thermal, visual, aural, olfactory, and spatial, including locational information).	0.5 Point	0.5 Point

Points shall be awarded in the utilisation of a digital user feedback platform capable in gathering the feedback from building occupants or residents to facilitate responsive operation of building and its system and better operate according to user expectations. The platform shall be able to gather feedback from building occupants on preferred thermal, visual, aural, olfactory, and spatial comfort or to gather residents' opinions on various community matters to derive insight on user expectations. With the digitalised data, the user experience shall be continuously enhanced via adjustments of operations.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Design proposal and requirements on feedback collection platform.
- Design requirement on capability of system to be adjustable and operational guide on system adaption.

At Verification stage (New Buildings & Existing Buildings):

- Screenshots of the digital feedback collection platform.
- Protocol to gather, analyse the collected feedback, and adjust the systems.

(ii) Community experience

Offer building occupants or residents a user-friendly digital platform that grants them convenient access to a variety of services available within the building and its community. These services may include co-working spaces booking, events registration, carpooling, community forum, and more.

Assessment Criteria

IN3.5 User Experience	New Buildings	Existing Buildings
(ii) Community experience: a user-friendly digital platform that grants building occupants or residents convenient access to a variety of services available within the building and its community.	0.5 Point	0.5 Point

Points shall be awarded in the utilisation of a digital platform capable in:

- Searching services offered by the building or its community (e.g., events calendar, co-working spaces, community forum etc) and setting up preferences.
- Booking/registering the services.

- Receiving notifications of the services offered
- Personalising their digital app experience by selecting their interests, notifications, and preferences.
- Recording and analysing:
  - ✓ Daily/monthly active use.
  - ✓ Usage trends (e.g., which services and amenities tenants use).
  - ✓ Popularity of events, services, spaces, and amenities offered.
  - ✓ User satisfaction, etc.

With the digitalised data, the user experience shall be continuously enhanced via adjustments of the services offered.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Design proposal and requirements describing the functionality of the digital platform.
- Letter of commitment for implementation from developer or building owner.

At Verification stage (New Buildings & Existing Buildings):

- Screenshots of the user interfaces of the digital platform showing its capability (e.g., search for and book an event).

(iii) Electronic notice board (for residential building)

An electronic notice board for residential building is a digital platform that replaces traditional physical notice boards with an interactive, digital display. This technology enhances communication and information dissemination within the residential community.

Assessment Criteria

IN3.5 User Experience	**New Buildings**	**Existing Buildings**
(iii) a. Electronic notice board: to improve communication within residential building community, making it easier to share information, engage residents, and enhance the overall living experience.	0.5 Point	0.5 Point
b. Innovative use of the electronic noticed board system.	0.5 Point	0.5 Point
	For Residential buildings only	*For Residential buildings only*

Half (0.5) point shall be awarded in the utilisation of an electronic noticed board system capable in:

- Setting up user roles and permissions to allow authorised personnel (property managers, administrators) to manage and update content while ensuring the information is accurate and up to date.
- Offering an intuitive content management system (CMS) that allows administrators to create, schedule, and update notices easily.
- Incorporating interactive elements such as polls, surveys, or feedback forms to engage residents and gather their opinions.

Another half (0.5) point shall be awarded for innovative use of the electronic noticed board system such as integrating the e-notice board with other systems (e.g., access control systems) to provide a seamless experience for residents.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Design proposal and requirements describing the functionality of the electronic notice board system.
- Letter of commitment for implementation from developer or building owner.

At Verification stage (New Buildings & Existing Buildings):

- Screenshots of the electronic notice board system.
- Guidelines on how to use the electronic notice board system effectively for resident and property management personnel.

(iv) Parcel delivery management (for residential building)

Parcel delivery management for residential building is a crucial aspect of ensuring efficient and secure handling of packages for residents. Implementing a streamlined process for parcel delivery can save time for both residents and property management, reduce the risk of lost or misplaced packages, and enhance overall resident satisfaction.

Assessment Criteria

IN3.5 User Experience	New Buildings	Existing Buildings
(iv) a. Parcel delivery management: a user-friendly parcel delivery management system that enhance the convenience and satisfaction of residents, as well as streamline the operations of property management.	0.5 Point	0.5 Point
b. Innovative use of the parcel delivery management system.	0.5 Point *For Residential buildings only*	0.5 Point *For Residential buildings only*

Half (0.5) point shall be awarded in the utilisation of a user-friendly parcel delivery management system capable in:

- Providing individual lockers where delivery personnel can securely deposit packages, and residents can retrieve them using unique codes or mobile apps.
- Implementing a digital solution that integrates with the parcel locker system. This can include a mobile app or a web portal where residents receive notifications, access locker codes, and track their deliveries.
- Allowing residents to access the parcel locker system around the clock to accommodate various delivery schedules.

Another half (0.5) point shall be awarded for innovative use of the parcel delivery management system (e.g., autonomous delivery robot).

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Design proposal and requirements describing the functionality of the parcel delivery management system.
- Letter of commitment for implementation from developer or building owner.

At Verification stage (New Buildings & Existing Buildings):

- Screenshots of the parcel delivery management system.

- Guidelines on how to use the parcel delivery management system for courier, resident, and property management personnel (e.g., delivery procedures, how to retrieve the packages, how long packages can remain in the locker, how to troubleshoot issues with the parcel locker system, etc).

Intelligence - Innovation

A maximum of 2 points can be scored across the Innovation section. Points scored in this section can add to the overall score for the Intelligence Section, capped at 15 points in total.

Assessment Criteria

Intelligence - Innovation	New Buildings	Existing Buildings
Projects can demonstrate substantial performance to a specific Intelligence indicator or outcome, where innovation points can be awarded on a case-by-case basis. Points shall be awarded based on the strength of evidence of benefits and potential impact.	Up to 2 Points	Up to 2 points

Points are awarded on a case-by-case basis, according to the potential impact and coverage shall be at least 50%. For high impact items, 0.5 point is awarded. For low impact items, 0.25 point is awarded. For example, for energy storage systems equipped with smart coordination to work with intermittent generation sources (e.g., Photovoltaics), up to 1 point shall be awarded.

Projects that submit Green Mark application after 31 May 2023 and attain Smartscore Office Gold or Platinum will be awarded 1 and 2 points respectively. Similarly, any project that attains the Intelligence Badge will be awarded 2 credits within the Innovation section of the Smartscore Office certification.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

The project team is to submit a concise summary that articulates:

- The nature of the environmental benefit of their intervention.
- Justify the impact of the intervention through detailed calculations and comparisons with industry norms.
- Substantiate the calculations and comparisons with evidence and data.

At Verification stage (New Buildings & Existing Buildings):

- Details of the implemented intervention including measurements and monitoring of the environmental performance and lessons learnt if the intervention does not perform as expected.

Guidance Notes

Projects can innovate to go above and beyond to attain exceptional Intelligence outcomes as intended in one or more criterion or demonstrate unique solutions to enhance other aspects of Intelligence not specified in the criteria. Innovations will be considered on a case-by-case basis.

Some examples, include, but not limited to:

- Use of Singapore Green Building Council certified smart building products or product with equivalent certification where 0.25 point shall be awarded for each smart product used that is certified by Singapore Green Building Council or other equivalent certification entities. The coverage rate shall be at least 50% of the applicable areas.
- Adoption of Digital Twin technology. The role of the Digital Twin is to function as the piece in the value chain that ties the various digitized deliverables in the previous sections together. The Digital Twin should provide the necessary insights through a single, coherent platform that acts as a “system of systems”, to align all building data in a structured way that supports stakeholders to make better decisions. It should also provide actionable insights by upholding the 5 characteristics of data quality – Completeness, Relevance, Accuracy, Reliability, and Timeliness. For example, the Digital Twin should present geometrical data, subsystem data, and business data (Completeness) that are aggregated and

organized logically and correctly associated with each other (Relevance). The Digital Twin should also maintain data access to source in real-time to eliminate data duplication, thereby ensure there is a single source of truth (Accuracy and Reliability). The Digital Twin should also be accessible to any stakeholder, in accordance with access rights and privileges, to provide organization wide presence (Timeliness).

- An Enabling Infrastructure (EI) such as Robotics Middleware Framework (RMF) that enables interoperability among heterogenous robot fleets while managing robot traffic that share common resources such as space, building infrastructure (e.g., lifts, doors), and other automation systems within the same facility.
- Deployment of Autonomous Last-Mile Delivery Robots for non-residential buildings.

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