Building and Construction Authority

An MND Statutory Board

Our Ref : APPBCA-2021-07 Environmental Sustainability Group

22 Mar 2021

See Distribution List

Dear Sir/Madam

CALL FOR INDUSTRY COMMENTS ON PROPOSED CHANGES TO ENVIRONMENTAL SUSTAINABILITY REQUIREMENTS FOR NEW BUILDING DEVELOPMENTS AND EXISTING BUILDINGS

Objective

The Building and Construction Authority (BCA) would like to seek industry comments on the proposed changes to the Code for Environmental Sustainability of Buildings.

Background

2. The legislation on Environmental Sustainability was first introduced in 2008 as part of the key initiatives under the earlier Green Building Masterplans to advance sustainable building development. With this legislation, new buildings and existing buildings with major retrofits with Gross Floor Area (GFA) of 2,000m^2 and above are required to meet the minimum environmental sustainability standard[1]. It was subsequently enhanced to include existing buildings with major energy use change (i.e. chiller installation or retrofits) with GFA of 5000m^2 or more in 2017[2]. The Codes for Environmental Sustainability requirements that set out the minimum environmental sustainability standards were put in place for regulatory compliance in support of these requirements.

[1] Under the Building Control (Environmental Sustainability) Regulations 2008, building works are to be designed and constructed to meet the minimum environmental sustainability standard. The compliance forms part of the building plan approval and TOP/CSC clearance. Major retrofits refer to building works that involve provision, extension or substantial alteration of the building envelope and building services in/in connection with an existing building.

[2] Under the Building Control (Environmental Sustainability Measures for Existing Buildings) Regulations 2013, the compliance with the minimum environmental sustainability standard is required when there is an installation and replacement of building cooling system for all buildings except for the following building types : industrial, residential (excluding serviced apartments), railway, port, airport services and facilities, religious building, data centre and utility buildings. It was implemented in phases, starting with large commercial buildings with GFA of 15,000 m^2 or more in 2014 followed by those with GFA of 5000 m^2 or more in 2017.

3. In 2020, BCA and the Singapore Green Building Council (SGBC) have co-led the co-creation of the next Singapore Green Building Masterplan[3] (SGBMP) with stakeholders from the public, private and people sectors, including Trade Associations and Chambers (TACs). One of the key initiatives under the SGBMP is to review the environmental sustainability requirements to support the strive towards more energy efficient buildings.

4. As part of the Whole of Government (WOG) initiatives in mitigating the effects of climate change, we will streamline the Code requirements to focus on sustainability indicators which would help drive better building energy efficiency and carbon reduction potential to support the transition to a more sustainable, low-carbon Built Environment.

Industry Consultation

5. Earlier, the SGBMP working committees have contributed to the setting of energy efficiency measures for buildings. Several industry practitioners were also engaged and have provided their feedback on the areas of improvements to the Code requirements.

6. Further, we would also like to take the opportunity to disseminate the proposed changes to building professionals and members of various Trade Associations and Chambers (TACs) for further inputs and comments before finalising the Code requirements.

Consultation Details and Closing Date for Comments

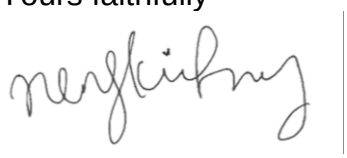
7. Please see Annex A and B on the proposed compliance framework and summary of the changes for further feedback.

8. Building professionals and members of TACs can send their views and inputs using the feedback form or email to bca_gm_efiling@bca.gov.sg by **20 Apr 2021**.

For Clarification

9. We would appreciate it if you could convey the contents of this circular to the members of your organisation. For clarification, please submit your enquiry through BCA's Online Feedback Form or call us at 1800 342 5222.

Yours faithfully



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[3] The SGBMP is part of the Singapore Green Plan 2030 which aims to strengthen our existing national sustainability efforts.

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Annex A

INDUSTRY CONSULTATION

Proposed Changes to the Code for Environmental Sustainability of Buildings

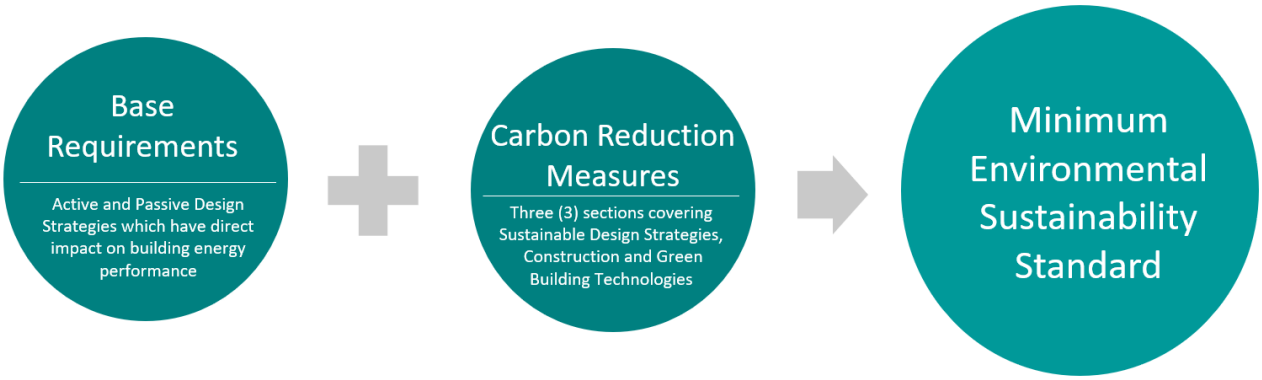
Under Building Control (Environmental Sustainability) Regulations 2008

Building and Construction Authority

1. Overview of Compliance Framework

1.1 Minimum Environmental Sustainability Standard

The level of environmental performance that meets all relevant Base Requirements and a selected number of sustainability indicators provided under the Carbon Reduction Measures are deemed to have met the minimum environmental sustainability standard of 50 points as prescribed in the Regulations.



1.2 Specific Requirements for Different Building Types

The required level of environmental performance will depend on the building works in relation to the building types and as follows :

Residential Buildings	**Non-Residential Buildings**
All Base Requirements where relevant	All Base Requirements where relevant
*4 Carbon Reduction Measures in total with at least two (2) options from Sustainable Construction and one (1) option each from Sustainable Design Strategies and Technologies	*4 Carbon Reduction Measures in total with at least two (2) options from Sustainable Construction and one (1) option each from Sustainable Design Strategies and Technologies
**Not applicable for building works that only involve the erection of simple structures and buildings solely used for specific functions and as listed below :* • *Link ways* • *Underground passes* • *Open sheds* • *Standalone substation* • *Lift upgrading* • *Farm structures* • *Workers dormitories* • *Treatment plants* • *Transit facilities*	
Mixed Use Buildings	
Each part of the building works in relation to the residential and non-residential buildings shall be regarded as separate building works. The level of environmental performance shall be in accordance with the requirements set for each part of the buildings works.	

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2. Base Requirements

2.1 Environmental Sustainability Attributes

The Base Requirements comprises environmental sustainability attributes that are to be complied with, where applicable. The details are provided in the following Table 2.1.1 and Table 2.2.2 for the respective building types.

Table 2.1.1 – Base Requirements for Residential Buildings	
SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
RB01 Building Energy Performance	
A building shall be designed and constructed with energy efficiency measures to reduce energy consumption of building energy systems	Energy performance of building energy systems
RB01-1 Air-Conditioning System	
Reduce energy required for space cooling by providing energy efficient air-conditioning systems that could meet the following energy performance standard or equivalent. **Design System Efficiency (TDSE)** Single/ Multi Spilt System: 5 ticks rated Variable Refrigerant Flow (VRF) system: 3 ticks rated Note : (1) The single/multi-spilt air conditioners and VRF system are to be rated and labelled with Energy Label as required under the Mandatory Energy Labelling Scheme administered by NEA. (2) Other systems such as centralised cooling system are to meet the design system efficiency standard that is equivalent to VRF system of 3 ticks rating.	Air-conditioning system for at least 80% of the total number of dwelling units and common facilities
RB01-2 Lighting System for Common Facilities and Areas	
Reduce energy required to illuminate spaces in common facilities and areas with proper lighting level. The lighting provision shall be at least 40% more energy efficient than the prescribed lighting power budget stated in SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment. Lighting provision for building façade and landscape are to comply with the prescribed lighting power budget stated in SS 530.	Lighting system for common facilities and areas, building façade and landscape.
RB01-3 Mechanical Ventilation System for Carpark Areas	
Reduce energy required by regulating the demand for mechanical ventilation in carpark areas by way of CO detection sensor control with Variable Speed Drive (VSD).	Mechanical ventilation system for carpark areas
RB01-4 Vertical Transportation System	
Reduce energy consumption by providing energy efficient vertical transportation systems that are equipped with variable voltage variable frequency (VVVF) drives and sleep mode features.	Lift systems that serve four (4) floors or more

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SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
RB02 Envelope and Roof Thermal Transfer	
A building shall be designed and constructed with good thermal performance to reduce solar heat gain through its building envelope and roof.	Thermal performance of building envelope and roof
RB02-1 Building Envelope	
Minimise heat gain through building envelope to enhance thermal comfort and to reduce the energy needed to condition the indoor environment when required. (a) The building envelope is to be designed with Residential Envelope Transmittance Value (RETV) of no more than 22 W/m^2 based on the methodology stated in the Code on Envelope Thermal Performance for Buildings; OR (b) The building envelope designed is deemed to have satisfied the performance requirements if it meets the following criteria :	Building envelope design

Window to Wall Ratio (WWR)	Shading Coefficients of Glass (SC_{glass})
< 0.30	≤ 0.67
0.30 to < 0.35	≤ 0.59
0.35 to < 0.40	≤ 0.52
0.40 to < 0.45	≤ 0.48
0.45 to ≤ 0.50	≤ 0.43

RB02-2 Roof	
The average thermal transmittance (U-Value) of roof shall not exceed the prescribed limits as stated below :	Roof design

Roof Weight Group	Weight Range (kg/m^2)	Maximum U- value (W/m^{2}k)
Light	<50	0.8
Medium	50 to 230	1.1
Heavy	>230	1.5

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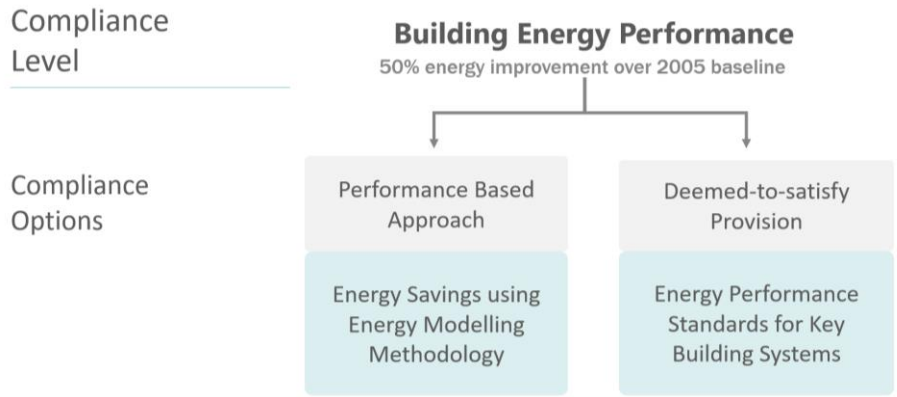
Table 2.1.2 – Base Requirements for Non-Residential Buildings	
SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
NRB01 Building Energy Performance	
A building shall be designed and constructed with energy performance that meet minimum energy improvements of 50% over 2005 baseline. This can be translated to 30% energy savings over current Singapore Standard and baseline.  The compliance with this requirement shall be demonstrated by way of energy modelling methodology or by meeting the respective performance standards set for key energy systems set out in the following sections.	Energy performance of building energy systems
NRB01-1 Performance Based Approach via Energy Modelling	
Facilitate energy load reduction strategies and cost-effective design decision at design stage to meet minimum energy savings of 30% as compared with its reference model based on prevailing Singapore Standard and baseline. The demonstration of the energy savings requirement shall be conducted via energy modelling in accordance with the framework set out in accordance with the Energy Modelling Methodology and Requirements. For buildings with cooling provision that tap on District Cooling System (DCS) operated by supplier of district cooling services that are subject to the District Cooling Act and/or Energy Conservation Act (ECA), the energy performance of the DCS can be excluded in the energy modelling simulation. *(Note: The energy modelling methodology and requirement will be enhanced and incorporated in the Code for compliance. At this juncture, you may wish to refer to the Energy Modelling Methodology in GM NRB2015 as a reference for better understanding.)*	Building energy systems that are stated in the energy modelling methodology and requirements

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SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
NRB01-2 Energy Performance Standards for Key Building Systems	
Facilitate energy load reduction with provision of enhanced energy efficient active systems and equipment that could contribute towards meeting a minimum energy savings of 30% as compared with its reference model based on prevailing Singapore Standard and baseline.	Key building system provisions stated in the following sub-sections
NRB01-2(a) Air-Conditioning System	
Reduce energy required to provide and distribute conditioned air within the space by having energy efficient air-conditioning system.	Air-conditioning system and cooling provision from existing air-conditioning system and district cooling system that serve new buildings or floor areas

(i) Water-Cooled Building Cooling system
- Water-Cooled Chiller
- Chilled Water Pump
- Condenser Water Pump
- Cooling Tower
- Air-Distribution System

Total Design System Efficiency (TDSE) for Water-Cooled Building Cooling System	
New Buildings	Existing Buildings with New Extension and Major Retrofits
0.85 kW/RT	0.9 kW/RT

where the minimum water-cooled chilled water plant efficiency for new commercial buildings is 0.63 kW/RT. As for other building developments, the minimum plant efficiency will be based on the chilled water supply temperature and as follows :

Minimum Water-Cooled Chilled Water Plant Efficiency η_c							
Commercial Buildings	Other Building Developments						
	Chilled Water Temp (°C)	6	7	8	9	10	For chilled water temp above 10 °C, the threshold will be adjusted from 0.64kW/RT by 0.01 kW/RT for every 1°C increase in chilled water supply temperature
0.63	Water-Cooled Chiller System Efficiency (kW/RT)	0.68	0.67	0.66	0.65	0.64	

For buildings with cooling provision that tap on District Cooling System (DCS), the TDSE requirement does not apply but the air-distribution system efficiency must meet the minimum energy performance standard of 0.25 kW/RT.

(ii) Air-Cooled Building Cooling System
- Unitary Air-Conditioners (Single or combination of systems)
  - Variable Refrigerant Flow (VRF) system
  - Single – Spilt Units
  - Multi-Spilt Units
  - Air-Distribution System

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SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE

• Air-Cooled Chilled-Water System can be adopted in relation to existing building development with inherent constraints and with peak building cooling load of not more than 500 RT
  ○ Air-Cooled Chiller
  ○ Chilled Water Pump
  ○ Air-Distribution System
 	
Total Design System Efficiency (TDSE) for Air-Cooled Building Cooling System
New and Existing Buildings with New Extension or Major Retrofits
1.0 kW/RT
 	
where the minimum system efficiency for different building cooling systems are as follows :
 	
Minimum Air-Conditioning System Efficiency η_c
Unitary System (Outdoor Condenser Units) / **Air-Cooled Chilled Water Plant**
All Buildings / Applicable to only Existing Buildings with New Extension or Major Retrofits
0.78 kW/RT (inclusive of site derating factor) / 0.85 kW/RT
 	
Note:
(1) Total Design System Efficiency (TDSE) refers to combined design system efficiency of the chiller plant or condenser units and air distribution systems.
(2) The TDSE can be adjusted to allow for pressure drop adjustments for fan system where there is a need for more allowance due to functionality and activities as per recommended by SS 553 – Table 2b.
(3) Where there is a combination of water cooled and air-cooled building cooling system, the respective TDSEs are to be complied with.
(4) The supply of water-cooled chillers that use refrigerants with Global Warming Potential (GWP) above 15 and 750 respectively will be banned from end 2022 under the Energy Conservation Act. Hence, it is advisable to consider the adoption of chillers using refrigerants of low GWP. Please refer to NEA's website for more details.	

NRB01-2(b) Lighting System	
Reduce energy required to illuminate interior spaces with proper lighting level. The lighting provision shall be at least 40% more energy efficient than the prescribed lighting power budget stated in SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment. Lighting provision for building façade and landscape are to comply with the prescribed lighting power budget stated in SS 530.	Lighting systems for interior spaces, building facades and landscape

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SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
NRB01-2(c) Mechanical Ventilation System	
Reduce energy required to supply and distribute fresh air within the space by having energy efficient mechanical ventilation system and controls. (i) Provision of mechanical ventilation system of at least 10% more energy efficient than the prescribed standard stated in SS 553 for normally occupied spaces that utilise mechanical ventilation as the preferred ventilation mode. (ii) Provision of Carbon Monoxide (CO) detection sensor control with Variable Speed Drive (VSD) to regulate demand for mechanical ventilation in carpark areas.	Mechanical ventilation systems for normally occupied spaces and carpark areas
NRB01-2(d) Vertical Transportation System	
Reduce energy consumption by providing energy efficient vertical transportation systems that are equipped with variable voltage variable frequency (VVVF) drives and sleep mode features.	Lifts and escalators
NRB02 Envelope and Roof Thermal Transfer	
A building shall be designed and constructed with good thermal performance to reduce solar heat gain through the building envelope and roof.	Thermal performance of building envelope and roof
NRB02-1 Building Envelope	
Minimise heat gain through building envelope to enhance thermal comfort and to reduce the energy needed to condition the indoor environment. (a) The building envelope is to be designed with Envelope Thermal Transfer Value (ETTV) of not more than 45 W/m^2 based on the methodology stated in the Code on Envelope Thermal Performance for Buildings ; OR (b) The building envelope designed is deemed to have satisfied the performance requirements if it meets the following criteria :	Building envelope design

Window to Wall Ratio (WWR)	Shading Coefficients of Glass (SC_{glass})
< 0.20	≤ 0.51
0.20 to < 0.25	≤ 0.41
0.25 to < 0.30	≤ 0.35
0.30 to < 0.35	≤ 0.30
0.35 to ≤ 0.40	≤ 0.27
0.40 to ≤ 0.50	≤ 0.22

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SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
NRB02-2 Roof	
Minimise heat gain through roof to reduce the energy needed to condition the indoor environment. (a) The roof with skylights is to be designed with Roof Thermal Transfer Value (RTTV) of not more than 50 W/m^2 based on the methodology stated in the Code on Envelope Thermal Performance for Buildings. (b) For roof without skylights, the average thermal transmittance (U-Value) of roof shall not exceed the prescribed limits as stated below : Roof Weight Group / Weight Range (kg/m^2) / Maximum U-value (W/m^{2}k) Light / <50 / 0.5 Medium / 50 to 230 / 0.8 Heavy / >230 / 1.2	Roof design with and without skylights
NRB03 Air-tightness and Leakage	
A building shall be designed and constructed with energy conservation measures to reduce air leakage through doors, windows and other openings on the building envelope.	Measures to minimise air infiltration
NRB03-1 Windows and Curtain Walls	
Minimise air infiltration through building envelope by way of effective means of weather-stripping of windows and curtain walls. The windows and curtain walls shall be designed to ensure that the air leakage rates do not exceed the limits specified in the following standards. (a) SS 212 – Specification for Aluminum Alloy Windows (b) SS 381 – Material and Performance Tests for Aluminum Curtain Walls	Windows and curtain walls – Component testing
NRB03-2 Openings between conditioned and non-conditioned spaces	
Conditioned air is to be well confined to minimise heat gain due to warmer infiltration of air into the space with appropriate mitigation measures. Building entrances and door openings to building exterior or non air-conditioned spaces and the like, shall (a) be provided with doors that are equipped with automated technology or self-closing devices with the use of pressure independent control valve and energy meters to measure the consumption of fan coiled units (FCUs) within the tenanted space, where relevant; and	Building entrances and door openings to building exterior or non-air-conditioned spaces

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SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
(b) be equipped with enclosed vestibules or air lock rooms for doorway with high pedestrian traffic flow*. The interior door and exterior door should have a minimum distance of not less than 2.5 m apart. * Doorway with high pedestrian traffic flow refers to main entrances and those leading to transport nodes or other commercial buildings.	
NRB04 Measurement and Verification (M & V) Instrumentation	
Facilitate energy management and monitoring of air-conditioning system operating efficiency with the provision of permanent measuring instrumentation.	Energy measurement and management of air-conditioning systems
NRB04-1 Instrumentation for Chilled Water Air-Conditioning System	
Provision of permanent measuring instruments for monitoring of the energy performance of the chilled water plants and air distribution systems. The installed instrumentation must have the capability to calculate the resultant system efficiency within 5% of its true value in accordance with SS 591: 2013. Each measurement system shall include sensors, any signal conditioning, data acquisition system and the wiring connecting these components. The permanent measuring instruments and devices are to be accessible[see note (5)] and must not be located directly above the chillers, to facilitate verification and maintenance. They must be installed in accordance with the manufacturers' recommendation and SS 591: 2013. The measurement systems provided shall also comply with the following requirement: (a) All data logging with capability to trend at 1-minute sampling time interval, and recorded to the 3rd decimal digit; (b) Building management system (BMS), standalone energy monitoring system (EMS) or local sequential controller (LSC) shall have capability to compute and display of key indicators including total system energy efficiency and its component (water-side and air-side efficiency) as well as the calculated heat balance of the chilled water system; (c) Magnetic in-line flow meter, with 1% uncertainty and capable of electronic in-situ verification to within ±2% of its original factory calibration. If installation of magnetic in-line meters is not possible, ultrasonic flow meters or other flow meters that can meet the indicated performance may be used;	Instrumentation for Water cooled and air cooled chilled water plant and/or air-distribution system

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SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
(d) Temperature sensors are to be provided for chilled water and condenser water loop and shall have an end-to-end measurement uncertainly within ±0.05°C over the entire measurement range. Each temperature measurement location shall have test-plugs or additional thermowells located before and after each temperature sensor along the chilled water and condenser water lines for verification of measurement accuracy. All thermo-wells shall be installed in a manner that enables the sensors to be in direct contact with fluid flow; and (e) Dedicated power meters (of IEC Class 1 or better) and metering current transformers (of Class 1 or better) where applicable, are to be provided for each of the following groups of equipment where applicable: chillers, chilled water pumps, condenser water pumps, cooling towers, air-distribution sub-system (i.e. AHUs, PAHUs, FCUs [see note 6]). Note : (5) The temperature sensors are best placed in an accessible location with mounting height of not more than 3m, where possible. Otherwise, there should be evidence of provision for access by way of mobile platform or other suitable form. (6) Where the FCUs' power consumption could not be metered or provided, the evidences of nameplate power can be used to derive the air-distribution efficiency without the need of sub-metering. (7) For buildings with cooling provision that tap on District Cooling System (DCS), only the relevant instrumentation in relation to the proposed buildings is applicable. (8) Upon project completion, a heat balance substantiating test can be carried out to ascertain the accuracy of the M & V instrumentation provided for the central chilled water system. To meet the accuracy requirement, more than 80% of the heat balance (%) derived over the entire normal operating hours is to be within ± 5% for a period of one (1) week.	
NRB04-2 Instrumentation for Variable Refrigerant Flow (VRF) System	
Provision of permanent measuring instruments for monitoring of the energy performance of the Variable Refrigerant Flow (VRF) condensing units and air-distribution systems. The installed instrumentation must have the capability to calculate the resultant system efficiency within 10% uncertainty. Each measurement system shall include sensors, any signal conditioning, data acquisition system and the wiring connecting these components. The measurement systems provided shall also comply with the following requirement: (a) All data logging with capability to trend at 5-minute sampling time interval, and recorded to the 3rd decimal digit;	Instrumentation for VRF systems which serve an aggregate conditioned floor areas of 2000 m^2 or more.

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SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
(b) Building management system (BMS), standalone energy monitoring system (EMS) shall have capability to compute and display of the overall system energy efficiency and to facilitate data extraction for verification purpose; and (c) Dedicated power meters (of IEC Class 1 or better) and metering current transformers (of Class 1 or better) where applicable, are to be provided for all condensing units of the VRF system and air-distribution sub-systems (i.e. AHUs, PAHUs, FCUs [see note 6]).	
NRB05 Electrical Submetering	
Facilitate measurement and monitoring of major energy end uses for energy management and audit. Separate sub-meters shall be provided and linked to a monitoring system that can measure and trend energy consumption data of the following systems:	Energy measurement and management of other building energy systems

Sub-System for Metering	
Lifts and escalators	More than 5 numbers or sets or with sum of all feeders > 50 kVA.
Mechanical Ventilation Systems	Total subsystem's load > 15 kW Sub-metering applicable to individual fan system motors that are more than 1.5 kW in the following areas • Normally Occupied Spaces • M & E Plant Rooms • Carparks
Centralised hot water supply system	> 50 kW thermal heating capacity
General power supply and lighting systems for tenancy areas and owners' premises	Sub-metering for tenancy areas and owners' premises are to be separated. The sub-circuits serving these areas can be provided based on sub-system basis and /or per floor level.

Note:

(9) If there is a need to cater to high plug loads or process loads exceeding 50 kVA in areas such as manufacturing, carpark, data centre, EV charging stations, please provide separate sub-metering for these specific areas to better manage the energy consumption, where relevant.

(10) The provision of sub-metering for chiller plant systems and VRF system are covered under NRB04.

SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
NRB06 Maintenance of Building Cooling System Performance	
Ensure adequate service clearances so that the building cooling system performance can be maintained during operation as designed. *Service clearances are to be provided as per manufacturers' specification or prescribed standards stated in the following clauses, whichever governs.*	Space requirement for water-cooled and air-cooled chilled water systems
NRB06-1 Chillers	
Access space provisions are as follows : (a) Clear space of 2 m or more at the front of chiller unit piping section for tube maintenance and cleaning, repair and replacement of bigger components; (b) Clearance of 1.2 m or more between the chillers measured from plinth to plinth for regular maintenance; and (c) Overhead service clearance of 1.5 m or more above the chiller for overhaul maintenance.	Chillers
NRB06-2 Pump Systems	
Access space provisions are as follows : (a) Except for the areas where the pipes are connected, a clearance of 0.6 m or more is to be provided round the pump for regular maintenance; and (b) Clear head room space of 1 m or more above the pump and motor to facilitate overhaul maintenance or replacement.	Chilled water pumps (CHWP) and condensers water pumps (CWP)
NRB06-3 Cooling Towers	
Maintenance provisions are as follows : (a) Provision of maintenance platform, stairs and catwalks of 600 mm width or more with handrails around the cooling towers and access to the level for periodic maintenance, inspection of water basin and fill media; and (b) Clear space of 2 m or more from the top of cooling towers to location of the trellis, where applicable. Note (11) : Proper clearances on all sides of the cooling tower should be provided in accordance with manufacturer's technical recommendation to ensure the heat rejection performance of cooling towers is not affected or should not be less than the lateral width of the cooling tower, whichever governs.	Cooling towers

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NRB06-4 Air-Distribution Systems	
Air handling units (AHU) of cooling capacity greater than 35 kW shall be floor mounted as stipulated in SS 553. The access space provisions are as follows : (a) AHU access – Provide minimum 1m clear space from the AHU room door entrance to the AHU for general maintenance; (b) Cooling coil pipe and filter access – Provide minimum 800 mm clear space after pipe connection to facilitate cooling coil cleaning and filter access; (c) Fan access – Provide minimum 800 mm clear space for fan/motor access and maintenance (if the access is not from cooling coil connection side); and (d) AHU side and back clearance – Provide minimum 600 mm clear space for general access and maintenance.	Floor mounted AHUs

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3. Carbon Reduction Measures

3.1 Environmental Sustainability Indicators

A suite of environmental sustainability indicators in relation to energy and carbon emission reduction measures is provided as elective options classified in the following three (3) sections.

1

Sustainable Design Strategies

optimises the use of passive design strategies in response to local climate and site conditions to improve on indoor environmental quality while minimising energy use.

2

Sustainable Construction

promotes the adoption of sustainable practices, material procurement and design which inculcate responsible use and conservation of resources during construction and building operation.

3

Sustainable Technologies

encourages the provision of green building technologies that are oriented towards establishing low energy building consumption and smart control systems that could adapt to the users' needs and enhance building energy performance.

A selection of four (4) carbon reduction measures appropriate for the building development from the suite of environmental sustainability indicators provided in Table 3.1.1 and Table 3.1.2 will be required. There must have two (2) options from Sustainable Construction and one (1) option each from Sustainable design strategies and Sustainable Technologies as part of the requirements to meet the minimum environmental sustainability standard.

Table 3.1.1 – Carbon Reduction Measures for Residential Buildings

1 Sustainable Design Strategies

optimises the use of passive design strategies in response to local climate and site conditions to improve on indoor environmental quality while minimising energy use.

SUSTAINABILITY INDICATORS	APPLICABILITY & SCOPE
RBE01-1 Tropical Building Envelope Performance	
Enhance building envelope performance to minimise heat gain to internal spaces for better indoor thermal comfort with any of the following provisions : (a) Façade design with Residential Envelope Transmittance Value (RETV) of no more than 20 W/m^2. (b) Application of cool paints that are certified by an approved local product certification body for 80% of the east and west facing external walls or roof areas. Note (1) The selected paint system must meet the allowable limits set for daylight reflectance as required under the Approved Document. (c) Provision of innovative façade technology or solutions such as the use of electrochromic glass, integration of photovoltaic modules, parametric façade and so on for at least 20% of the façade areas.	Building envelope and roof
RBE01-2 Naturally Ventilated Building Design	
Enhance indoor thermal comfort through the provision of building and unit layout design which facilitate good natural ventilation. (a) Building layout design comprises 40% of all units with window openings facing prevailing wind directions (b) Dwelling unit design comprises 30% of living rooms and bedrooms designed with effective inlet and outlet openings on either opposite or adjacent wall to facilitate good cross ventilation. (c) Design for natural ventilation with minimum coverage of 80% (by number) in at least two(2) of the following areas • Lift lobbies and Corridors • Staircases • Carparks • Common facilities	Dwelling units and common areas

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SUSTAINABILITY INDICATORS	APPLICABILITY & SCOPE
RBE01-3 Effective Daylighting	
Encourage design that optimise the use of effective natural lighting for better visual comfort. (a) Dwelling units : Daylighting provision for 25% of the total number of residential units that meets the desired lighting level of $DA200_{lx,\ 50\%}$ in 60% of applicable areas (namely bedrooms, living room, family room and study room) based on daylight availability table provided. *(Note: The daylight availability tables will be incorporated in the Code for compliance. At this juncture, you may wish to refer to GM RB2016 for more info on daylighting availability tables for better understanding.)* (b) Common areas: Provision of daylighting with minimum coverage of 80% (by number) in at least two (2) of the following areas : • Lift lobbies and Corridors • Staircases • Carparks • Common facilities	Dwelling units, common areas and carparks

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Table 3.1.1 – Carbon Reduction Measures for Residential Buildings – Cont'd

2 Sustainable Construction

promotes the adoption of sustainable practices, material procurement and design which inculcate responsible use and conservation of resources during construction and building operation.

SUSTAINABILITY INDICATORS	APPLICABILITY & SCOPE
RBE02-1 Resource Efficiency Measures	
Encourage design that optimizes resource efficiency and minimise waste generation in building construction. (a) Existing building structures with more than 50% of the floor and/or wall areas conserved for adaptive reuse. (b) Design with Concrete Usage Index (CUI) of not more than 0.48. (c) Embodied carbon reporting to account for the upfront carbon emissions of three (3) key construction materials namely, concrete, steel, and glass used in building developments.	Building design and construction
RBE02-2 Low Carbon Concrete	
Enhance carbon reduction potential through the use of following sustainable materials for construction. (a) Eco-friendly cement : Use of concrete (up to grade C50/60) with clinker content of less than 400 kg/m^3 or SGBC– certified concrete for 80% of the super-structural works. (b) Aggregate replacement : Use of recycled concrete aggregate (RCA), washed copper slag (WCS) and/or granite fines from approved sources that meet the minimum usage requirement (that is 1.5% x GFA for RCA and/or 0.75 x GFA for WCS or granite fines). (c) Processed waste : Use of NEWSand for non-structural application.	Concrete building elements
RBE02-3 Sustainable Products	
Encourage the specification and use of environmentally friendly products that are certified with Environmental Product Declaration (EPD) requirements or two-ticks rating by an approved local certification body. The provision shall include at least five (5) products for 80% of applicable areas or building components.	Building products

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Table 3.1.1 – Carbon Reduction Measures for Residential Buildings – Cont'd

3 Sustainable Technologies

encourages the provision of green building technologies that are oriented towards establishing low energy building consumption and smart control systems that could adapt to the users' needs and enhance building energy performance.

SUSTAINABILITY INDICATORS	APPLICABILITY & SCOPE
RBE03-1 Renewable Energy System	
Encourage the use of on-site renewable energy sources to reduce the use of electricity by at least 10% of the expected total building electricity consumption of common facilities and areas.	Solar photovoltaic system
RBE03-2 Smart Home Solutions	
Encourage the provision of communication technology which enables some degree of automation and controls over key energy systems such as air-conditioning usage and lighting. There should also have suitable means that would minimally help homeowners to better manage their energy and water consumption in an intuitive manner. It can come in the form of web-based or mobile application to provide useful and timely information on utilities consumption and breakdown for units and/or common facilities.	Energy and water management system for homeowners or facility managers
RBE03-3 Green Building Technologies	
Encourage the adoption of green building technologies and integrative use of sensors which help reduce energy consumption. Examples of the systems that can be considered are as follows : • Energy recovery system • Lifts with regenerative function • Occupancy sensors /controls for lighting in private lift lobbies, staircases or common toilets • Others (to be evaluated on a case to case basis)	Building and sensor related technologies

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Table 3.1.2 – Carbon Reduction Measures for Non-Residential Buildings

1 Sustainable Design Strategies

optimises the use of passive design strategies in response to local climate and site conditions to improve on indoor environmental quality while minimising energy use.

SUSTAINABILITY INDICATORS	APPLICABILITY & SCOPE
NRBE01-1 Tropical Building Envelope Performance	
Enhance building envelope performance to minimise heat gain to internal spaces for better indoor thermal comfort with any of the following provisions : (a) Façade design with Envelope Thermal Transmittance Value (ETTV) of no more than 40 W/m^2 or come with provision of good thermal bridging. (b) Application of cool paints that are certified by an approved local product certification body for 80% of the east and west facing external wall or roof areas. Note (1) The selected paint system must meet the allowable limits set for daylight reflectance as required under the Approved Document. (c) Provision of innovative façade technology or solutions such as use of electrochromic glass, integration of photovoltaic modules, parametric façade and so on for at least 20% of the façade areas.	Building envelope and roof
NRBE01-2 Naturally Ventilated Building Design	
Enhance indoor thermal comfort through the provision of building layout design which facilitate good natural ventilation. (a) Building layout design comprises 20% of all normally occupied spaces with openings facing prevailing wind directions (b) Design for natural ventilation with minimum coverage of 80% in at least two (2) of the following areas • Lift lobbies • Corridors • Staircases • Carparks • Atriums • Toilets	Naturally ventilated occupied spaces and common areas

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SUSTAINABILITY INDICATORS	APPLICABILITY & SCOPE
NRBE01-3 Effective Daylighting	
Encourage the provision of effective natural lighting for better visual comfort. (a) Normally occupied spaces : Daylighting provision with desired lighting level and specific Daylight Autonomy (DA) requirements as outlined in the following table for a minimum 15% of total occupied areas using the daylighting availability tables provided. The provision must come with integration of daylighting controls.	Normally occupied spaces and common areas

S/N	Minimum Lighting Level Based on Space Occupancy Type	Daylight Autonomy requirement per unit area of space
1	Office, Institutional spaces where lux requirement is 500 lux	DA_{500lx}, 50%
2	Industrial, sports facilities, retail areas where lux requirement is 300 lux	DA_{300lx}, 50%
3	Hotel, resort-like and service apartment where lux requirement is 200 lux	DA_{200lx}, 50%

(Note: The daylight availability table will be incorporated in the Code for compliance. At this juncture, you may wish to refer to GM NRB2015 for more info on daylighting availability table for better understanding.)

(d) Common areas : Daylighting provision with integrated daylight controls for a minimum coverage of 80% (by number) in at least two (2) of the following areas

- Lift lobbies
- Corridors
- Staircases
- Carparks
- Atriums
- Toilets

(b) Provision of daylight redirecting technologies such as light shelves or tubular daylight to enhance lighting level.

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Table 3.1.2 – Carbon Reduction Measures for Non-Residential Buildings – Cont'd

2 Sustainable Construction

promotes the adoption of sustainable practices, material procurement and design which inculcate responsible use and conservation of resources during construction and building operation.

SUSTAINABILITY INDICATORS	APPLICABILITY & SCOPE
NRBE02-1 Resource Efficiency Measures	
Encourage design that optimizes resource efficiency and minimise waste generation in building construction. (a) Existing building structures with more than 50% of the floor and/or facade areas conserved for adaptive reuse. (b) Design with Concrete Usage Index (CUI) of not more than 0.48. (c) Embodied carbon reporting to account for the upfront carbon emissions of three (3) key construction materials namely, concrete, steel and glass used in building developments.	Building design and construction
NRBE02-2 Low Carbon Concrete	
Enhance carbon reduction potential with the use of sustainable materials for construction. (a) Eco-friendly cement : Use of concrete (up to grade C50/60) with clinker content of less than 400 kg/m^3 or SGBC– Certified concrete for 80% of the super-structural works. (b) Aggregate replacement : Use of recycled concrete aggregate (RCA), washed copper slag (WCS) and/or granite fines from approved sources that meet the minimum usage requirement (that is 1.5% x GFA for RCA and/or 0.75 x GFA for WCS or granite fines). (c) Processed waste : Use of NEWSand for non-structural application.	Concrete building elements
NRBE02-3 Sustainable Products	
Encourage the specification and use of environmentally friendly products that are certified with Environmental Product Declaration (EPD) requirements or two-ticks rating by an approved local certification body. The provision shall include at least five (5) products for 80% of applicable areas or building components.	Building products, mechanical and electrical products

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Table 3.1.2 – Carbon Reduction Measures for Non-Residential Buildings – Cont'd

3 Sustainable Technologies

encourages the provision of green building technologies that are oriented towards establishing low energy building consumption and smart control systems that could adapt to the users' needs and enhance building energy performance.

SUSTAINABILITY INDICATORS	APPLICABILITY & SCOPE
NRBE03-1 Renewable Energy System	
Encourage the use of on-site renewable energy sources to reduce the use of electricity by at least 1% of the expected total building electricity consumption.	Solar photovoltaic system
NRBE03-2 Smart Building Solutions	
Encourage the provision of minimum three (3) building solutions which facilitates some form of automation and controls over building systems for better energy management and thermal comfort as listed below. (a) Use of BACnet, Modbus or any other open protocol as the network backbone of the building management system where data points can be used to facilitate communication and integration with other building systems. (b) Energy management system, applications and dashboard that help building owners and/or tenants to better manage their energy consumption in an intuitive manner. (c) Demand controlled ventilation system such as carbon dioxide sensors or devices to regulate the fresh air intake and ventilation based on occupants' need. (d) Timer sensors/controls for lighting and ventilation systems in common areas and facilities . (e) Differential pressure monitoring equipment in Air Handling Units (AHUs). (f) Others (to be evaluated on a case to case basis)	Building solutions that facilitate energy management and controls
NRBE03-3 Green Building Technologies	
Encourage the adoption of low-carbon solutions and technologies which help reduce energy consumption. Examples of the systems that can be considered are as follows : • Energy recovery system • Lifts with regenerative function • Passive displacement ventilation system • Hybrid cooling system • Smart sensor and control technologies • Dedicated outdoor air system • Others (to be evaluated on a case to case basis)	Building and sensor related technologies

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Summary of Key Changes to the Requirements under the Current Code for Environmental Sustainability of Buildings (3rd Edition)

<table>
<tr><th>Criteria Ref</th><th>Current Code for Environmental Sustainability of Buildings (3rd Edition)</th><th>Criteria Ref</th><th>Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)</th></tr>
<tr><td></td><td>General

The minimum Green Mark Score of 50 points and the stipulated pre-requisite requirements

The criteria comprise 5 environmental impact categories namely
Part 1 – Energy Efficiency
Part 2 – Water Efficiency
Part 3 – Environmental Protection
Part 4 – Indoor Environmental Quality
Part 5 – Other Green Features

The score is the total of all the numerical scores assigned based on the degree of compliance with the applicable criteria listed under the 5 categories</td><td></td><td>General

The minimum environmental sustainability standard (equivalent 50 points) shall have a level of environmental performance that meets all relevant base requirements and a selected number of sustainability indicators provided under Carbon Reduction Measures

The Elective Options are broadly grouped in 3 Sections namely
Section 1 – Sustainable Design Strategies
Section 2 – Sustainable Construction
Section 3 – Sustainable Technologies

<table>
<tr><th>RESIDENTIAL BUILDINGS</th><th>NON-RESIDENTIAL BUILDINGS</th></tr>
<tr><td>2 Base Requirements
4 Carbon Reduction Measures in total with at least two (2) options from Sustainable Construction and one (1) option each from Sustainable Design Strategies and Technologies</td><td>6 Base Requirements
*4 Carbon Reduction Measures in total with at least two (2) options from Sustainable Construction and one (1) option each from Sustainable Design Strategies and Technologies

*Not applicable for building works that only involve the erection of simple structures and special functions such as link ways, underground passes, open sheds, standalone substation, lift upgrading, farm structures, workers' dormitories, treatment plants, transit facilities.</td></tr>
<tr><td colspan="2">Note that there are sub-clauses under the Base Requirements. For residential buildings - 6 sub-clauses and for non-residential buildings - 15 sub-clauses that are to be complied with, where relevant.</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Criteria Ref</th><th>Current Code for Environmental Sustainability of Buildings (3rd Edition)</th><th>Criteria Ref</th><th>Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)</th></tr>
<tr><td colspan="2">Part 1 – Energy Efficiency</td><td colspan="2">Part 1 – Base Requirements</td></tr>
<tr><td>NRB 1-2</td><td>
Air Conditioning System
(a) Water-Cooled Chilled-Water Plant :
• Water-Cooled Chiller
• Chilled-Water Pump
• Condenser Water Pump
• Cooling Tower
<table>
<tr><th rowspan="2">Baseline</th><th colspan="2">Peak Building Cooling Load</th></tr>
<tr><th>≥ 500 RT</th><th>< 500 RT</th></tr>
<tr><td>Prerequisite Requirements

Minimum Design System Efficiency (DSE) for central chilled-water plant</td><td>0.70 kW/RT</td><td>0.80 kW/RT</td></tr>
</table>
(b) Air-Cooled Chilled-Water Plant /Unitary Air-Conditioners
• Air-Cooled Chilled- Water Plant
  ○ Air-Cooled Chiller
  ○ Chilled Water Pump
• Unitary Air-Conditioners
  ○ Variable Refrigerant Flow (VRF) system
  ○ Single – Spilt Units
  ○ Multi-Spilt Units
</td><td>NRB 01

NRB01-2(a)</td><td>
Building Energy Performance

The compliance with the energy performance that meet minimum energy improvements of 50% over 2005 baseline (that is 30% energy savings over prevailing Singapore Standard and baseline) by way of energy modelling simulation OR the respective performance standards set out below.

Air-Conditioning System
(i) Water-Cooled Building Cooling System
• Water-Cooled Chiller;
• Chilled-Water Pump;
• Condenser Water Pump;
• Cooling Tower; and
• Air-Distribution System
<table>
<tr><th colspan="2">Total Design System Efficiency (TDSE) for Water-Cooled Building Cooling System</th></tr>
<tr><td>New Buildings</td><td>Existing Buildings with New Extension and Major Retrofits</td></tr>
<tr><td>0.85 kW/RT</td><td>0.9 kW/RT</td></tr>
</table>
(ii) Air-Cooled Building Cooling System
• Unitary Air-Conditioners (Single or combination of systems)
  ○ Variable Refrigerant Flow (VRF) system
  ○ Single – Spilt Units
  ○ Multi-Spilt Units
  ○ Air-Distribution System
</td></tr>
</table>

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
NRB 1-2 Cont'd		NRB01-2(a) Cont'd	

Baseline	Peak Building Cooling Load	
	≥ 500 RT	< 500 RT
Prerequisite Requirements Minimum Design System Efficiency (DSE) for air cooled chilled-water plant or unitary conditioners	0.80 kW/RT	0.90 kW/RT

- Air-Cooled Chilled-Water System can be adopted in relation to existing building development with inherent constraints and with peak building cooling load of not more than 500 RT
  - Air-Cooled Chiller
  - Chilled Water Pump
  - Air-Distribution System

Total Design System Efficiency (TDSE) for Air-Cooled Building Cooling System
New and Existing Buildings with New Extension or Major Retrofits
1.0 kW/RT

where TDSE refers to the combined design system efficiency of the chiller plant or condenser units and air-distribution systems.

Note : (1) Unlike current Code, the minimum energy performance standard is pegged based on the Total Design System Efficiency which comprises both the water-side and air-side system efficiency. In other words, it is a requirement to consider the air-distribution system efficiency in meeting the TDSE, although there is no minimum standard set for these systems. Noted that there will be minimum standards required for water cooled chilled water plant, air-cooled chilled water plant and unitary air conditioners – condensers and as follows :

Water-Cooled Building Cooling System

Minimum Water-Cooled Chilled Water Plant Efficiency η_c

Commercial Buildings	Other Building Developments						
	Chilled Water Temp (°C)	6	7	8	9	10	For chilled water temp above 10 °C, the threshold will be adjusted from 0.64kW/RT by 0.01 kW/RT for every 1°C increase in chilled water supply temperature
0.63	Water-Cooled Chiller System Efficiency (kW/RT)	0.68	0.67	0.66	0.65	0.64	

<table>
<tr><th>Criteria Ref</th><th>Current Code for Environmental Sustainability of Buildings (3rd Edition)</th><th>Criteria Ref</th><th>Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)</th></tr>
<tr><td></td><td></td><td></td><td>

For buildings with cooling provision that tap on District Cooling System (DCS), the TDSE requirement does not apply but the air-distribution system efficiency must meet the minimum energy performance standard of 0.25 kW/RT.

Air- Cooled Building Cooling System

<table>
<tr><th colspan="2">Minimum Air-Conditioning System Efficiency η_c</th></tr>
<tr><th>Unitary System (Outdoor Condenser Units)</th><th>Air-Cooled Chilled Water Plant</th></tr>
<tr><td>All Buildings</td><td>Applicable to only Existing Buildings with New Extension or Major Retrofits</td></tr>
<tr><td>0.78 kW/RT (inclusive of 20% site deration factor)</td><td>0.85 kW/RT</td></tr>
</table>

The provision of air-cooled chilled water plant can only be considered for existing buildings with new extension or major retrofits.

(2) The TDSE can be adjusted to allow for pressure drop adjustments for fan system where there is a need for more allowance due to functionality and activities as per recommended by SS 553 – Table 2b.

(3) Where there is a combination of water cooled and air-cooled building cooling system, the respective TDSEs are to be complied with.

(4) Building energy modelling simulation can be used as the methodology used to meet the performance requirement of 50% energy savings (new buildings) and 40% energy savings (existing buildings) over 2005 baseline for compliance

</td></tr>
</table>

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
NRB 1-4 RB 1-4	**Artificial Lighting** Encourage the use of energy efficient lighting to minimise energy consumption from lighting usage while maintaining proper lighting level Points are accorded based on percentage improvement in mechanical ventilation system efficiency over the baseline stipulated in SS 530.	NRB01-2(b) RB01-2	**Lighting System** Reduce energy required to illuminate interior spaces with proper lighting level. The lighting provision shall be at least 40% more energy efficient than the prescribed lighting power budget stated in SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment. Lighting provision for building façade and landscape are to comply with the prescribed lighting power budget stated in SS 530. *Note:* *(1) There is a minimum energy improvement of 40% over baseline stipulated in SS 530* *(2) Lighting provision for exterior such as building façade and landscape are considered separately and to meet the prescribed lighting power budget.*
NRB 1-4 (b)	**Mechanical Ventilation** Encourage energy efficient mechanical ventilation system design as the preferred ventilation mode to minimise air-conditioned spaces. Points are accorded based on percentage improvement in mechanical ventilation system efficiency over the baseline stipulated in SS 553.	NRB01-2(c)	**Mechanical Ventilation System** Reduce energy required to supply and distribute fresh air within the space by having energy efficient mechanical ventilation system and controls. (i) Provision of mechanical ventilation system of at least 10% more energy efficient than the prescribed standard stated in SS 553 for normally occupied spaces that utilise mechanical ventilation as the preferred ventilation mode. *Note(1) There is a minimum energy improvement of 10% over baseline stipulated in SS 553 which is applicable only to the normally occupied spaces and carpark areas.*

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
NRB 1-2 (d)	**Measurement and Instrumentation Requirements for water cooled chilled water air conditioning system** (d) *Prerequisite Requirements :* Provision of permanent measuring instruments for monitoring of water-cooled chilled-water plant efficiency. The installed instrumentation shall have the capability to calculate a resultant plant efficiency (i.e. kW/RT) within 5 % of its true value and in accordance with ASHRAE Guide 22 and AHRI Standard 550/590. The following instrumentation and installation are also required to be complied with : (i) Location and installation of the measuring devices to meet the manufacturer's recommendation. (ii) Data acquisition system with a minimum resolution of 16 bit. (iii) All data logging with capability to trend at 1 minute sampling time interval. (iv) Flow meters are to be provided for chilled-water and condenser water loop and shall be of ultrasonic / full bore magnetic type or equivalent. (v) Temperature sensors are to be provided for chilled water and condenser water loop and shall have an end-to-end measurement uncertainty not exceeding ± 0.05 °C over the entire measurement or calibration range. All thermo-wells shall be installed in a manner that ensures that the sensors can be in direct contact with fluid flow. Provisions shall be made for each temperature measurement location to have two spare thermo-wells located at both side of the temperature sensor for verification of measurement accuracy.	NRB04 NRB 04-1	**Measurement and Verification (M & V) Instrumentation** **Instrumentation for Chilled Water Air-Conditioning System** Provision of permanent measuring instruments for monitoring of the energy performance of the chilled water plants and air distribution systems. The installed instrumentation must have the capability to calculate the resultant system efficiency within 5% of its true value in accordance with SS 591: 2013. Each measurement system shall include sensors, any signal conditioning, data acquisition system and the wiring connecting these components. The permanent measuring instruments and devices are to be accessible and must not be located directly above the chillers, to facilitate verification and maintenance. They must be installed in accordance with the manufacturers' recommendation and SS 591: 2013. The measurement systems provided shall also comply with the following requirement: (a) All data logging with capability to trend at 1-minute sampling time interval, and recorded to the 3rd decimal digit; (b) Building management system (BMS), standalone energy monitoring system (EMS) or local sequential controller (LSC) shall have capability to compute and display of key indicators including total system energy efficiency and its component (water-side and air-side efficiency) as well as the calculated heat balance of the chilled water system. (c) Magnetic in-line flow meter, with 1% uncertainty and capable of electronic in-situ verification to within ±2% of its original factory calibration. If installation of magnetic in-line meters is not possible, ultrasonic flow meters or other flow meters that can meet the indicated performance may be used; (d) Temperature sensors are to be provided for chilled water and condenser water loop and shall have an end-to-end measurement uncertainly within ±0.05°C over the entire measurement range. Each temperature measurement location shall have test-plugs or additional thermowells located before and after each temperature sensor along the chilled water and condenser water lines for verification of measurement accuracy. All

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
NRB 1-2 (d)	(vi) Dedicated power meters are to be provided for each of the following groups of equipment : chillers, chilled water pumps, condenser water pumps and cooling towers.	NRB 04-1	thermo-wells shall be installed in a manner that enables the sensors to be in direct contact with fluid flow; and (e) Dedicated power meters (of IEC Class 1 or better) and metering current transformers (of Class 1 or better) where applicable, are to be provided for each of the following groups of equipment where applicable: chillers, chilled water pumps, condenser water pumps, cooling towers, air-distribution sub-system (i.e. AHUs, PAHUs, FCUs). *Note:* *(1) This requirement Is extended to cover air-cooled chilled water plant* *(2) Added requirements on the manner and location of the permanent instruments and devices as well as the functionality and capability of data loggers and energy monitoring system for better monitoring as highlighted in blue.* *(3) Provision of calibrated magnetic in-line flow meters for better measurement accuracy is preferred.* *(4) It is a new requirement to have dedicated power meters to be provided for air-distribution sub-systems (that is AHUs, PAHUs, FCUs). In the case of FCUs, if submetering cannot be provided, the evidences of way of nameplate motors can be considered.*

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
	Note : No requirement on VRF system under Current Code	NRB04-2	**Instrumentation for Variable Refrigerant Flow (VRF) system** Provision of permanent measuring instruments for monitoring of the energy performance of the Variable Refrigerant Flow (VRF) condensing units and air-distribution systems. The installed instrumentation must have the capability to calculate the resultant system efficiency within 10% uncertainty. Each measurement system shall include sensors, any signal conditioning, data acquisition system and the wiring connecting these components. The measurement systems provided shall also comply with the following requirement: (a) All data logging with capability to trend at 5-minute sampling time interval, and recorded to the 3rd decimal digit; (b) Building management system (BMS), standalone energy monitoring system (EMS) shall have capability to compute and display of the overall system energy efficiency and to facilitate data extraction for verification purpose; and (c) Dedicated power meters (of IEC Class 1 or better) and metering current transformers (of Class 1 or better) where applicable, are to be provided for all condensing units of the VRF system and air-distribution sub-systems (i.e. AHUs, PAHUs, FCUs). *Note :* *(1) This is a new requirement to cover instrumentation for VRF system for better energy monitoring. It is only applicable if the VRF system serve an aggregate conditioned floor areas of* ***2000 m² or more****.* *(2) Requirement for dedicated power meters to be provided for air-distribution sub-systems (that is AHUs, PAHUs, FCUs). In the case of FCUs, if*

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
			submetering cannot be provided, the evidences of way of nameplate motors can be considered. *(3) Suppliers' proprietary system can be used to determine the system efficiency of the condensing units.*
	Note : No requirement on service clearances under Current Code	NRB06	**Maintenance of Building Cooling System Performance** Ensure adequate service clearances so that the building cooling system performance can be maintained during operation as designed. *Service clearances are to be provided as per manufacturers' specification or prescribed standards stated in the following clauses, whichever governs.* This is applicable to Chillers, Pump Systems, Cooling Towers, Air-Distribution System – AHUs only *Note : This is a new requirement to ensure that the building cooling system performance can be maintained during building operation.*
Part 1 – Energy Efficiency		**Part 2 – Elective Options under Section 1 : Sustainable Design Strategies**	
RB1-3 NRB 1-5	**Daylighting** Encourage design that optimises the use of effective daylighting to reduce energy use for artificial lighting. (a) Use of daylight and glare simulation analysis to verify the adequacy of ambient lighting levels in all dwelling unit's living and dining areas. The ambient lighting levels should meet the illuminance level and Unified Glare Rating (UGR) stated in SS CP 38 – Code of Practice for Artificial lighting in Buildings. (b) Daylighting in the following common areas with extent of coverage of 80% (i) Lift lobbies and Corridors (ii) Staircases (iii) Carparks	RBE01-3 NRBE01-3	**Effective Daylighting** Encourage design that optimise the use of effective natural lighting for better visual comfort. (a) Dwelling units : Daylighting provision for 25% of the total number of residential units that meets the desired lighting level of $DA200_{lx,\ 50\%}$ in 60% of applicable areas (namely bedrooms, living room, family room and study room) based on daylight availability table provided. (b) Common areas: Provision of daylighting with minimum coverage of 80% (by number) in at least two (2) of the following areas : • Lift lobbies and Corridors • Staircases • Carparks

<table>
<tr><th>Criteria Ref</th><th>Current Code for Environmental Sustainability of Buildings (3rd Edition)</th><th>Criteria Ref</th><th>Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)</th></tr>
<tr><td></td><td>(a) Use of daylighting and glare simulation analysis to verify the adequacy of ambient lighting levels in meeting the illuminance level and Unified Glare Rating (UGR) stated in SS 531:Part 1:2006 – Code of Practice for Lighting of Work Places.

(b) Daylighting in the following common areas
(i) Toilets
(ii) Staircases
(iii) Corridors
(iv) Lift lobbies
(v) Atriums
(vi) Carparks

Extent of coverage : 80% - with integration with daylight control</td><td></td><td>(a) Normally Occupied Spaces : Daylighting provision with desired lighting level and specific Daylight Autonomy (DA) requirements as outlined in the following table for a minimum 15% of total occupied areas with integration of daylighting controls.

<table>
<tr><th>S/N</th><th>Minimum Lighting Level Based on Space Occupancy Type</th><th>Daylight Autonomy requirement per unit area of space</th></tr>
<tr><td>1</td><td>Offices and Institutional spaces where lux requirement is 500 lux</td><td>DA_{500lx}, 50%</td></tr>
<tr><td>2</td><td>Industrial, sports facilities, retail areas where lux requirement is 300 lux</td><td>DA_{300lx}, 50%</td></tr>
<tr><td>3</td><td>Hotel, resort-like and service apartment where lux requirement is 200 lux</td><td>DA_{200lx}, 50%</td></tr>
</table>

Note : Daylight availability tables will be made available for use to simplify the compliance with daylighting requirement. Daylight simulation is not required.

(b) Common areas : Daylighting provision with integrated daylight controls for a minimum coverage of 80% (by number) in at least two(2) of the following areas
• Lift lobbies
• Corridors
• Staircases
• Carparks
• Atriums
• Toilets</td></tr>
</table>

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
Part 3 – Environmental Protection		**Part 2 – Elective Options – Section 2: Sustainable Construction**	
RB 3-1 NRB 3-1	**Sustainable Construction** (a) Use of Sustainable and Recycled Materials (i) Green Cements with approved industrial by-product (such as Ground Granulated Blastfurnace Slag (GGBS), silica fume, fly ash) to replace Ordinary Portland Cement (OPC) by at least 10% by mass for superstructural works. (ii) Recycled Concrete Aggregates (RCA) and Washed Copper Slag (WCS) from approved sources to replace coarse and fine aggregates for concrete production of main building elements (b) Concrete Usage Index (CUI) Encourage designs with efficient use of concrete for building components – Points accorded for a range of CUI from 0.7 to 0.35	RBE02-1 NRBE02-1	**Resource Efficiency Measures** (a) Existing building structures with more than 50% of the floor and/or wall areas conserved for adaptive reuse. (b) Design with Concrete Usage Index (CUI) of not more than 0.48. (c) Embodied carbon reporting to account for the upfront carbon emissions of three (3) key construction materials namely, concrete, steel, and glass used in building developments. *Note:* *(1) Item (a) is similar to the requirement under Green Features and Innovation of Current Code.* *(2) Item (b) – the methodology will be the same as current Code with a low CUI stipulated to encourage efficient concrete usage* *(3) Item (c) – A new requirement incorporated to encourage carbon accounting for three key construction materials*
		RBE02-2 NRBE02-2	**Low Carbon Concrete** Enhance carbon reduction potential through the use of following sustainable materials for construction. (a) Eco-friendly cement : Use of concrete (up to grade C50/60) with clinker content of less than 400 kg/m^2 or SGBC– certified concrete for 80% of the super-structural works. (b) Aggregate replacement : Use of recycled concrete aggregate (RCA) and/or washed copper slag (WCS) from approved sources that meet the minimum usage requirement (that is 1.5% x GFA for RCA and/or 0.75 x GFA for WCS) (c) Processed Waste : Use of NEWSand for non-structural application. *Note : These requirements are generally similar to current Code but is enhanced to include processed waste.*

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
RB 3-2 NRB 3-2	**Sustainable Products** Promote the use of environmentally friendly products that are certified by approved local certification body. Points accorded based on weightage and extent of coverage. Applicable for building products	RBE02-3 NRBE02-3	**Sustainable Products** Encourage the specification and use of environmentally friendly products that are certified with Environmental Product Declaration (EPD) requirements or two-ticks rating by an approved local certification body. The provision shall include at least five (5) products for 80% of applicable areas or building components. Applicable for building products, M & E products *Note : This requirement is enhanced to encourage the use of building products with lower embodied carbon.*
Part 1 – Energy Efficiency		**Part 2 – Elective Options – Section 3: Sustainable Technologies**	
RB 1-8	**Renewable Energy** Encourage the use of renewable energy sources – Points can be accorded based on the % replacement of building electricity consumption	RBE03-1 NRB03-1	**Renewable Energy System** Encourage the use of on-site renewable energy sources to reduce the use of electricity by • at least 10% of the expected total building electricity consumption of common facilities and areas (for residential buildings). • at least 1% of the expected total building electricity consumption (for non-residential buildings). *Note : This requirement is enhanced to encourage the use of building products with lower embodied carbon.*
		RBE03-2 NRB03-2 RBE03-3 NRB03-3	**Smart Monitoring System** **Smart Building Solutions** **Green Building Technologies** *Note : Some criteria under Part 5 – Green Features and Innovation under current Code are incorporated. New requirements are included to encourage the use of smart technologies and solutions to minimise building energy consumption.*

Table A-2 – Areas of Responsibility in relation to Residential Building Developments

Residential Building Criteria	Responsibility
Base Requirements	
RB01 Building Energy Performance	
RB01-1 Air-Conditioning System	PE (Mechanical) [1]
RB01-2 Lighting System for Common Facilities and Areas	PE (Electrical) [2]
RB01-3 Mechanical Ventilation System for Carpark Areas	PE (Mechanical)
RB01-4 Vertical Transportation System	PE (Electrical)
RB 02 Envelope and Roof Thermal Transfer	
RB02-1 Building Envelope	QP (BP)[2]
RB02-2 Roof	QP (BP)
Elective Options	
Section 1 – Sustainable Design Strategies	
RBE01-1 Tropical Building Façade Performance	QP (BP)
RBE01-2 Naturally Ventilated Building Design	QP (BP)
RBE01-3 Effective Daylighting	QP (BP)
Section 2 – Sustainable Construction	
RBE02-1 Resource Efficiency Measures	QP (BP)
RBE02-2 Low Carbon Concrete	QP (BP)
RBE02-3 Sustainable Products	QP (BP)
Section 3 – Sustainable Technologies	
RBE03-1 Renewable Energy System	PE (Electrical)
RBE03-2 Smart Home Solutions	Appropriate Practitioners[3]
RBE03-3 Green Building Technologies	Appropriate Practitioners

[1] PE (Mechanical) or PE(Electrical) refers to a professional engineer registered under the Professional Engineers Act (Cap 253) in the branch of mechanical engineering or electrical engineering

[2] QP (BP) refers to Qualified Person who submits Building Plan

[3] Appropriate practitioners refer to QP (BP), PE(Mechanical) and/or PE(Electrical)

Table A-2 – Areas of Responsibility in relation to Non-Residential Building Developments

Non-Residential Building Criteria	Responsibility
Base Requirements	
NRB01 Building Energy Performance	
NRB01-1 Whole Building Approach via Energy Modelling	Appropriate Practitioners
NRB01-2 Energy Performance Standards for Key Systems	Appropriate Practitioners
NRB 02 Envelope and Roof Thermal Transfer	
NRB02-1 Building Envelope	QP (BP)
NRB02-2 Roof	QP (BP)
NRB03 Air-Tightness and Leakage	
NRB03-1 Windows and Curtain Walls	QP (BP)
NRB03-2 Openings between Conditioned and Non-Conditioned Spaces	QP (BP)
NRB04 Measurement and Verification (M & V) Instrumentation	
NRB04-1 Instrumentation for Chilled Water Air-Conditioning System	PE (Mechanical)
NRB04-2 Instrumentation for Variable Refrigerant Flow (VRF) System	PE (Mechanical)
NRB05 Electrical Submetering	PE (Electrical)
NRB06 Maintenance of Building Cooling System Performance	
NRB06-1 Chillers	PE (Mechanical)
NRB06-2 Pump Systems	PE (Mechanical)
NRB06-3 Cooling Towers	PE (Mechanical)
NRB06-4 Air-Distribution Systems	PE (Mechanical)
Elective Options	
Section 1 – Sustainable Design Strategies	
NRBE01-1 Tropical Building Façade Performance	QP (BP)
NRBE01-2 Naturally Ventilated Building Design	QP (BP)
NRBE01-3 Effective Daylighting	QP (BP)
Section 2 – Sustainable Construction	
NRBE02-1 Resource Efficiency Measures	QP (BP)
NRBE02-2 Low Carbon Concrete	QP (BP)
NRBE02-3 Sustainable Products	QP (BP)
Section 3 – Sustainable Technologies	
NRBE03-1 Renewable Energy System	PE (Electrical)
NRBE03-2 Smart Building Solutions	Appropriate Practitioners
NRBE03-3 Green Building Technologies	Appropriate Practitioners

Annex B

INDUSTRY CONSULTATION

Proposed Changes to the Code for Environmental Sustainability Measures for Existing Buildings

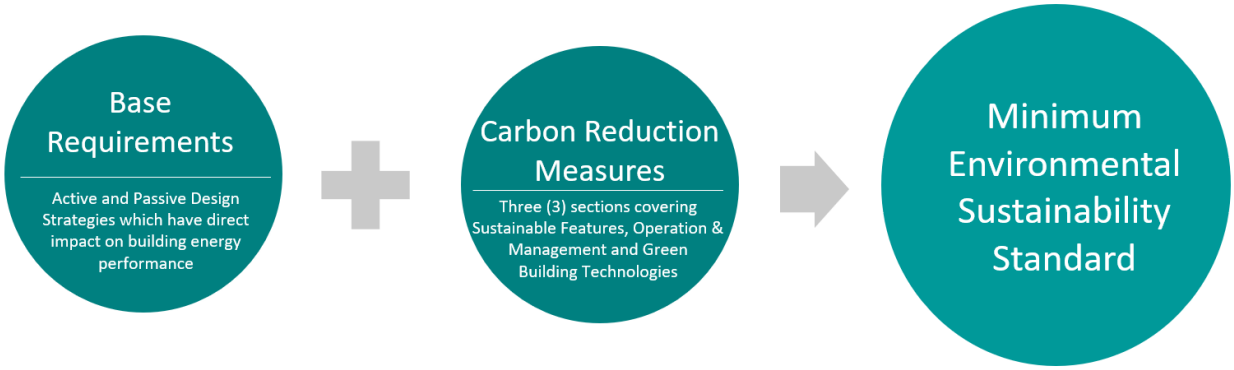
Under Building Control (Environmental Sustainability Measures) Regulations 2013

Building and Construction Authority

1. Overview of Compliance Framework

1.1 Minimum Environmental Sustainability Standard

The level of environmental performance that meets all relevant Base Requirements and a selected number of sustainability indicators provided under the Elective Options are deemed to have met the minimum environmental sustainability standard of 50 points as prescribed in the Regulations.



2. Base Requirements

2.1 Environmental Sustainability Attributes

The Base Requirements comprises environmental sustainability attributes that are to be complied with, where applicable. The details are provided in the following Table 2.1.1.

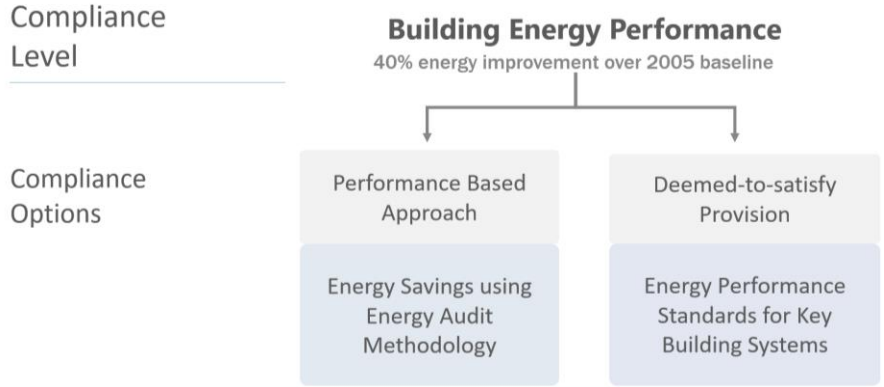
Table 2.1.1 – Base Requirements for Existing Non-Residential Buildings	
SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
ENRB01 Building Energy Performance	
A building shall be designed and constructed with energy performance that meet minimum energy performance improvements of 40% over the 2005 baseline. This can be translated to 20% energy savings over current Singapore Standard and baseline.  The compliance with this requirement shall be demonstrated by way of energy audit or by meeting the respective performance standards set for key energy systems set out in the following sections.	Energy performance of building energy systems

Table 2.1.1 – Base Requirements for Existing Non-Residential Buildings	
SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
ENRB01-1 Performance Based Approach via Energy Audit	
Facilitate energy efficiency improvement of 20% by way of attaining the Energy Usage Intensity (EUI) stipulated after retrofits.	Air-conditioning system (inclusive of air-distribution system) and lighting provision. Other energy systems that are replaced to be included.

Energy Use Intensity (EUI) for Different Building Categories ($kWh/m^2.yr$)

Commercial		Healthcare	
Office Buildings (Large)	155	Hospitals	275
Office Buildings (Small)	135	Community Hospitals	230
Hotels (Large)	230	Polyclinic	150
Hotels (Small)	185	Nursing/ Youth Homes	90
Retail Malls	240		
Educational		**Others**	
Institutions of Higher Learning (University, Polytechnics, ITE)	130	Sport and Recreation Centres	110
Private Schools and Colleges	110	Community Centres	150
Junior Colleges	60	Cultural Institution	180
Secondary Schools	40	Civic Buildings	80
Primary Schools	40	Mixed developments (by GFA mix)	

Source : GM 2021 Framework

The demonstration of the energy savings requirement shall be conducted via energy audit approach in accordance with the methodology and requirements stipulated.

(Note: Conceptually, the energy audit approach will entail the need to establish the average EUI for past three years before retrofits begin. The expected EUI could be derived by considering the potential energy savings from the retrofits. For compliance, the expected EUI is required to meet the stipulated EUI for the same building category and the air-conditioning provision shall have a minimum total system efficiency TSE of 0.9 kW/RT during operation. More details will be provided in the Code later for better understanding.)

ENRB01-2 Energy Performance Standards for Key Building Systems	
Improve building energy performance with provision of enhanced energy efficient active systems and equipment that could contribute towards meeting a minimum energy savings of 20% as compared with its energy performance before major energy use change.	As above

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SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
ENRB01-2(a) Air-Conditioning System	
Reduce energy required to provide and distribute conditioned air within the space by having energy efficient air-conditioning system. (i) Water-Cooled Building Cooling system • Water-Cooled Chiller • Chilled Water Pump • Condenser Water Pump • Cooling Tower • Air-Distribution System **Total Design System Efficiency (TDSE) for Water-Cooled Building Cooling System** Existing Buildings with Major Energy Use Change 0.9 kW/RT where the minimum energy performance standard set for water-cooled chilled water plant efficiency is 0.63 kW/RT. (ii) Air-Cooled Building Cooling System • Unitary Air-Conditioners (Single or combination of systems) ○ Variable Refrigerant Flow (VRF) system ○ Single – Spilt Units ○ Multi-Spilt Units ○ Air-Distribution System • Air-Cooled Chilled-Water System can be adopted in relation to existing building development with inherent constraints and with peak building cooling load of not more than 500 RT ○ Air-Cooled Chiller ○ Chilled Water Pump ○ Air-Distribution System **Total Design System Efficiency (TDSE) for Air-Cooled Building Cooling System** Existing Buildings with Major Energy Use Change 1.0 kW/RT where minimum energy performance standards for different building cooling systems are as follows :	Water cooled building cooling system and VRF system provision for an aggregate conditioned floor areas of 2000 m^2 or more if there is replacement.

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SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
Minimum Air-Conditioning System Efficiency η_c **Unitary System (Outdoor Condenser Units)**: 0.78 kW/RT *(inclusive of site deration factor)* **Air-Cooled Chilled Water Plant**: 0.85 kW/RT Note: (1) Total Design System Efficiency (TDSE) refers to combined design system efficiency of the chiller plant or condenser units and air distribution systems. (2) The TDSE can be adjusted to allow for pressure drop adjustments for fan system where there is a need for more allowance due to functionality and activities as per recommended by SS 553 – Table 2b. (3) Where there is a combination of water cooled and air-cooled building cooling system, the respective TDSEs are to be complied with. (4) The supply of water-cooled chillers that use refrigerants with Global Warming Potential (GWP) above 15 and 750 respectively will be banned from end 2022 under the Energy Conservation Act. Hence, it is advisable to consider the adoption of chillers using refrigerants of low GWP. Please refer to NEA's website for more details.	
ENRB01-2(b) Lighting System	
Reduce energy required to illuminate interior spaces with proper lighting level. The lighting provision shall be at least 40% more energy efficient than the prescribed lighting power budget stated in SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment.	Lighting provision
ENRB01-2(c) Mechanical Ventilation System	
Reduce energy required to supply and distribute fresh air within the space by having energy efficient mechanical ventilation system and controls. (i) Provision of mechanical ventilation system of at least 10% more energy efficient than the prescribed standard stated in SS 553 for normally occupied spaces that utilise mechanical ventilation as the preferred ventilation mode. (ii) Provision of Carbon Monoxide (CO) detection sensor control with Variable Speed Drive (VSD) to regulate demand for mechanical ventilation in carpark areas.	Mechanical ventilation for normally occupied spaces and carpark areas if there is replacement
ENRB01-2(d) Vertical Transportation System	
Reduce energy consumption by providing energy efficient vertical transportation systems that are equipped with variable voltage variable frequency (VVVF) drives and sleep mode features.	Lifts and/or escalators if there are replacements

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SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
ENRB02 Measurement and Verification (M & V) Instrumentation	
Facilitate energy management and monitoring of air-conditioning system operating efficiency with the provision of permanent measuring instrumentation.	Energy measurement and management of air-conditioning systems
ENRB02-1 Instrumentation for Chilled Water Air-Conditioning System	
Provision of permanent measuring instruments for monitoring of the energy performance of the chilled water plants and air distribution systems. The installed instrumentation must have the capability to calculate the resultant system efficiency within 5% of its true value in accordance with SS 591: 2013. Each measurement system shall include sensors, any signal conditioning, data acquisition system and the wiring connecting these components. The permanent measuring instruments and devices are to be accessible[see note (5)] and should not be located directly above the chillers, to facilitate verification and maintenance. They must be installed in accordance with the manufacturers' recommendation and SS 591: 2013. The measurement systems provided shall also comply with the following requirement: (a) All data logging with capability to trend at 1-minute sampling time interval, and recorded to the 3rd decimal digit; (b) Building management system (BMS), standalone energy monitoring system (EMS) shall have capability to compute and display of key indicators including total system energy efficiency and its component (water-side and air-side efficiency) as well as the calculated heat balance of the chilled water system; (c) Magnetic in-line flow meter, with 1% uncertainty and capable of electronic in-situ verification to within ±2% of its original factory calibration. If installation of magnetic in-line meters is not possible, ultrasonic flow meters or other flow meters that can meet the indicated performance may be used; (d) Temperature sensors are to be provided for chilled water and condenser water loop and shall have an end-to-end measurement uncertainly within ±0.05°C over the entire measurement range. Each temperature measurement location shall have test-plugs or additional thermowells located before and after each temperature sensor along the chilled water and condenser water lines for verification of measurement accuracy. All thermo-wells shall be installed in a manner that enables the sensors to be in direct contact with fluid flow; and	Instrumentation for water cooled and air cooled chilled water system

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SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
(e) Dedicated power meters (of IEC Class 1 or better) and metering current transformers (of Class 1 or better) where applicable, are to be provided for each of the following groups of equipment where applicable: chillers, chilled water pumps, condenser water pumps, cooling towers, air-distribution sub-system (i.e. AHUs, PAHUs, FCUs[see note 6]). (f) A heat balance substantiating test for the chilled water system is to be computed in accordance to SS 591 for verification of the accuracy of the M & V instrumentation. To meet the accuracy requirement, more than 80% of the heat balance (%) derived over the entire normal operating hours is to be within 5% for a period of one (1) week. Note : (5) The temperature sensors are best placed in an accessible location with mounting height of not more than 3m, where possible. Otherwise, there should be evidence of provision for access by way of mobile platform or other suitable form. (6) Where the FCUs' power consumption could not be provided, evidences of nameplate power can be provided to derive the air-distribution efficiency without the need for sub-metering.	
ENRB02-2 Instrumentation for Variable Refrigerant Flow (VRF) System	
Provision of permanent measuring instruments for monitoring of the energy performance of the Variable Refrigerant Flow (VRF) condensing units and air-distribution systems. The installed instrumentation must have the capability to calculate the resultant system efficiency within 10% uncertainty. Each measurement system shall include sensors, any signal conditioning, data acquisition system and the wiring connecting these components. The measurement systems provided shall also comply with the following requirement: (a) All data logging with capability to trend at 5-minute sampling time interval, and recorded to the 3rd decimal digit; (b) Building management system (BMS), standalone energy monitoring system (EMS) shall have capability to compute and display of the overall system energy efficiency and to facilitate data extraction for verification purpose.	Instrumentation for VRF systems which serve an aggregate conditioned floor areas of 2000 m^2 or more

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SUSTAINABILITY ATTRIBUTES	APPLICABILITY & SCOPE
(c) Dedicated power meters (of IEC Class 1 or better) and metering current transformers (of Class 1 or better) where applicable, are to be provided for all condensing units of the VRF system and air-distribution sub-systems (i.e. AHUs, PAHUs, FCUs [see note 6]).	
ENRB03 Real Time Remote Monitoring of Chiller Plant System Operation	
Facilitate real time diagnostic and monitoring of chiller plant system operation with the provision of web-based control system with remote access functionality.	Energy measurement and management
ENRB04 Energy Utilisation Reporting	
Encourage monitoring of the building energy consumption trend over time and review of energy efficiency measures and improvement plan.	Energy use trending and improvement
ENRB05 Indoor Temperature	
Minimise incidences of overcooling and energy wastage by ensuring that the normal dry-bulb temperature for indoor spaces is maintained at 23°C and above.	Indoor air temperature
ENRB06 Indoor Air Quality (IAQ) Audit	
Facilitate improvement on indoor environmental quality by way of a post-retrofit IAQ audit. The audit shall be conducted by an accredited laboratory under Singapore Accreditation Council with respect to the recommended IAQ parameters and acceptable limits stated in Table 1 of *SS554: 2016 Code of Practice for Indoor Air Quality for Air-Conditioned Buildings* or in Annex E of NEA's *Guidelines for Good Indoor Air Quality in Office Premises*	Indoor air quality

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3. Carbon Reduction Measures

3.1 Environmental Sustainability Indicators

A suite of environmental sustainability indicators in relation to carbon reduction measures is provided as elective options for selection. These elective options are broadly classified to three sections as detailed in the following chart :

1

Sustainable Features

encourages incorporation of cost effective green features and passive strategies when building upgrade so as to minimise the overall building energy consumption and to improve on indoor thermal comfort.

2

Sustainable Operation and Management

facilitates smart monitoring and integration of sustainability management practices to maximise operational efficiency and carbon reduction opportunities.

3

Sustainable Technologies

encourages the provision of green technology that is oriented towards establishing low energy building consumption and smart control systems that could adapt to the users' needs and facilitate better building performance management.

A selection of three (3) elective options appropriate for the building development from the suite of environmental sustainability indicators provided in Table 3.1.1 will be required. There must be one option from each section (namely Sustainable Features, Sustainable Operation and Management and Sustainable Technologies) as part of the requirement to meet the minimum environmental sustainability standard.

Table 3.1.1 – Base Requirements for Existing Non-Residential Buildings

1 Sustainable Features

encourages incorporation of cost effective green features and passive strategies when building upgrade so as to minimise the overall building energy consumption and to improve on indoor thermal comfort.

SUSTAINABILITY INDICATORS	APPLICABILITY & SCOPE
ENRBE01-1 Building Envelope Enhancement	
Enhance building envelope performance to minimise heat gain to internal spaces for better indoor thermal comfort with any of the following provisions : (a) Façade design with Envelope Thermal Transmittance Value (ETTV) of no more than 40 W/m^2. (b) Application of cool paints that are certified by an approved local product certification body for 80% of the east and west facing external wall and/or roof areas. Note (1) The selected paint system must meet the allowable limits set for daylight reflectance as required under the Approved Document. (c) Provision of innovative façade technology or solutions such as the use of electrochromic glass, integration of photovoltaic modules, parametric façade and so on for at least 20% of the façade areas.	Building envelope
ENRBE01-2 Natural Ventilation Strategies	
Reduce energy demand for cooling and ventilation by way of enhanced provision of naturally ventilated spaces by at least 5% of the applicable areas.	Naturally ventilated occupied spaces and common areas
ENRBE01-3 Sustainable Products	
Encourage the specification and use of environmentally friendly products that are certified with Environmental Product Declaration (EPD) requirements or two-ticks rating by an approved local certification body. The provision shall include at least three (3) products for 80% of applicable areas or building components.	Building products mechanical and electrical products

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Table 3.1.1 – Base Requirements for Existing Non-Residential Buildings – Cont'd

2 Sustainable Operation and Management

facilitates smart monitoring and integration of sustainability management practices to maximise operational efficiency and carbon reduction opportunities.

SUSTAINABILITY INDICATORS	APPLICABILITY & SCOPE
ENRBE02-1 Electrical Sub-Metering for Major Energy Use	
Facilitate measurement and monitoring of major energy end uses for energy management and audit. Separate sub-meters shall be provided and linked to a monitoring system that can measure and trend energy consumption data of the following systems:	Energy measurement and management of other energy systems when upgrade

Sub-System for Metering	
Lifts and escalators	More than 5 numbers or sets or with sum of all feeders > 50 kVA.
Mechanical Ventilation Systems	Total subsystem's load > 15 kW Sub-metering applicable to individual fan system motors that are more than 1.5 kW in the following areas • Normally Occupied Spaces • M & E Plant Rooms • Carparks
Centralised hot water supply system	> 50 kW thermal heating capacity
General power supply and lighting systems for tenancy areas and owners' premises	Sub-metering for tenancy areas and owners' premises are to be separated. The sub-circuits serving these areas can be provided based on sub-system basis and /or per floor level. If there is a need to cater to high plug loads or process loads exceeding 50 kVA in areas such as manufacturing, carpark, data centre, EV charging stations, please provide separate sub-metering for these specific areas to better manage the energy consumption, where relevant.

Note (2) : The provision of sub-metering for chiller plant systems and VRF system are covered under ENRB02.

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SUSTAINABILITY INDICATORS	APPLICABILITY & SCOPE
ENRBE02-2 Maintenance of Building Cooling System Performance	
Ensure adequate service clearances so that the building cooling system performance can be maintained after system upgrade. *Service clearances are to be provided as per manufacturers' specification or prescribed standards stated in the following clauses, whichever governs.*	Space requirements for water cooled and air cooled chilled water system provision
ENRBE02-2(a) Chillers	
Access space provisions are as follows : (i) Clear space of 2 m or more at the front of chiller unit piping section for tube maintenance and cleaning, repair and replacement of bigger components; (ii) Clearance of 1.2 m or more between the chillers measured from plinth to plinth for regular maintenance; and (iii) Overhead service clearance of 1.5 m or more above the chiller for overhaul maintenance.	Chillers
ENRBE02-2(b) Pump Systems	
Access space provisions are as follows : (i) Except for the areas where the pipes are connected, a clearance of 0.6 m or more is to be provided round the pump for regular maintenance; and (ii) Clear head room space of 1 m or more above the pump and motor to facilitate overhaul maintenance or replacement.	Chilled water pumps (CHWP) and condensers water pumps (CWP)
ENRBE02-2(c) Cooling Towers	
Maintenance provisions are as follows : (i) Provision of maintenance platform, stairs and catwalks of 600 mm width or more with handrails around the cooling towers and access to the level for periodic maintenance, inspection of water basin and fill media; and (ii) Clear space of 2 m or more from the top of cooling towers to location of the trellis, where applicable. Note (3) : Proper clearances on all sides of the cooling tower should be provided in accordance with manufacturer's technical recommendation to ensure the heat rejection performance of cooling towers is not affected or should not be less than the lateral width of the cooling tower, whichever governs.	Cooling towers

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ENRBE02-2(d) Air-Distribution Systems	
Air handling units (AHU) of cooling capacity greater than 35 kW shall be floor mounted as stipulated in SS 553. The access space provisions are as follows : (i) AHU access – Provide minimum 1m clear space from the AHU room door entrance to the AHU for general maintenance ; (ii) Cooling coil pipe and filter access – Provide minimum 800 mm clear space after pipe connection to facilitate cooling coil cleaning and filter access; (iii) Fan access – Provide minimum 800 mm clear space for fan/motor access and maintenance (if the access is not from cooling coil connection side); and (iv) AHU side and back clearance – Provide minimum 600 mm clear space for general access and maintenance.	Floor mounted AHUs
ENRBE02-3 User Engagement Plan	
Encourage the provision of user engagement plan and strategies that facilitate users' involvement and contribution in reducing the overall carbon footprint. It should have a combination of minimum two strategic approaches such as sustainability related activities, educational programmes, green fit-out guidelines, green lease or incentives for tenants meeting measurable outcome.	Approaches adopted must have users' involvement

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Table 3.1.1 – Base Requirements for Existing Non-Residential Buildings – Cont'd

3 Sustainable Technologies

encourages the provision of green technology that is oriented towards establishing low energy building consumption and smart control systems that could adapt to the users' needs and facilitate better building performance management.

SUSTAINABILITY INDICATORS	APPLICABILITY & SCOPE
ENRBE03-1 Renewable Energy System	
Encourage the use of on-site renewable energy sources to reduce the use of electricity by at least 1% of the expected total building electricity consumption.	Solar photovoltaic system
ENRBE03-2 Smart Building Solutions	
Encourage the provision of minimum three (3) building solutions which facilitates some form of automation and controls over building systems for better energy management and thermal comfort as listed below. (a) Use of BACnet, Modbus or any other open protocol as the network backbone of the building management system where data points can be used to facilitate communication and integration with other building systems. (b) Energy management system, applications and dashboard that help building owners and/or tenants to better manage their energy consumption in an intuitive manner (c) Demand controlled ventilation system such as carbon dioxide sensors or devices to regulate the fresh air intake and ventilation based on occupants' need. (d) Timer sensors/controls for lighting and ventilation systems in common areas and facilities (e) Differential pressure monitoring equipment in Air Handling Units (AHUs) (f) Others (to be evaluated on a case to case basis)	Building solutions that facilitate energy management and controls

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Table 3.1.1 – Base Requirements for Existing Non-Residential Buildings – Cont'd

3 Sustainable Technologies

encourages the provision of green technology that is oriented towards establishing low energy building consumption and smart control systems that could adapt to the users' needs and facilitate better building performance management.

SUSTAINABILITY INDICATORS	APPLICABILITY & SCOPE
ENRBE03-3 Green Building Technologies	
Encourage the adoption of low-carbon solutions and technologies which help minimise energy consumption. Examples of the systems that can be considered are as follows : • Energy recovery system • Lifts with regenerative function • Passive displacement ventilation system • Hybrid cooling system • Smart sensor and control technologies • Dedicated outdoor air system • Others (to be evaluated on a case to case basis)	Building and sensor related technologies

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Summary of Key Changes to the Requirements under the Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)

Criteria Ref	Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)
	General The minimum environmental sustainability standard can be met by meeting the stipulated requirements which is deemed to meet 50 points as required. There is a total of seven requirements/conditions covering that need to be fulfilled for regulatory compliance and as follows. P1 – Energy Consumption Monitoring P2 – Air Conditioning System Minimum Operating Efficiency P3 – Energy Improvement on Lighting System P4 – Water Consumption Monitoring P5 – Chiller Plant Measurement and Verification (M&V) Instrument P6 – Indoor Temperature P7 – Indoor Air Quality (IAQ) Surveillance Audit		**General** The minimum environmental sustainability standard (equivalent 50 points) shall have a level of environmental performance that meets all relevant base requirements and a selected number of sustainability indicators provided under Elective Options The Elective Options are broadly grouped in 3 Sections namely Section 1 – Sustainable Features Section 2 – Sustainable Operation and Management Section 3 – Sustainable Technologies NON-RESIDENTIAL BUILDINGS 6 Base Requirements 3 Carbon reduction measures in total with one measure from each of the three sections under Sustainable features, Sustainable Operation and Management and Sustainable Technologies *Note that there are sub-clauses under the Base Requirements for non-residential buildings - 6 sub-clauses that are to be complied with, where relevant.*

Criteria Ref	Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)
Code requirements		**Part 1 – Base Requirements**	
P2	**Air Conditioning System Minimum Operating Efficiency** (i) For Buildings using Water-cooled Chilled-water Plant • Water-Cooled Chiller • Chiller-Water Pump • Condenser Water Pump • Cooling Tower **Baseline** — **Building Cooling Load (RT)**: **< 500** / **≥500** — **Minimum Efficiency (kW/RT)** Minimum Design System Efficiency (DSE) for central chilled-water plant: 0.8 / 0.75 (ii) For Buildings using Air-cooled Chilled-water Plant or Unitary Air-Conditioner • Air-Cooled Chiller i. Air-Cooled Chiller ii. Chilled Water Pump • Unitary Air-Conditioners i. Variable Refrigerant Flow (VRF) system ii. Single-Split Units iii. Multi-Split Units **Baseline** — **Building Cooling Load (RT)**: **< 500** / **≥500** — **Minimum Efficiency (kW/RT)** Pre-requisite Requirement Minimum Design System Efficiency (DSE) for: 1.1 / 1.0	ENRB01-2(a)	**Building Energy Performance** The compliance with the energy performance that meet minimum energy improvements of 40% over 2005 baseline *(that is 20% energy savings over prevailing Singapore Standard and baseline) by way of energy audit methodology or the respective performance standards set out below.* **Air-Conditioning System** (i) Water-Cooled Building Cooling System • Water-Cooled Chiller; • Chilled-Water Pump; • Condenser Water Pump; • Cooling Tower; and • Air-Distribution System **Total Design System Efficiency (TDSE) for Water-Cooled Building Cooling System** Existing Buildings with Major Energy Use Change 0.9 kW/RT Where the minimum energy performance standard set for water-cooled chilled water plant efficiency is 0.63kW/RT. (ii) Air-Cooled Building Cooling System • Unitary Air-Conditioners (Single or combination of systems) ○ Variable Refrigerant Flow (VRF) system ○ Single – Spilt Units ○ Multi-Spilt Units ○ Air-Distribution System

<table>
<tr><th>Criteria Ref</th><th>Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)</th><th>Criteria Ref</th><th>Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)</th></tr>
<tr><td></td><td></td><td></td><td>

Air-Cooled Chilled-Water System can be adopted in relation to existing building development with inherent constraints and with peak building cooling load of not more than 500 RT

Air-Cooled Chiller
Chilled Water Pump
Air-Distribution System

<table>
<tr><th>Total Design System Efficiency (TDSE) for Air-Cooled Building Cooling System</th></tr>
<tr><td>New and Existing Buildings with New Extension or Major Retrofits</td></tr>
<tr><td>1.0 kW/RT</td></tr>
</table>
where minimum energy performance standards for different building cooling systems are as follows :
<table>
<tr><th colspan="2">Minimum Air-Conditioning System Efficiency η_c</th></tr>
<tr><th>Unitary System (Outdoor Condenser Units)</th><th>Air-Cooled Chilled Water Plant</th></tr>
<tr><td>0.78 kW/RT (inclusive of 20% site deration factor)</td><td>0.85 kW/RT</td></tr>
</table>
Note:
(1) Total Design System Efficiency (TDSE) refers to combined design system efficiency of the chiller plant or condenser units and air distribution systems.
(2) The TDSE can be adjusted to allow for pressure drop adjustments for fan system where there is a need for more allowance due to functionality and activities as per recommended by SS 553 – Table 2b.
(3) Where there is a combination of water cooled and air-cooled building cooling system, the respective TDSEs are to be complied with.
</td></tr>
</table>

<table>
<tr><th>Criteria Ref</th><th>Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)</th><th>Criteria Ref</th><th>Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)</th></tr>
<tr><td></td><td></td><td></td><td>(4) Energy Audit Approach can be used as the methodology used for compliance. It will entail the need to establish the average EUI for past three years before retrofits begin. The expected EUI could be derived by considering the potential energy savings from the retrofits. For compliance, the expected EUI is required to meet the stipulated EUI for the same building category and the air-conditioning provision shall have a minimum total system efficiency TSE of 0.9 kW/RT during operation.</td></tr>
<tr><td>P3</td><td>Artificial Lighting

To encourage the use of energy efficient lighting to minimise energy consumption from lighting usage while maintaining proper lighting level.

To demonstrate at least 20% improvement in the lighting power budget for common areas over the baseline stated in the table below.
<table>
<tr><th>Type of Usage</th><th>Maximum Lighting Power Budget (W/m^2)</th></tr>
<tr><td>Offices</td><td>15</td></tr>
<tr><td>Classrooms</td><td>15</td></tr>
<tr><td>Hotel guest room</td><td>15</td></tr>
<tr><td>Lecture theatres</td><td>15</td></tr>
<tr><td>Auditoriums / Concert halls</td><td>10</td></tr>
<tr><td>Shops / Supermarkets / Departmental stores (including general, accent & display lighting)</td><td>25</td></tr>
<tr><td>Restaurants</td><td>15</td></tr>
<tr><td>Lobbies / Atrium / Concourse</td><td>10</td></tr>
<tr><td>Stairs</td><td>6</td></tr>
<tr><td>Corridors</td><td>10</td></tr>
<tr><td>Toilets</td><td>15</td></tr>
<tr><td>Car parks</td><td>5</td></tr>
<tr><td>Electronic Manufacturing and fine detail / Assembly industries</td><td>20</td></tr>
<tr><td>Medium and heavy industries</td><td>15</td></tr>
<tr><td>Warehouses / Storage areas</td><td>10</td></tr>
</table></td><td>NRB01-2(b)</td><td>Lighting System

Reduce energy required to illuminate interior spaces with proper lighting level. The lighting provision shall be at least 40% more energy efficient than the prescribed lighting power budget stated in SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment.

Note: The energy improvements will be accounted based on SS 530 instead of the prescribed standard shown in current Code.</td></tr>
</table>

Criteria Ref	Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)
	Note : No requirement on mechanical ventilation under Current Code	ENRB01-2(c)	**Mechanical Ventilation System** Reduce energy required to supply and distribute fresh air within the space by having energy efficient mechanical ventilation system and controls. (i) Provision of mechanical ventilation system of at least 10% more energy efficient than the prescribed standard stated in SS 553 for normally occupied spaces that utilise mechanical ventilation as the preferred ventilation mode (ii) Provision of Carbon Monoxide (CO) detection sensor control with Variable Speed Drive (VSD) to regulate demand for mechanical ventilation in carpark areas. *Note:* *(1) There is a minimum energy improvement of 10% over baseline stipulated in SS 553 which is applicable only to the normally occupied spaces and carpark areas.* *(2) Only applicable if there is a replacement of the mechanical ventilation system.*
	Note : No requirement on vertical transportation system under Current Code	ENRB 01-2(d)	**Vertical Transportation System** Reduce energy consumption by providing energy efficient vertical transportation systems that are equipped with variable voltage variable frequency (VVVF) drives and sleep mode features. *Note: Only applicable if there is a replacement of the lift and escalator*
P5	**Measurement and Instrumentation Requirements for water cooled chilled water air conditioning system** To provide permanent measuring instruments for monitoring of chilled water system operating efficiency. The installed instrumentation shall have the capability to calculate the resultant operating system efficiency (i.e. kW/RT) within 5% of its true value and in accordance with SS 591. Each measurement system shall	ENRB02-1	**Measurement and Verification (M & V) Instrumentation** **Instrumentation for Chilled Water Air-Conditioning System** Provision of permanent measuring instruments for monitoring of the energy performance of the chilled water plants and air distribution systems. The installed instrumentation must have the capability to calculate the resultant system efficiency within 5% of its true value in accordance with

Criteria Ref	Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)
	include the sensor(s), any signal conditioning, the data acquisition system and wiring connecting these components.		SS 591: 2013. Each measurement system shall include sensors, any signal conditioning, data acquisition system and the wiring connecting these components. The permanent measuring instruments and devices are to be accessible[see note (5)] and should not be located directly above the chillers, to facilitate verification and maintenance. They must be installed in accordance with the manufacturers' recommendation and SS 591: 2013. The measurement systems provided shall also comply with the following requirement: (a) All data logging with capability to trend at 1-minute sampling time interval, and recorded to the 3rd decimal digit; (b) Building management system (BMS), standalone energy monitoring system (EMS) shall have capability to compute and display of key indicators including total system energy efficiency and its component (water-side and air-side efficiency) as well as the calculated heat balance of the chilled water system; (c) Magnetic in-line flow meter, with 1% uncertainty and capable of electronic in-situ verification to within ±2% of its original factory calibration. If installation of magnetic in-line meters is not possible, ultrasonic flow meters or other flow meters that can meet the indicated performance may be used; (d) Temperature sensors are to be provided for chilled water and condenser water loop and shall have an end-to-end measurement uncertainly within ±0.05°C over the entire measurement range. Each temperature measurement location shall have test-plugs or additional thermowells located before and after each temperature sensor along the chilled water and condenser water lines for verification of measurement accuracy. All thermo-wells shall be installed in a manner that enables the sensors to be in direct contact with fluid flow; and (e) Dedicated power meters (of IEC Class 1 or better) and metering current transformers (of Class 1 or better) where applicable, are to be provided for each of the following groups of equipment where applicable: chillers, chilled water pumps, condenser water pumps,

Criteria Ref	Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)
			cooling towers, air-distribution sub-system (i.e. AHUs, PAHUs, FCUs). (f) A heat balance substantiating test for the chilled water system is to be computed in accordance to SS 591 for verification of the accuracy of the M & V instrumentation. To meet the accuracy requirement, more than 80% of the heat balance (%) derived over the entire normal operating hours is to be within 5% for a period of one (1) week. *Note :* *(1) The temperature sensors are best placed in an accessible location with mounting height of not more than 3m, where possible. Otherwise, there should be evidence of provision for access by way of mobile platform or other suitable form.* *(2) It is a new requirement to have dedicated power meters to be provided for air-distribution sub-systems (that is AHUs, PAHUs, FCUs). In the case of FCUs, if submetering cannot be provided, the evidences of way of nameplate motors can be considered.*
	Note : No requirement on VRF system under Current Code	ENRB02-2	**Instrumentation for Variable Refrigerant Flow (VRF) system** Provision of permanent measuring instruments for monitoring of the energy performance of the Variable Refrigerant Flow (VRF) condensing units and air-distribution systems. The installed instrumentation must have the capability to calculate the resultant system efficiency within 10% uncertainty. Each measurement system shall include sensors, any signal conditioning, data acquisition system and the wiring connecting these components.

Criteria Ref	Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)
			The measurement systems provided shall also comply with the following requirement: (a) All data logging with capability to trend at 5-minute sampling time interval, and recorded to the 3rd decimal digit; (b) Building management system (BMS), standalone energy monitoring system (EMS) shall have capability to compute and display of the overall system energy efficiency and to facilitate data extraction for verification purpose; and (c) Dedicated power meters (of IEC Class 1 or better) and metering current transformers (of Class 1 or better) where applicable, are to be provided for all condensing units of the VRF system and air-distribution sub-systems (i.e. AHUs, PAHUs, FCUs). *Note : This is a new requirement to cover instrumentation for VRF system for better energy monitoring. It is only applicable if the VRF system serve an aggregate conditioned floor areas of 2000 m^2 or more.*
	Note: No requirement on real time remote monitoring of chiller plant system operation	ENRB03	**Real Time Remote Monitoring of Chiller Plant System Operation** Facilitate real time diagnostic and monitoring of chiller plant system operation with the provision of web-based control system with remote access functionality.
P1	**Energy Consumption Monitoring** To compute and monitor the building's Energy Use Intensity (EUI) for the past 3 years and review its energy efficiency improvement plan, where necessary	ENRB04	**Energy Utilisation Reporting** Encourage monitoring of building energy consumption trend over the past 3 years and review of energy efficiency improvement plan and measures. *Note: This is similar to current Code*

Criteria Ref	Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)
P6	**Indoor Temperature** To maintain the indoor dry-bulb temperature at 23°C and above to prevent overcooling	ENRB05	**Indoor Temperature** Minimise incidences of overcooling and energy wastage by ensuring that the normal dry-bulb temperature for indoor spaces is maintained at 23°C and above. *Note: This is the same as current Code*
P7	**Indoor Air Quality (IAQ) Surveillance Audit** To conduct an IAQ surveillance audit once every 3 years. The audit shall be conducted by an accredited laboratory under Singapore Accreditation Council with respect to the recommended IAQ parameters and acceptable limits stated in Table 1 of *SS554: 2016 Code of Practice for Indoor Air Quality for Air-Conditioned Buildings* or in Annex E of NEA's *Guidelines for Good Indoor Air Quality in Office Premises.*	ENRB06	**Indoor Air Quality (IAQ) Audit** Facilitate improvement on indoor environmental quality by way of a post-retrofit IAQ audit. The audit shall be conducted by an accredited laboratory under Singapore Accreditation Council with respect to the recommended IAQ parameters and acceptable limits stated in Table 1 of *SS554: 2016 Code of Practice for Indoor Air Quality for Air-Conditioned Buildings* or in Annex E of NEA's *Guidelines for Good Indoor Air Quality in Office Premises* *Note: This is the same as current Code*
		Part 2 – Elective Options Under Section 1 : Sustainable Design Strategies	
	Note : No requirement on Building Envelope Enhancement under current Code	ENRBE01-1	**Building Envelope Enhancement** Enhance building envelope performance to minimise heat gain to internal spaces for better indoor thermal comfort with any of the following provisions : (a) Façade design with Envelope Thermal Transmittance Value (ETTV) of no more than 40 W/m^2. (b) Application of cool paints that are certified by an approved local product certification body for 80% of the east and west facing external wall and/or roof areas. Note (1) The selected paint system must meet the allowable limits set for daylight reflectance as required under the Approved Document. (c) Provision of innovative façade technology or solutions such as the use of electrochromic glass, integration of photovoltaic modules, parametric façade and so on for at least 20% of the façade areas.

Criteria Ref	Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)
	Note : No requirement on Natural Ventilation Strategies under current Code	ENRBE01-2	**Natural Ventilation Strategies** Reduce energy demand for cooling and ventilation by way of enhanced provision of naturally ventilated spaces by at least 5% of the applicable areas. *Note: Applicable to occupied spaces and common areas*
	Note : No requirement on Sustainable Products under current Code	ENRBE01-3	**Sustainable Products** Encourage the specification and use of environmentally friendly products that are certified with Environmental Product Declaration (EPD) requirements or two-ticks rating by an approved local certification body. The provision shall include at least five (5) products for 80% of applicable areas or building components. *Note: Applicable to building products / Mechanical and Electrical products*
		Part 2 – Elective Options Under Section 2 : Sustainable Operation and Management	
	Note : No requirement on Electrical Sub-Metering for Major Energy Use under current Code	ENRBE02-1	**Electrical Sub-Metering for Major Energy Use** Facilitate measurement and monitoring of major energy end uses for energy management and audit. Separate sub-meters shall be provided and linked to a monitoring system that can measure and trend energy consumption data of the following systems: Sub-System for Metering Lifts and escalators: More than 5 numbers or sets or with sum of all feeders > 50 kVA. Mechanical Ventilation Systems: Total subsystem's load > 15 kW

Criteria Ref	Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)	
				Sub-metering applicable to individual fan system motors that are more than 1.5 kW in the following areas • Normally Occupied Spaces • M & E Plant Rooms • Carparks
			Centralised hot water supply system	> 50 kW thermal heating capacity
			General power supply and lighting systems for tenancy areas and owners' premises	Sub-metering for tenancy areas and owners' premises are to be separated. The sub-circuits serving these areas can be provided based on sub-system basis and /or per floor level. If there is a need to cater to high plug loads or process loads exceeding 50 kVA in areas such as manufacturing, carpark, data centre, EV charging stations, please provide separate sub-metering for these specific areas to better manage the energy consumption, where relevant.
			Note (2) : The provision of sub-metering for chiller plant systems and VRF system are covered under ENRB02.	

Criteria Ref	Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)
	Note : No requirement on maintainability provision under current Code	ENRBE02-2	**Maintenance of Building Cooling System Performance** Ensure adequate service clearances so that the building cooling system performance can be maintained after system upgrade. *Service clearances are to be provided as per manufacturers' specification or prescribed standards stated in the following clauses, whichever governs.* Access space provisions are as follows: 1. *Chillers* a. Clear space of 2 m or more at the front of chiller unit piping section for tube maintenance and cleaning, repair and replacement of bigger components; b. Clearance of 1.2 m or more between the chillers measured from plinth to plinth for regular maintenance; and c. Overhead service clearance of 1.5 m or more above the chiller for overhaul maintenance. 2. Pump systems a. Except for the areas where the pipes are connected, a clearance of 0.6 m or more is to be provided round the pump for regular maintenance; and b. Clear head room space of 1 m or more above the pump and motor to facilitate overhaul maintenance or replacement. 3. Cooling Towers a. Provision of maintenance platform, stairs and catwalks of 600 mm width or more with handrails around the cooling towers and access to the level for periodic maintenance, inspection of water basin and fill media; and b. Clear space of 2 m or more from the top of cooling towers to location of the trellis, where applicable. 4. Air handling units (AHU) of cooling capacity greater than 35kW (shall be floor mounted as stipulated in SS 553) a. AHU access – Provide minimum 1m clear space from the AHU room door entrance to the AHU for general maintenance ;

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			b. Cooling coil pipe and filter access – Provide minimum 800 mm clear space after pipe connection to facilitate cooling coil cleaning and filter access; c. Fan access – Provide minimum 800 mm clear space for fan/motor access and maintenance (if the access is not from cooling coil connection side); and d. AHU side and back clearance – Provide minimum 600 mm clear space for general access and maintenance.
	Note : No requirement on user engagement plan under current Code	ENRBE02-3	**User Engagement Plan** Encourage the provision of user engagement plan and strategies that facilitate users' involvement and contribution in reducing the overall carbon footprint. It should have a combination of minimum two strategic approaches such as sustainability related activities, educational programmes, green fit-out guidelines, green lease or incentives for tenants meeting measurable outcome. *Note: Users' involvement is required.*
		Part 2 – Elective Options Under Section 3 : Sustainable Technologies	
	Note : No requirement on renewable energy system under current Code	ENRBE03-1	**Renewable Energy System** Encourage the use of on-site renewable energy sources to reduce the use of electricity by at least 1% of the expected total building electricity consumption

Criteria Ref	Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)
	Note : No requirement on smart building solutions under current Code	ENRBE03-2	**Smart Building Solutions** Encourage the provision of minimum two (2) building solutions which facilitates some form of automation and controls over building systems for better energy management and thermal comfort as listed below. (a) Use of BACnet, Modbus or any other open protocol as the network backbone of the building management system where data points can be used to facilitate communication and integration with other building systems. (b) Energy management system, applications and dashboard that help building owners and/or tenants to better manage their energy consumption in an intuitive manner (c) Demand controlled ventilation system such as carbon dioxide sensors or devices to regulate the fresh air intake and ventilation based on occupants' need. (d) Timer sensors/controls for lighting and ventilation systems in common areas and facilities (e) Differential pressure monitoring equipment in Air Handling Units (AHUs) (f) Others (to be evaluated on a case to case basis)
	Note : No requirement on green building technologies under current Code	ENRBE03-3	**Green Building Technologies** Encourage the adoption of low-carbon solutions and technologies which help minimise energy consumption. Examples of the systems that can be considered are as follows : • Energy recovery system • Lifts with regenerative function • Passive displacement ventilation system • Hybrid cooling system • Smart sensor and control technologies • Dedicated outdoor air system • Others (to be evaluated on a case to case basis)