Building and Construction Authority

We shape a **safe**, **high quality**, **sustainable** and **friendly** built environment.

Our Ref. : BCA BC 15.0.3

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18 October 2011

See Distribution

Dear Sir/Madam

CONSULTATION ON PROPOSED REGULATORY MEASURES TO RAISE ENVIRONMENTAL SUSTAINABILITY STANDARDS FOR BUILDINGS

In the Sustainable Development Blueprint 2009, the Government announced the vision for Singapore's environmental sustainability in the next 20 years. One of the initiatives is to achieve at least 80% of the building stock to meet Green Mark standards.

2 In 2008, BCA implemented the Building Control (Environmental Sustainability) Regulations which requires **new** developments to achieve a minimum Green Mark (GM) score of 50.

3 However, this measure for new developments alone is not sufficient to greatly improve the sustainability of our built environment. Today, more than 90% of our existing building stock is built prior to the implementation of the Building Control (Environmental Sustainability) Regulations. There is therefore tremendous scope to make improvements to their energy efficiencies to pave the way for greening our built environment, leading to a significant reduction in greenhouse gas emissions for Singapore. To encourage building owners to do so, BCA has, since 2009, put in place a $100m incentive for retrofitting existing buildings to be more energy efficient.

4 It is timely to introduce some regulatory measures to guide owners of existing buildings to improve the minimum environmental sustainability standards of existing buildings. BCA would like to seek your comments on the following proposed regulatory requirements.

a) Mandatory submission of energy consumption and energy-related building data by utilities companies and building owners.

b) Regulatory requirement to meet the prescribed Green Mark standards for **all** buildings undergoing installation/replacement of their cooling systems.

c) Mandatory three-yearly audit of the operational system efficiency of the cooling systems for all new and retrofitted existing buildings.

5 The details of the proposal can be found in the consultation paper enclosed herein.

6 We would appreciate it if your comments/views could reach us before **30 November 2011**. You may send your feedback to us in email or snail mail to the following contacts. **Please provide your name, organisation (if you are representing one) and contact for clarification if necessary**.

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CONSULTATION PAPER
PROPOSED REGULATORY MEASURES TO RAISE ENVIRONMENTAL SUSTAINABILITY STANDARDS FOR BUILDINGS

Aim

The purpose of this paper is to consult on the following.

a) Proposed mandatory submission of energy consumption and energy-related building data by utilities companies and building owners.

b) Proposed regulatory requirement to meet the prescribed Green Mark standards for buildings undergoing installation/replacement of their cooling systems.

c) Proposed mandatory three-yearly audit of the operational system efficiency of the cooling systems for all new and retrofitted existing buildings.

Background

2 In the Sustainable Development Blueprint 2009, the Government announced the vision for Singapore's environmental sustainability in the next 20 years. One of the initiatives is to achieve at least 80% of the building stock to meet Green Mark standards.

3 In 2008, BCA implemented the Building Control (Environmental Sustainability) Regulations which requires new developments to achieve a minimum Green Mark (GM) score of 50.

4 However, this measure for new developments alone is not sufficient to greatly improve the sustainability of our built environment. Today, more than 90% of our existing building stock is built prior to the implementation of the Building Control (Environmental Sustainability) Regulations. There is therefore tremendous scope to make improvements to their energy efficiencies to pave the way for greening our built environment, leading to a significant reduction in greenhouse gas emissions for Singapore. To encourage building owners to do so, BCA has, since 2009, put in place a $100m incentive for retrofitting existing buildings to be more energy efficient.

Proposed Mandatory Submission of Annual Building Energy Consumption by Utilities Suppliers and Building Owners

Who will be affected?

5 Utilities suppliers and building owners (excluding owners of industrial buildings or dwelling units).

Purpose of Legislative Requirements

6 The data will form the basis of the national energy benchmarks, which BCA will share with building owners so that they can pro-actively improve the energy performance of their buildings. With availability of the data, BCA will also be able to monitor energy consumption patterns and measure the effectiveness of various initiatives that have been adopted to improve energy efficiency.

Legislative Details

7 The proposed regulatory measure will require the **submission of electricity consumption data** of all buildings (excluding industrial buildings and dwelling units) **on an annual basis**. Primarily, such information will be obtained from the utility suppliers. This will drastically reduce the need for building owners themselves to submit the data individually and separately to BCA.

8 The proposed regulation will also require owners of all buildings (excluding industrial buildings and dwelling units) **to provide basic building information** such as the gross floor area (GFA), building activity and building systems (e.g. air-conditioning and lighting systems) over an online portal set up for this purpose (see types of information required at **Annex A**). This will be conducted in phases starting with commercial buildings (namely office, hotel and retail buildings). The regulation will also require owners of selected buildings to provide more detailed information to support a comprehensive study on energy efficiency of the building stock. Owners of these selected buildings will be notified by way of a notice to provide the specific information within a prescribed duration.

Proposed Minimum Green Mark Standards for Buildings undergoing Installation/Replacement of Cooling Systems

Who will be affected?

9 In the initial phase, the regulatory requirements to meet minimum Green Mark Standards will apply to any building of the following building types whose gross floor area (GFA) is 15,000m^2 or more and is installing/replacing a water-cooled or air-cooled chiller system –

a) Hotel;

b) Retail buildings; and

c) Office buildings.

10 It is expected that there would be about 1,000 buildings that will fall within this initial phase.

Purpose of Legislative Requirements

11 The installation/replacement of the building cooling system is an extensive and costly building work. It is thus timely and important for building owners to relook at their existing building design and make improvements to this as well as other parts of the buildings to achieve greater energy savings going forward.

Legislative Details

12 The proposed regulatory measure will require buildings owners who intend to install/replace their building cooling systems **to comply with a minimum standard which is equivalent to Green Mark (Existing Non-Residential Buildings) (GM(ENRB)) version 3 at Certified level (i.e. achieving at least 50 points)**. Buildings which are required to meet this minimum standard are to score at least 30 points in the energy efficiency section and at least a total of 20 points in the other green requirements. In addition, the buildings must achieve minimum specified design system efficiency (DSE) for the cooling system used. The details of the proposed GM(ENRB) version 3 standards are at **Annex B**.

13 The standards will also require the installation of permanent measurement and verification instrumentation to monitor the energy efficiency of the central air-conditioning system.

14 To comply with this requirement, the building owner will need to **engage a Qualified Technical Person (QTP)** to look into the overall building design, propose any additional necessary retrofitting measure if necessary, and ensure that the overall performance of the building can achieve at least Green Mark 50 points. The retrofitted design, drawings, computations and Green mark score must be submitted to BCA and approved before the commencement of the retrofitting works.

15 The owners must ensure that the **retrofitting works are carried out and completed within three years** from the date of the submission of the design score to BCA. Upon completion of the works, the QTP is required to submit the as-built score (which must achieve at least 50 points) to BCA including the conduct of the first audit on its cooling system to ensure that its operational system efficiency (OSE) is within 5% tolerance of the minimum DSE required.

16 A QTP will be registered with BCA or an accrediting body. He must:

a) Have a minimum of five (5) years experience in chiller plant design; **AND**

b) Have completed and passed the Certificate Course on Measurement and verification of Central Chilled-Water Plant currently available at BCA Academy; **AND**

c) Have completed and passed the Green Mark Professional Module on Energy Management & Audit (currently named) **OR** the Singapore Certified Energy Manager Module on Energy Measurement & Appraisal (currently named) currently available at BCA Academy, Sustainable Energy Association of Singapore (SEAS) and IES Academy; **AND**

d) Be a Key Qualified Person certified under the Singapore ESCO Accreditation Scheme **OR** a Professional Engineer registered with the Professional Engineers Board in the field of mechanical engineering.

Proposed Mandatory Three-Yearly Audit of Building Cooling Systems

Who will be affected?

17 The following buildings will be affected by this requirement.

a) Buildings which have undergone retrofitting to comply with the minimum standard equivalent to GM(ENRB) version 3 Certified Level; and

b) New hotels, retail buildings and office buildings with centralised chilled-water building cooling system which are required to comply with the enhanced Green Mark standards for new buildings implemented on 1 December 2010.

Purpose of Legislative Requirements

18 Cooling systems typically account for 30-50% of a building's total energy consumption. While buildings may be designed to have energy efficient cooling systems, operating these systems at an optimum performance level is critical to ensuring that there will be real energy savings for the same usage load in the building.

Legislative Details

19 It is important that buildings, after being designed with efficient energy performance, will continue to be operated efficiently. The proposed regulatory measure will require owners of the following buildings **to conduct regular audits on the building cooling systems** to ensure that the operational energy efficiency is within a 5% tolerance of the minimum DSE required:

a) Buildings which have undergone retrofitting to comply with GM(ENRB) version 3 standards, as mentioned in **para 9 –**

i) for these buildings, owners will have to conduct their first OSE together with the submission of the as-built Green Mark score (which should be not less than 50 points) upon completion of the retrofitting works; and

ii) thereafter, owners are to conduct regular OSE audits, in at least 3 yearly intervals from their last audits, upon the receipt of notices from BCA.

b) New hotels, retail buildings and office buildings with centralised chilled-water building cooling system which are required to comply with the enhanced Green Mark standards for new buildings implemented on 1 December 2010 –

i) for these buildings, owners will have to conduct their first OSE within one year from the date of the first TOP/CSC (whichever is earlier); and

ii) thereafter, owners are to conduct regular OSE audits, in at least 3 yearly intervals from the last audits, upon the receipt of notices from BCA.

20 The details of the proposed OSE audits are at **Annex C**. A QTP must be engaged to conduct the OSE audits.

21 The above measure is expected to have minimal cost impact as building owners would have put in place permanent instrumentation when they build their new buildings or retrofit their buildings to meet minimum GM(ENRB) version 3 standards. The instrumentation installed will allow them to monitor their cooling system efficiencies in a cost-effective manner.

22 Compulsory audits on the other aspects of the building (e.g. lighting system, water fittings and waste management systems) will not be necessary.

For Comments

23 BCA would like to seek your comments on the above proposal. Comments and views from individuals are also welcome.

BCA Green Mark Criteria for Existing Non-Residential Buildings

Summary of Main Changes

The BCA Green Mark Criteria for Existing Non-Residential Buildings Version 2.1 will be revised to achieve greater energy and resource efficiency building development. The proposed changes include the following:

1. **Transition from Energy Savings/EEI to Building System Efficiency Approach**

   The proposed Version 3 criteria place more emphasis and focus on building system energy efficiency for point scoring. The previous pre-requisite energy criteria based on EEI, or Option A -Demonstrate 10% energy savings over the last three years (against own historical baseline) or Option C-based on committed energy savings over the next three years of 10% savings, has been removed. The new scoring approach will be based on the percentage improvement of the respective building system, versus the code baseline in year 2005.

2. **Maximum Cap of 50 points no longer applicable**

   The cap of 50 points for both Energy Related Requirement and other Green Requirement will be removed to encourage the design team to explore more energy or resource efficient options.

3. **Pre-requisite Requirement to attain Green Mark Certification**

   - Minimum 30 points obtained from Part 1 Energy Efficiency and minimum 20 points from other Green Requirement (Part 2 to Part 5)
   - Minimum air-conditioned system efficiency of 0.75 kW/ton for cooling load of more than 500 tons
   - Minimum air-conditioned system efficiency of 0.85 kW/ton for cooling load of 500 tons or less
   - Permanent Instrumentation for monitoring of chilled water plant operating system efficiency & heat balance
   - Water consumption monitoring
   - All water fittings are at least “Good” rating under PUB’s Water Efficient Labelling Scheme, or equivalent water efficiency flow rate
   - In house IAQ audit yearly

4. **Additional Pre-requisite Requirement to attain Green Mark Gold, Gold^{Plus} and Platinum rating**

   For Green Mark Gold Rating
   - Minimum air-conditioned system efficiency of 0.70 kW/ton for cooling load of more than 500 tons
   - Minimum air-conditioned system efficiency of 0.80 kW/ton for cooling load of 500 tons or less

   For Green Mark Gold^{Plus} Rating
   - Minimum air-conditioned system efficiency of 0.68 kW/ton for cooling load of more than 500 tons
   - Minimum air-conditioned system efficiency of 0.75 kW/ton for cooling load of 500 tons or less

   For Green Mark Platinum Rating
   - Minimum air-conditioned system efficiency of 0.65 kW/ton for cooling load of more than 500 tons
   - Minimum air-conditioned system efficiency of 0.70 kW/ton for cooling load of 500 tons or less

5. Enhance the scoring and weightage of the following criteria

- Better scoring for Artificial Lighting and Renewable Energy. Refer to Part 1-3 & 1-9
- Better scoring on having PUB Water Efficient Building Certificate and Alternative water sources. Refer to Part 2-2 & 2-3
- Extend the in-house building management team to GMFM & GMP. Refer to Part 3-1(c)
- Better scoring on conducting Post Occupancy Evaluation, provision of recycling bins and sustainable products. Refer to Part 3-2(a), 3-3(a) and 3-4
- Better scoring on Greenery Provision (GnP). Refer to Part 3-5(a)
- Better facilities for provision of bicycle parking lots: sheltered lots with adequate shower and changing facilities. Refer to Part 3-7
- Better scoring for compliance of illuminance (lux) level and controllability of lighting system. Refer to Part 4-3 (a) & (b)
- Better scoring for Thermal comfort conditions. Refer to Part 4-5

6. New inclusion

- Thermal Performance of Buildings Envelope, ETTV. Refer to Part 1-1
- Air distribution system of air conditioning system. Refer to Part 1-2(c)
- Provision of permanent measuring instruments, Heat Balance, Provision of variable speed controls for chiller plant equipment. Refer to Part 1-2(d), (e) & (f)
- Ventilation in Car parks & Common Areas. Refer to Part 1-4 & 1-5
- Energy efficient equipments certified by approved local certification body. Refer to Part 1-7(b)
- Water consumption monitoring of the buildings on monthly basis. Refer to Part 2-1(a)
- Irrigation System and Landscaping. Refer to Part 2-5(a) & (b)
- Cooling Towers. Refer to Part 2-6(b)
- Provision of roof top greenery and vertical greenery. Refer to Part 3-5(c) & (d)
- Provision of covered walkway to facilitate connectivity and use of public transport. Refer to Part 3-7(c)
- Provision of hybrid/electric vehicle parking lot with recharging facilities. Refer to Part 3-7(d)
- Implement effective IAQ management plan. Refer to Part 4-1(b)
- Use of high efficiency air filter. Refer to Part 4-1(c)
- At least one room temperature & Relative Humidity sensor display per air-con zone. Refer to Part 4-1(d)
- At least one carbon dioxide sensor display per air-con zone. Refer to Part 4-1(e)
- Use of low volatile organic compounds (VOC) paints. & environmental friendly adhesives. Refer to Part 4-2(a) & (b)

7. Specific Details

The specific details of the criteria and changes are listed as follows:

Document Ref	Description
Annex B-1	BCA Green Mark Criteria for Existing Non-Residential Building (Draft Version 3.0 for comment only)
Annex B-2	Comparison between Current BCA Green Mark Criteria for Existing Non-Residential Buildings (Ver 2.1) and the Revised Draft Criteria (Ver 3.0)

You may refer to http://www.bca.gov.sg/GreenMark/green_mark_criteria.html to download the current BCA Green Mark Criteria for Existing Non-Residential Buildings (Version 2.1)

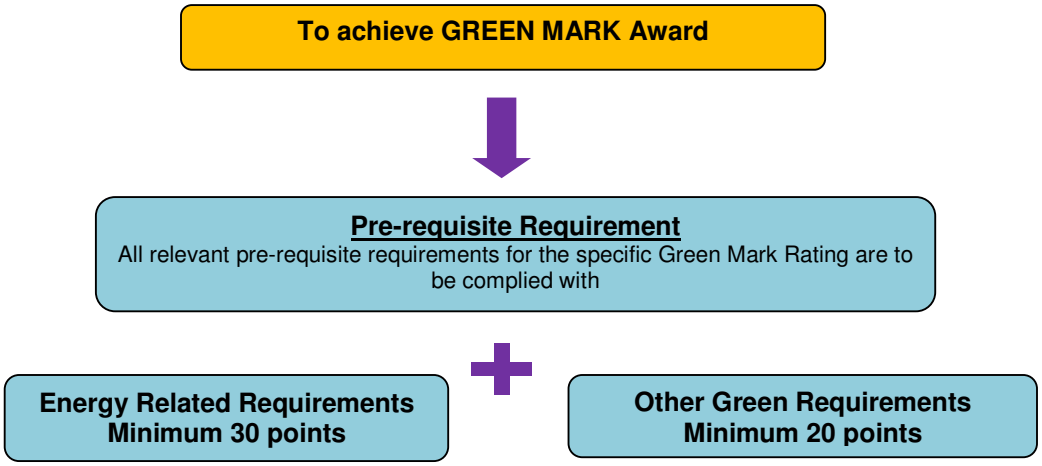
BCA Green Mark for Existing Non-Residential Buildings

ENRB Version 3.0

DRAFT for Comments

Oct 2011

Framework – BCA Green Mark for Existing Non-Residential Buildings (version 3.0)



Part 1 - Energy Efficiency

1-1 Thermal Performance of Building Envelope
1-2 System Energy Efficiency
1-3 Artificial Lighting
1-4 Ventilation in Carparks
1-5 Ventilation in Common Areas
1-6 Lifts and Escalators
1-7 Energy Efficient Practices & Feature
1-8 Energy Policy & Management
1-9 Renewable Energy

Part 2 - Water Efficiency

2-1 Water Monitoring
2-2 Water Efficient Fittings
2-3 Alternative Water Sources
2-4 Water Efficiency Improvement Plans
2-5 Irrigation System and Landscaping
2-6 Cooling Towers

Part 3 – Sustainable Operation & Management

3-1 Building Operation & Maintenance
3-2 Post Occupancy Evaluation
3-3 Waste Management
3-4 Sustainable Products
3-5 Greenery
3-6 Environmental Protection
3-7 Green Transport

Part 4 - Indoor Environmental Quality

4-1 Indoor Air Quality Performance
4-2 Indoor Air Pollutants
4-3 Lighting Quality
4-4 Thermal Comfort
4-5 Internal Noise Level

Part 5 – Other Green Features

5-1 Green Features & Innovations

POINT ALLOCATION – BCA Green Mark for Existing Non-Residential Buildings (Version 3.0)

	ASSESSMENT CRITERIA	POINT ALLOCATIONS
ENERGY EFFICIENCY		
Minimum 30 points to be scored	**Part 1 – Energy Efficiency**	
	1-1 Thermal Performance of Building Envelope	5
	1-2 System Energy Efficiency	32
	1-3 Artificial Lighting	13
	1-4 Ventilation in Carparks	4
	1-5 Ventilation in Common Areas	5
	1-6 Lifts and Escalators	2
	1-7 Energy Efficient Practices & Features	12
	1-8 Energy Policy & Management	1
	1-9 Renewable Energy	15
	SubTotal (Part 1)	**89**
OTHER GREEN REQUIREMENTS		
Minimum 20 points to be scored	**Part 2 - Water Efficiency**	
	2-1 Water Monitoring	3
	2-2 Water Efficient Fittings	12
	2-3 Alternative Water Sources	3
	2-4 Water Efficiency Improvement Plans	1
	2-5 Irrigation System and Landscaping	2
	2-6 Cooling Towers	2
	SubTotal (Part 2)	**23**
	Part 3 - Sustainable Operation & Management	
	3-1 Building Operation & Maintenance	4
	3-2 Post Occupancy Evaluation	3
	3-3 Waste Management	7
	3-4 Sustainable Products	8
	3-5 Greenery	10
	3-6 Environmental Protection	3
	3-7 Green Transport	4
	SubTotal (Part 3)	**39**
	Part 4 - Indoor Environmental Quality	
	4-1 Indoor Air Quality Performance	8
	4-2 Indoor Air Pollutants	2
	4-3 Lighting Quality	5
	4-4 Thermal Comfort	2
	4-5 Internal Noise Level	1
	SubTotal (Part 4)	**18**
	Part 5 – Other Green Features	
	5-1 Green Features & Innovations	10
	SubTotal (Part 5)	**10**
	SubTotal (Part 2 to Part 5)	**90**
	Total Green Mark Score	**179**

Green Mark Award Rating

BCA Green Mark Award Rating and Pre-requisite Requirements

Green Mark Score	Green Mark Rating
90 and above	Green Mark Platinum
85 to <90	Green Mark Gold^{Plus}
75 to <85	Green Mark Gold
50 to <75	Green Mark Certified

Pre-requisite Requirements for Existing Non-residential Building Criteria

PART 1 - ENERGY EFFICIENCY

1. ENERGY EFFICIENCY

Green Mark Rating	Minimum points achievement from Part 1 – Energy Efficiency	OR	Minimum percentage of energy saving better than energy efficiency standard in 2005 Code through energy modeling simulation
Green Mark Certified	30 points		25%
Green Mark Gold	35 points		28%
Green mark Gold^{Plus}	40 points		32%
Green Mark Platinum	45 points		36%

2. MINIMUM SYSTEMS' EFFICIENCY

Minimum Design System Efficiency/Operating System Efficiency (DSE/OSE)

(i) For buildings using Water-Cooled Chilled-Water Plant

Green Mark Rating	Peak Building Cooling Load (RT)	
	< 500	≥ 500
	Efficiency (kW/RT)	
Certified	0.85	0.75
Gold	0.80	0.70
Gold^{Plus}	0.75	0.68
Platinum	0.70	0.65

(ii) For Buildings using Air Cooled Chilled-water Plant or Unitary Air-Conditioner

Green Mark Rating	Peak Building Cooling Load (RT)	
	< 500	≥ 500
	Effic ency (kW/RT)	
Certified	1.1	1.0
Gold	1.0	Not applicable
Gold^{Plus}	0.85	
Platinum	0.78	

For building with peak building cooling load of more than 500 RT, the use of air cooled central chilled-water plant or other unitary air-conditioners are not applicable for Gold and higher ratings.

Note: The performance of the overall air-conditioning system for the building is based on the Operating System Efficiency (OSE) of the system during the normal building operating hours as defined below:

Office Building: Monday to Friday: 9am to 6pm Saturday: 9am to 11am Retail Mall: Monday to Sunday: 10am to 9pm Institutional: Monday to Friday: 9am to 5pm	Hotel and Hospital: 24-hour Industrial and Other Building Types: To be determined based on the operating hours

3. CHILLER PLANT M&V INSTRUMENTATION

(i) Provision of permanent measuring instruments for monitoring of water-cooled chilled-water system and air-cooled chilled water system operating system efficiency. The installed instrumentation shall have the capability to calculate resultant plant operating system efficiency (i.e. kW/RT) within 5% of its true value and in accordance with ASHRAE Guide 22 and AHRI 550/590. Heat balance test for water-cooled chilled-water system is required for verification of the accuracy of the M&V instrumentation.

4. **NATURAL VENTILATION AREA**:

Pre requisite requirement for Platinum - At least 75% of natural ventilated areas with effective cross ventilation and north and south facing window opening

PART 2 - WATER EFFICIENCY

(i) Water consumption monitoring**.[1 point]** (to comply with section 2-1(a))

(ii) All fittings are at least "Good" rating under PUB's Water Efficient Labelling Scheme, or adopt equivalent water efficiency flow-rate. **[6 points]** (section 2-2)

PART 3 - SUSTAINABLE OPERATION & MANAGEMENT

(i) Post Occupancy Evaluation **– [3 points]** (to comply with section 3-2)

(ii) Waste Management **– [4 points]** [to comply with section 3-3(a & b)]

PART 4 - INDOOR ENVIRONMENTAL QUALITY

1. IAQ Audit
   (i) to conduct an IAQ audit yearly that complies with NEA's Guidelines for Good Indoor Air Quality in Office Premises or SS554:2009 Code of Practice for `Indoor air quality for air-conditioned buildings' **[4 points]** [to comply with section 4-1(a)]

2. Illuminance (lux) level to comply with SS531 or CP 38 for various uses. The indoor dry-bulb temperature shall be within 22.5 ℃ to 25.5 ℃ and the relative humidity <70%. **[2 points]** [to comply with section 4-3(a) & 4-4(a)]

Energy Related Requirements

Part 1 - Energy Efficiency (Total Points: 89)	Green Mark Points
1-1 Thermal Performance of Building Envelope Enhance the overall thermal performance of building envelope to minimize heat gain thus reducing the overall cooling load requirement.	0.5 points for every reduction of 1 W/m2 in ETTV from the baseline of 50 W/m^2 Point scored = 0.5 x (50 – ETTV) (Up to 5 points)
1-2 System Energy Efficiency (a) Air-Conditioning System Encourage the use of better efficiency air-conditioned equipment to minimize the energy consumption. (System efficiency in kW/ton) The systems to be considered are as follows – (i) Water-Cooled Chilled-Water Plant: a) Water-Cooled Chiller b) Chilled water pump c) Condenser water pump d) Cooling tower Note: For buildings using district cooling system, there is no need to compute the plant efficiency under Part 1-2 (a) and (b). The points obtained will be pro-rated based on the air distribution system efficiency under Part 1-2(c) **OR** (ii) 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 Unit ▪ Multi-Spilt Unit Note: Where there is a combination of centralised air-con system with unitary air-conditioned system, the computation for the points scored will only be based on the air-conditioning system with a larger aggregate capacity.	(i) Water-Cooled Chilled-Water Plant If peak building cooling load ⩾ 500RT **14 points for achieving plant efficiency of 0.75 kW/ton** 0.35 point for every percentage improvement in the chiller plant efficiency better than 0.75 kW/ton Point scored = 0.35 x (% improvement) If peak building cooling load < 500RT **14 points for achieving plant efficiency of 0.85 kW/ton** 0.3 point for every percentage improvement in the chiller plant efficiency better than 0.85 kW/ton Point scored = 0.3 x (% improvement) (Up to 20 points) **OR** (ii) Air-Cooled Chilled-Water Plant/Unitary Air Conditioners Peak building cooling load ⩾ 500RT **14 points for achieving plant efficiency of 1.0 kW/ton** 0.25 point for every percentage improvement in the chiller plant efficiency better than 1.0 kW/ton Point scored = 0.25 x (% improvement) Peak building cooling load < 500RT **14 points for achieving plant efficiency of 1.1 kW/ton** 0.2 point for every percentage improvement in the chiller plant efficiency better than 1.1

	kW/ton Point scored = 0.2 x (% improvement) (Up to 20 points)
(iii) Air Distribution system: • Air Handling Units (AHUs) • Fan Coil Units (FCUs) Baseline – Fan power limitation in air conditioning system Allowable nameplate motor power Constant volume: 0.47 W/CMH Variable volume: 0.74 W/CMH	(iii) Air Distribution System 0.15 Point for every percentage improvement in the air distribution system efficiency over the baseline Point scored = 0.15 x (% improvement) (Up to 8 points)
(iv) Provision of permanent measuring instruments for monitoring of water-cooled chilled-water plant and air-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 550/590. The following instrumentation and installation are also required to be complied with: • Location and installation of the measuring devices to meet the manufacturer's recommendation. • Data acquisition system to have a minimum resolution of 16 bit. • All data logging with capability to trend at 1 minute sampling time interval. • Flow meters to be provided for chilled-water and condenser water loop and shall be of ultrasonic / full bore magnetic type or equivalent. • Temperature sensors with minimum accuracy of 0.05 ℃ @ 0℃. All thermo-wells shall be installed in a manner which 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.	1 points
(v) Verification of central water cooled chilled-water plant instrumentation: Heat Balance – substantiating test for water cooled chilled-water plant to be computed in accordance with AHRI 550/590. The operating system efficiency and heat balance to be submitted to BCA upon commissioning.	1 point
(vi) Provision of variable speed controls for chiller plant equipment such as chilled-water pumps and cooling tower fans to ensure better part-load plant efficiency.	1 point
(vii) Sensors or similar automatic control devices are used to regulate outdoor air flow rate to maintain	1 point

<table>
<tr>
<td>the concentration of carbon dioxide.

(b) Mechanical Ventilation System
Power Budget (W/m2) for the mechanical ventilation system should be calculated
<table>
<tr><th colspan="2">Allowable nameplate motor power</th></tr>
<tr><td>Constant volume</td><td>Variable volume</td></tr>
<tr><td>0.47 W/CMH</td><td>0.74 W/CMH</td></tr>
</table>
(c) Natural Ventilation System
Encourage building that facilitates good natural ventilation.
(i) Proper design of building layout that utilises prevailing wind conditions to achieve adequate cross ventilation.

Note: Where there is a combination of (a), (b) and (c), the points awarded will be pro-rated according to the floor area(excluding common areas such as carparks, toilets, staircase)</td>
<td>0.6 point for every subsequent 1% improvement from the baseline
(Up to 32 points)

20 based points will be awarded for use of natural ventilation

1.6 points for every 10% of NV areas with window openings facing north and south directions and cross ventilation
(Up to 32 points)</td>
</tr>
<tr>
<td>1-3 Artificial Lighting

Encourage the use of energy efficient lighting to minimize energy consumption from lighting usage while maintaining proper lighting level.

Please refer to the Annex 1 for the baselines of lighting power budget</td>
<td>0.3 point for every percentage improvement in lighting power budget

Point scored = 0.3 x (% improvement)

(Up to 13 points)

Excluding tenant lighting provision – Up to 5 points)</td>
</tr>
<tr>
<td>1-4 Ventilation in Carparks

Encourage the use of energy efficient design and control of ventilation systems in carparks.

(a) Carparks designed with natural ventilation.
(b) CO sensors are used to regulate the demand for mechanical ventilation (MV)

Note: Where there is a combination of different ventilation mode adopted for carpark design, the points obtained will be prorated accordingly.</td>
<td>Naturally ventilated carparks – 4 points

Points scored based on the mode of mechanical ventilation provided

Fume extract – 2.5 points
MV with or without supply – 2 points

(Up to 4 points)</td>
</tr>
<tr>
<td>1-5 Ventilation in Common Areas

Encourage the use of energy efficient of ventilation systems in the following common areas:
(a) Toilets
(b) Staircases
(c) Corridors
(d) Lift lobbies
(e) Atrium</td>
<td>Extent of Coverage: At least 90% of each applicable area

Point scored based on the mode of ventilation provided in the applicable areas

Natural ventilation – 1.5 points for each area
Mechanical ventilation – 0.5 point for each area

(Up to 5 points)</td>
</tr>
<tr>
<td>1-6 Lifts and Escalators

Encourage the use of energy efficient lifts and escalators.

Lifts and/or escalators with AC variable voltage and variable frequency (VVVF) motor drive and sleep mode features.</td>
<td>Extent of Coverage: All lifts and escalators

Lifts – 1 point
Escalators- 1 point</td>
</tr>
</table>

<table>
<tr>
<td>1-7 Energy Efficient Practices & Features

Encourage the use of energy efficient practices and features which are innovative and/or have positive environmental impact.

(a) Computation of the energy consumption in the form of energy efficiency index (EEI)

(b) Use of energy efficiency equipment that are certified by approved local certification body

(c) Use of energy efficient features
Example:
• Re-generative lift
• Lifts with gearless drive
• Heat recovery system
• Sun pipes
• Light shelves
• Photocell sensors to maximize the use of daylight
• Heat pumps, etc.</td>
<td>

1 point

0.5 point for each equipment type
(Up to 2 point)

2 points for every 1% energy saving over the total building energy consumption

(Up to 11 points for item (b) & (c)))</td>
</tr>
<tr>
<td>1-8 Energy Policy and Management

(a) Energy policy, energy targets and regular review with top management’s commitment as part of an environmental strategy

(b) To show intent, measures and implementation strategies of energy efficiency improvement plans to achieve energy target set over the next three years. Committed energy savings accrued from proposed measures should be quantified.</td>
<td>

0.5 point

0.5 point</td>
</tr>
<tr>
<td>1-9 Renewable Energy

Encourage the application of renewable energy sources in buildings.</td>
<td>Point scored based on the expected energy efficiency index (EEI) and % replacement of electricity by renewable energy source
<table>
<tr><th rowspan="2">Energy Efficiency Index (EEI)</th><th colspan="2">Every 1% replacement of electricity (based on total electricity consumption) by renewable energy source</th></tr>
<tr><th>Include tenant’s usage</th><th>Exclude tenant’s usage</th></tr>
<tr><td>≥ 30 kW//m²/yr</td><td>5 points</td><td>3 points</td></tr>
<tr><td>< 30 kW//m²/yr</td><td>3 points</td><td>1.5 oints</td></tr>
</table>
(Up to 15 points)</td>
</tr>
</table>

Other Green Requirements

<table>
<tr><th>Part 2 - Water Efficiency (Total Points: 23)</th><th>Green Mark Points</th></tr>
<tr><td>2-1 Water Monitoring

Provide private-metering and leak detection system for better control and monitoring.

(a) To monitor the water consumption on monthly basis

(b) Provision of private-meters for major water uses (e.g. cooling tower, water features, irrigation, swimming pools, tenants' usage)

(c) Linking all private-meters to the Building Management System (BMS) for leak detection</td><td>

1 point

1 point

1 point</td></tr>
<tr><td>2-2 Water Efficient Fittings

Encourage the use of water efficient fittings under Water Efficiency Labelling Scheme (WELS) or adopt equivalent water efficient flow-rate/flush volumes for water fittings:-
▪ Basin taps and mixers
▪ Showers
▪ Sink/Bib taps and mixers
▪ Urinals
▪ Other water efficient fittings

Or

To have PUB Water-Efficient Building Certificate</td><td>Rating based on Water Efficiency Labeling Scheme (WELS)
<table><tr><td>Very Good</td><td>Excellent</td></tr><tr><td colspan="2">Weightage</td></tr><tr><td>9</td><td>12</td></tr></table>Points scored based on the number and water efficiency rating of the fitting type used

(up to 12 points)

Note: All water fittings under WELS "Good" rating or equivalent water flow-rate would be entitled to 6 points

9 points</td></tr>
<tr><td>2-3 Alternative Water Sources

Use of suitable systems that utilize alternative water sources for non-potable uses: irrigation, washing, water features, toilet flushing, etc (excluding cooling tower make up water) to reduce use of potable water. Alternative sources can include rainwater, greywater (for toilet flushing only), NEWater, AHU condensate and recycled water from approved sources.</td><td>Points awarded based on % reduction in potable water usage of the applicable uses

> 50 % - 3 points
< 10 % to 50 % - 2 point
< 10 % - 1 point

(Up to 3 points)</td></tr>
<tr><td>2-4 Water Efficiency Improvement Plans

Targets to improve building water performance against own building water performance baseline should be set. To show intent, measures and implementation strategies of water efficiency improvement plans over the next three years. Committed water savings accrued from proposed measures should be quantified. (PUB water efficiency management plan is acceptable as evidence)</td><td>1 points</td></tr>
<tr><td>2-5 Irrigation System and Landscaping</td><td></td></tr>
</table>

(a) Use of automatic water efficient irrigation system with rain sensor, soil moisture sensor or equivalent control system. (b) Use of drought tolerant plants that require minimal irrigation.	Extent of Coverage: At least 50% of the landscape areas are served by the system 1 point Extent of Coverage: At least 50% of the landscape areas 1 point
2-6 Cooling Towers Reduce potable water use for cooling purpose. (a) Use of cooling tower water treatment system which can achieve 7 or better cycles of concentration at acceptable water quality. (b) Use of NEWater or on-site recycled water from approved sources.	 1 point 1 point

Part 3 - Sustainable Operation & Management (Total Points: 40)	**Green Mark Points**
3-1 Building Operation & Maintenance (a) The environmental policy that reflects the sustainability goals set. (b) A green guide for the occupants or visitors should be disseminated through various channels. Best practices to reduce energy use, water use and maintain a good indoor environment should be documented in this green guide. To demonstrate evidences of occupant involvement in environmental sustainability. (c) In-house building management team comprises one Certified Green Mark Facilities Manager (GMFM), Green Mark Manager (GMM), Singapore Certified Energy Manager (SCEM) or Green Mark Professional (GMP). (d) The environmental management system of the building is ISO14000 or ISO 50001 certified.	 1 point 1 point 0.5 point for certified GMM 0.5 point for certified GMFM 1 point for certified GMP or SCEM (Up to 1 point) 1 point
3-2 Post Occupancy Evaluation (a) Conduct post occupancy survey for occupant's satisfaction on energy and environmental performance. Required number of people surveyed shall be - 10% of total occupancy and up to 100 maximum. - minimum 5 people shall be surveyed If total occupancy is less than 50. (b) List of corrective actions taken following the post	 2 point 1 point

<table>
<tr><td>occupancy evaluation, if any.</td><td></td></tr>
<tr><td>3-3 Waste Management

• Provision of facilities or recycling bins for collection and storage of different recyclable waste such as paper, glass, plastic food waste, etc.

• Promote and encourage waste minimization and recycling among occupants, tenants and visitors through various avenues

• Provide the proper storage area for the waste

• Engage the recycling company to quantify, monitor and recycle of a large range of waste generated in-house. Types of waste recycled:
1. Glass waste
2. Paper waste
3. Metal waste (including drink cans)
4. Plastic waste
5. Other wastes – e.g. Printer cartridges, used electronic equipment, food waste</td><td>2 point

2 point

1 points

2 points</td></tr>
<tr><td>3-4 Sustainable Products

Promote use of environmentally friendly products that are certified by approved local certification body and are applicable to non-structural and architectural related building components.</td><td>Weightage based on the extent of environmental friendliness of products

Good | Very Good | Excellent
1 | 1.5 | 2</td><td>Points scored based on the weightage and the extent of coverage & impact

1 point for high impact item
0.5 point for low impact item

(Up to 8 points)</td></tr>
<tr><td>3-5 Greenery
Encourage greater use of greenery, restoration of trees to reduce heat island effect.

(a) Greenery Provision (GnP) is calculated by considering the 3D volume covered by plants using the following Green Area Index (GAI) :
Grass GAI = 1 ; Shrubs GAI = 3; Palms Trees GAI = 4; Trees GAI = 6

(b) Use of compost recycled from horticulture waste.

(c) Provision of roof top greenery

(d) Provision of Vertical Greenery</td><td>GnP = 0.5 to < 1.0 - 1 point
GnP = 1.0 to < 2 - 2 point
GnP = 2 to < 3.0 - 3.5 points
GnP ≥ 3.0 - 5 points
(Up to 5 points)

1 point

For roof top greenery areas
≥20% and 50% of useable roof areas 1 point
≥ 50% of useable roof areas 2 points

Vertical greenery areas of
≥10m2 and <50m2 1 point
≥ 50m2 2 points</td><td></td></tr>
</table>

3-6 Environmental Protection	
(a) Green procurement policy – Adoption of sustainable and environmental-friendly procurement and purchasing policy in the operation and maintenance of the building.	1 point
(b) Reduce the potential damage to the ozone layer and the increase in global warming through the release of ozone depleting substances and greenhouse gases.	
• Refrigerants with ozone depletion potential (ODP) of zero or with global warming potential (GWP) of less than 100.	1 point
▪ Use of refrigerant leak detection system at critical areas of plant rooms containing chillers and other equipments with refrigerants.	1 point
3-7 Green Transport	
Promote the use of public transport or bicycles to reduce pollution from individual car use with the following provision:	
(a) Good access to nearest MRT/LRT or bus stops.	1 point
(b) Provision of covered walkway to facilitate connectivity and the use of public transport	1 point
(c) Provision of hybrid/electric vehicle refuelling/recharge stations and priority parking lots within the development	1 point
(d) Provision of sheltered bicycle parking lots with adequate shower and changing facilities.	1 point

Part 4 – Indoor Environmental Quality (Total Points: 19)	Green Mark Points
4-1 Indoor Air Quality Performance To promote a healthy indoor environment. (a) To conduct full IAQ audit once in three years that complies with Guidelines for Good Indoor Air Quality in Office Premises or SS554:2009 Code of Practice for `Indoor air quality for air-conditioned buildings' by a accredited laboratory under Singapore Accreditation Council. (b) Implement effective IAQ management plan to ensure building ventilation systems are frequently maintained to ensure clean delivery of air. Internal surface condition testing for ACMV systems to be included. (c) Use of high efficiency air filter (at least MERV 13) in AHU to reduce indoor contaminants and provide good protection for cooling coil and reducing frequency or eliminating duct cleaning (d) Room Temperature & Relative Humidity sensor display (at least 1 unit per zone) (e) Additional carbon dioxide sensor display (at least 1 unit per zone)	4 points 1 point 1 point 1 point 1 point
4-2 Indoor Air Pollutants Minimise airborne contaminants, mainly from inside sources to promote a healthy indoor environment. (a) Use of low volatile organic compounds (VOC) paints certified by approved local certification body. (b) Use of environmental friendly adhesives certified by approved local certification body.	1 point 1 point
4-3 Lighting Quality To encourage good workplace lighting quality to promote productivity and occupant comfort (i) Lighting level to comply with SS531 or CP38 for various uses. (ii) Controllability of lighting system	1 point At least 90% of occupants are able to adjust lighting control to suit their task needs and preference Controlled by light switches - 1 point Controlled by task lights - 2 point

	(Up to 2 point)
(iii) High frequency ballast	All applicable areas in the entire building that are served by fluorescent luminaries 20% to < 40% - 0.5 point 40% to < 60% - 1 point 60% to < 80% - 1.5 points 80% and above - 2 points (Up to 2 points)
4-4 Thermal Comfort (a) Ensure the consistent indoor conditions for thermal comfort: Indoor dry-bulb temperature within 22.5 ℃ to 25.5 ℃ and relative humidity <70% (b) Controllability of temperature	1 point 1 point
4-5 Internal Noise Level Ensure internal noise level are maintained at an appropriate levels and to comply with SS553:2009	1 point

Part 5 – Other Green Features (Total Points: 10)	Green Mark Points
5-1 Green Features and Innovations To encourage the use of other green features which are innovative or/and have positive environmental impact. Examples : • Green Mark for Office Interior certificate • Green Lease • Ultraviolet light-C band (UV) emitters in all air handling units (AHUs) to improve indoor air quality • Provision of carpark guidance system • Use of self cleaning façade system • Use of grey water recycling system • Recycling of AHU condensate • Use of non-chemical termite treatment system such as termite baiting system • Titanium Dioxide solutions to remove odour in toilets • Use of pneumatic waste collection system • Use of double refuse chutes for separating recyclable from non-recyclable waste • Stormwater management	2 points for high impact item 1 point for medium impact item 0.5 point for low impact item (Up to 10 Bonus Points)

Annex 1: Maximum lighting power budget (including ballast loss)

Type of usage	Maximum lighting power budget (W/m2)
Offices	15
Classrooms	15
Hotel guest room	15
Lecture theatres	15
Auditoriums / Concert halls	10
Shops / Supermarkets / Departmental stores (including general, accent & display lighting)	25
Restaurants	15
Lobbies / Atriums / Concourse	10
Stairs	10
Corridors	10
Car parks	5
Electronic manufacturing and fine detail / Assembly industries	20
Medium and heavy industries	15
Warehouses / Storage areas	10

Existing Non-Residential Building Criteria

Pre-requisite requirements

Criteria	Version 2.1	Version 3.0
Part 1 – Energy Efficiency	<u>For Green Mark Certified level</u> Option A Demonstrate 10% energy savings over the last three years (against own historical baseline) Option B Top 50th percentile in building energy performance i.e. EEI of 215 kWh/m^2/year for office buildings EEI of 420 kWh/m^2/year for hotel buildings EEI of 479 kWh/m^2/year for retail malls Option C Committed energy savings over the next three years of 10% savings (against own historical baseline) **For Green Mark Gold** ▪ Offices, Hotels and Retail Malls - To achieve the following Energy Efficiency Index (EEI) i.e. EEI of 205 kWh/m^2/year for office buildings EEI of 404 kWh/m^2/year for hotel buildings EEI of 459 kWh/m^2/year for retail malls ▪ Other Building Types - Demonstrate 15% energy savings over last three years **For Green Mark Gold^{Plus}** ▪ Offices, Hotels and Retail Malls - To achieve the following Energy Efficiency Index (EEI) i.e. EEI of 177 kWh/m2/yr for office buildings EEI of 368 kWh/m2/yr for hotels EEI of 421 kWh/m2/yr for retail malls ▪ Other Building Types - Demonstrate 30% energy savings over last three years ▪ Air-conditioning system efficiency is ≤ 0.75 kW/RT. **For Green Mark Platinum** ▪ Offices, Hotels and Retail Malls - To achieve the following Energy Efficiency Index (EEI) i.e. EEI of 154 kWh/m2/yr for office buildings	<table><tr><th>Green Mark Rating</th><th>Minimum points achievement from Part 1 – Energy Efficiency</th></tr><tr><td>Green Mark Certified</td><td>30 points</td></tr><tr><td>Green Mark Gold</td><td>35 points</td></tr><tr><td>Green mark Gold^{Plus}</td><td>40 points</td></tr><tr><td>Green Mark Platinum</td><td>45 points</td></tr></table>

<table>
<tr>
<td></td>
<td>EEI of 333 kWh/m2/yr for hotels
EEI of 384 kWh/m2/yr for retail malls

▪ Other Building Types - Demonstrate 35% energy savings over last three years
▪ Air-conditioning system efficiency is ≤ 0.7 kW/RT.</td>
<td></td>
</tr>
<tr>
<td>Part 1 – Energy Efficiency: minimum system efficiency</td>
<td>Air con plant efficiency ≤ 0.9 kW/ton (measured)
Unitary air-conditioners efficiency ≥ 2.4 COP</td>
<td>(i) buildings using Water-Cooled Chilled-Water Plant
<table>
<tr><th rowspan="2">Green Mark Rating</th><th colspan="2">Peak Building Cooling Load (RT)</th></tr>
<tr><th>< 500</th><th>≥ 500</th></tr>
<tr><th></th><th colspan="2">Efficiency (kW/RT</th></tr>
<tr><td>Certified</td><td>0.85</td><td>0 75</td></tr>
<tr><td>old</td><td>0.80</td><td>0.70</td></tr>
<tr><td>Gold^{Plus}</td><td>0.75</td><td>0.68</td></tr>
<tr><td>Platinum</td><td>0.70</td><td>0.65</td></tr>
</table>
(ii) For Buildings using Air Cooled Chilled-water Plant or Unitary Air-Conditioner
<table>
<tr><th rowspan="2">Green Mark Rating</th><th colspan="2">Peak Building Cooling Load (RT)</th></tr>
<tr><th>< 500</th><th>≥ 500</th></tr>
<tr><th></th><th colspan="2">Efficiency (kW/RT)</th></tr>
<tr><td>Certified</td><td>1.1</td><td>1.0</td></tr>
<tr><td>Gold</td><td>1.0</td><td rowspan="3">Not applicable</td></tr>
<tr><td>Gold^{Plus}</td><td>0.85</td></tr>
<tr><td>Platinum</td><td>0.78</td></tr>
</table>
</td>
</tr>
<tr>
<td>Part 1 – Permanent measuring instruments for monitoring of water-cooled chilled-water system and air-cooled chilled water system operating system efficiency.</td>
<td></td>
<td>Provision of permanent measuring instruments for monitoring of water-cooled chilled-water system and air-cooled chilled water system operating system efficiency. The installed instrumentation shall have the capability to calculate resultant plant operating system efficiency (i.e. kW/RT) within 5% of its true value and in accordance with ASHRAE Guide 22 and AHRI 550/590.
Heat balance test for water-cooled chilled-water system is required for verification of the accuracy of the M&V instrumentation.</td>
</tr>
</table>

Existing Non-Residential Building Criteria

Part 2 – Water Efficiency	▪ At least 10 points under Water Efficiency for Green Mark GoldPlus ▪ At least 12 points under Water Efficiency for Green Mark Platinum	
Part 2 - Water Efficiency: Water consumption monitoring		To have water consumption monitoring on monthly basis
Part 2 - Water Efficiency: Water efficiency fitting	To achieve PUB's Water Efficient Building Certification	All fittings are at least "Good" rating under PUB's Water Efficient Labelling Scheme, or adopt equivalent water efficiency flow-rate.
Part 3 – Sustainable Operation management: Waste management	▪ Provision of facilities or recycling bins for collection and storage of different recyclable waste • Promote and encourage waste minimization and recycling among occupants, tenants and visitors through various avenues ▪ Engage the recycling company to quantify, monitor and recycle of a large range of waste generated in-house	▪ Provision of facilities or recycling bins for collection and storage of different recyclable waste • Promote and encourage waste minimization and recycling among occupants, tenants and visitors through various avenues

Part 1 – Energy Efficiency		
Criteria	Version 2.1 (Capped at 50 points max)	Version 3.0 (no cap)
1-1 Thermal Performance of Building Envelope	-	0.5 points for every reduction of 1 W/m2 in ETTV from the baseline of 50 W/m^2 (up to 5 points)
1-2 System Energy Efficiency	Water-cooled chilled water plant 7 points for achieving Efficiency of 0.9 kW/ton 1.0 point for every subsequent 0.05 kW/ton improvement from 0.9 kW/ton (cap at 13 points) or Unitary air-conditioners/condensing units: 7 points for achieving Efficiency of 2.4 COP 0.6 point for every subsequent 0.15 COP improvement from 2.4 COP (cap at 13 points).	(a) Air conditioning System (i) Water-Cooled Chilled-Water Plant <u>If peak building cooling load ⩾ 500RT</u> **14 points for achieving plant efficiency of 0.75 kW/ton** 0.35 point for every percentage improvement in the chiller plant efficiency better than 0.75 kW/ton <u>If peak building cooling load < 500RT</u> **14 points for achieving plant efficiency of 0.85 kW/ton** 0.3 point for every percentage improvement in the chiller plant efficiency better than 0.85 kW/ton (Up to 20 points) **OR** (ii) Air-Cooled Chilled-Water Plant/Unitary Air Conditioners <u>Peak building cooling load ⩾ 500RT</u> **14 points for achieving plant efficiency of 1.0 kW/ton** 0.25 point for every percentage improvement in the chiller plant efficiency better than 1.0 kW/ton

		Peak building cooling load < 500RT **14 points for achieving plant efficiency of 1.1 kW/ton** 0.2 point for every percentage improvement in the chiller plant efficiency better than 1.1 kW/ton (Up to 20 points) (iii) Air Distribution System 0.15 Point for every percentage improvement in the air distribution system efficiency over the baseline Point scored = 0.15 x (% improvement) (Up to 8 points) (iv) 1 point for the provision of permanent measuring instruments for monitoring of water-cooled chilled-water plant and air-cooled chilled-water plant efficiency. The installed instrumentation shall have the capability to calculate resultant plant efficiency (i.e. kW/RT) within 5% of its true value and in accordance with ASHRAE Guide 22 and AHRI 550/590. (v) 1 point for Heat Balance substantiating test for water cooled chilled-water plant to be computed in accordance with AHRI 550/590. The operating system efficiency and heat balance to be submitted to BCA upon commissioning. (vi) 1 point for provision of variable speed controls for chiller plant equipment
	7 points for achieving efficiency of 0.47 W/CMH for CAV system and 0.74 W/CMH for VAV system.(cap at 13 points)	(b) Mechanical Ventilation System 0.6 point for every subsequent 1% improvement from the baseline (Up to 32 points)

	Full 13 points will be awarded for the use of 100% natural ventilation	(c) Natural Ventilation System • 20 based points will be awarded for use of natural ventilation • 1.6 points for every 10% of NV areas with window openings facing north and south directions and cross ventilation (Up to 32 points)
1-3 Artificial Lighting	• points for achieving lighting density of 5% better than lighting power budget in SS530 • 0.5 point for every subsequent percentage improvement from baseline lighting density of 5% better than lighting power budget in SS530 (Up to 8 points) • Up to 4 points if tenant lighting provision are excluded	• 0.3 points for every percentage improvement in lighting power budget (up to 13 points) • Up to 4 points if tenant lighting provision are excluded
1-4 Ventilation in Carparks	-	• Naturally ventilated carparks – 4 points • Points scored based on the mode of mechanical ventilation provided with CO sensors control: Fume extract – 2.5 points MV with or without supply – 2 points
1-5 Ventilation in Common Areas	-	• Point scored based on the mode of ventilation provided in the applicable areas • Natural ventilation – 1.5 points for each area • Mechanical ventilation – 0.5 point for each area • Extent of Coverage: At least 90% of each applicable area
1-6 Lifts and Escalators	-	• Lifts and/or escalators with AC variable voltage and variable frequency (VVVF) motor drive and sleep mode features. • Lifts – 1 point • Escalators- 1 point • Extent of Coverage: All lifts and escalators

Existing Non-Residential Building Criteria

<table>
<tr><td>1-7 Energy Efficient Practices & Features</td><td>1 point for every 0.2% replacement of electricity by renewable / clean energy (Up to 10 Bonus Points)</td><td>• 1 point for computation of the energy consumption in the form of energy efficiency index (EEI)
• 0.5 point for each equipment certified by approved local certification body (up to 2 points)
• 2 points for every 1% energy saving over the total building energy consumption
• Up to 11 points for item b & c</td></tr>
<tr><td>1-8 Energy Policy & Management</td><td>• 1 point for setting energy policy, energy targets and regular review with top management's commitment as part of an environmental strategy
• 2 points to show intent, measures and implementation strategies of energy efficiency improvement plans to achieve energy target set over the next three years.</td><td>• 0.5 point for setting energy policy, energy targets and regular review with top management's commitment as part of an environmental strategy
• 0.5 point to show intent, measures and implementation strategies of energy efficiency improvement plans to achieve energy target set over the next three years.</td></tr>
<tr><td>1-9 Renewable Energy</td><td>Include in the Energy Efficient Practices & Features criterion</td><td><table>
<tr><th rowspan="2">Energy Efficiency Index (EEI)</th><th colspan="2">Every 1% replacement of electricity (based on total electricity consumption) by renewable energy source</th></tr>
<tr><th>Include tenant's usage</th><th>Exclude tenant's usage</th></tr>
<tr><td>≥ 30 kW//m²/yr</td><td>5 points</td><td>3 points</td></tr>
<tr><td>< 30 kW//m²/yr</td><td>3 points</td><td>1.5 points</td></tr>
</table></td></tr>
</table>

<table>
<tr><td colspan="3">Part 2 – Water Efficiency</td></tr>
<tr><td>Criteria</td><td>Version 2.1</td><td>Version 3.0</td></tr>
<tr><td>2-1 Water Monitoring</td><td>-</td><td>• 1 point for monitoring the water consumption on monthly basis</td></tr>
<tr><td>2-2 Water Efficient Fittings</td><td>• 6 points for having PUB Water-Efficient Building</td><td>• 9 points for having PUB Water-Efficient Building</td></tr>
</table>

	Certificate • 6 points for "Very Good" WELS rating fittings or adopt equivalent water efficient flow-rate/flush volumes for water fittings • 9 points for "Excellent" WELS rating fittings or adopt equivalent water efficient flow-rate/flush volumes for water fittings • Use of dual flushing low capacity flushing systems under WELS: Good – 1 point Very Good – 2 points Excellent – 3 points	Certificate • 6 points for "Good" WELS rating fittings or adopt equivalent water efficient flow-rate/flush volumes for water fittings • 9 points for "Very Good" WELS rating fittings or adopt equivalent water efficient flow-rate/flush volumes for water fittings • 12 points for "Excellent" WELS rating fittings or adopt equivalent water efficient flow-rate/flush volumes for water fittings
2-3 Alternative Water Sources	Points awarded based on % reduction in potable water usage of the applicable uses > 50 % - 2 points < 10 % to 50 % - 1 point < 10 % - 0.5 point	Points awarded based on % reduction in potable water usage of the applicable uses > 50 % - 3 points < 10 % to 50 % - 2 points < 10 % - 1 point
2-5 Irrigation System and Landscaping	-	• 1 point for use of automatic water efficient irrigation system with rain sensor, soil moisture sensor or equivalent control system(extent of coverage: At least 50% of the landscape areas are served by the system) • 1 point for use of drought tolerant plants that require minimal irrigation (extent of coverage: At least 50% of the landscape areas)
2-6 Cooling Towers	-	1 point for use of NEWater or on-site recycled water from approved sources

Part 3 – Sustainable Operation & Management		
Criteria	Version 2.1	Version 3.0

Existing Non-Residential Building Criteria

3-1 Building Operation & Maintenance	1 point for certified GMM or SCEM	(C) 0.5 points for certified GMFM, 0.5 points for certified GMM, 1 point for certified SCEM or GMP (up to 1 point) (d) environmental management system of the building is ISO 14000 or ISO 50001 certified
3-2 Post Occupancy Evaluation	• 1 point for conducting post occupancy survey for occupant's satisfaction on energy and environmental performance: • The minimum number of people surveyed should be around 10% of total occupancy or 30 whichever is the maximum	• points for conducting post occupancy survey for occupant's satisfaction on energy and environmental performance: • Required number of people surveyed shall be - 10% of total occupancy and up to 100 maximum. - Minimum 5 people shall be surveyed If total occupancy is less than 50.
3-3 Waste Management	• 1 point for provision of facilities or recycling bins • 1 point for promoting and encouraging waste minimization and recycling among occupants, tenants and visitors through various avenues • 4 points for engaging the recycling company	• 2 points for provision of facilities or recycling bins • 2 points for promoting and encouraging waste minimization and recycling among occupants, tenants and visitors through various avenues • 1 point for providing the proper storage area for the waste • 2 points for engaging the recycling company
3-4 Sustainable Products	• 1 point for high impact item; 0.5 point for low impact item (Up to 2 points) • products that are certified under the Singapore Green Label Scheme (SGLS)	• 1 point for high impact item; 0.5 point for low impact item (up to 8 points) • environmentally friendly products that are certified by approved local certification body
3-5 Greenery	GnP = 0.5 to < 1.0 - 0.5 point GnP = 1.0 to < 1.5 - 1 point GnP = 1.5 to < 3.0 - 1.5 points GnP ≥ 3.0 - 2 points	GnP = 0.5 to < 1.0 - 1 point GnP = 1.0 to < 2 - 2 points GnP = 2 to < 3.0 - 3.5 points GnP ≥ 3.0 - 5 points

		For roof top greenery areas ≥20% and <50% of useable roof areas 1 point ≥ 50% of useable roof areas 2 points Vertical greenery areas of ≥10m2 and <50m2 1 point ≥ 50m2 2 points
3-7 Green Transport	1 point for adequate bicycles parking lots	• 1 point for provision of covered walkway to facilitate connectivity and the use of public transport • 1 point for provision of hybrid/electric vehicle refuelling/recharge stations and priority parking lots within the development • 1 point for provision of sheltered bicycle parking lots with adequate shower and changing facilities

Part 4 – Indoor Environmental Quality		
Criteria	Version 2.1	Version 3.0
4-1 Indoor Air Quality Performance	• 1 point for having carbon monoxide monitoring in carpark areas	• 1 point for implementing effective IAQ management plan • 1 point for use of high efficiency air filter • 1 point for Room Temperature & Relative Humidity sensor display (at least 1 unit per zone) • 1 point for Additional carbon dioxide sensor display (at least 1 unit per zone)
4-2 Indoor Air Pollutants	-	• 1 point for use of low volatile organic compounds (VOC) paints certified by approved local certification body • 1 point for use of environmental friendly adhesives certified by approved local certification

		body
4-3 Lighting Quality	• • At least 90% of occupants are able to adjust lighting control to suit their task needs and preference Controlled by light switches - 0.5 point Controlled by task lights - 1 point	• At least 90% of occupants are able to adjust lighting control to suit their task needs and preference Controlled by light switches - 1 point Controlled by task lights - 2 point

Part 5 – Other Green Features		
Criteria	Version 2.1	Version 3.0
5-1 Green Features & Innovations	-	New inclusion • Green mark for Office Interior certificate • Green Lease • Stormwater management • Recycling of organic food waste

ANNEX C

Mandatory three (3) yearly audit of Operational System Efficiency (OSE) of the building cooling system

1.0 Definitions

1. Three-yearly audit shall mean the submission by a qualified technical person.

2. The operational system efficiency (OSE) shall refer to the actual operating efficiency over a period of 1 week based on the prescribed operating hours in the table below:

Type of Development	**Normal Operating Hours**
Office Building	Monday to Friday: 9am – 6pm Saturday: 9am – 11am
Retail Mall	Monday to Sunday: 10am – 9pm
Hotel	Monday to Sunday: 24 hours

3. Building cooling systems shall mean a central water-cooled chilled water plant.

2.0 Scope

2.1 Commercial buildings required to comply with the Environmental Sustainability standards for Buildings.

Buildings regulated under Green Mark Version 4 for New Non-residential Buildings (NRB - V4.0)

Buildings regulated under Green Mark Version 3 for Existing Non-residential Buildings (ENRB - V3.0)

3.0 Instrumentations

The instrumentations used for the purpose of the OSE submission shall comply with the minimum standards for permanent instrumentations of central chilled water plant stipulated in NRB – V4.0 and/or ENRB – V3.0.

4.0 Documentations Required

4.1 One (1) Week raw data of the following parameters in excel (xls.) format.

1. Chilled water supply header(s) temperature(s) in degrees Celsius (°C)

2. Chilled water return header(s) temperature(s) in degrees Celsius (°C)

3. Chilled water flow measurements in litres per second (L/s)

4. Condenser water supply header(s) temperature(s) in degrees Celsius (°C)

5. Condenser water return header(s) temperature(s) in degrees Celsius (°C)
6. Condenser water flow measurements in litres per second (L/s)
7. Power measurements of chiller(s), chilled water pump(s), condenser water pump(s) and cooling tower(s) fan(s)

4.2 Location of temperature sensor, flow sensor and power meters used for the measurement and computation of the OSE should be clearly indicated in the following documents and submitted

1. Screen shot(s) of the building management system (BMS) and/ or Energy Management System (EMS) indicating sensor locations and heat balance boundary.
2. As-built drawings of chiller plant indicating sensors (temperature sensors and flow meters) locations
3. Electrical single line diagram indicating location of power meters

4.3 The following charts/ graphs shall be prepared and submitted

1. Cooling load profile
    a. X-axis: time over 24hours;
    b. Y-axis: cooling load in Rtons
2. Chilled water supply and return delta temperature (ΔT)
    a. X-axis: time over 24hours;
    b. Y-axis: ΔT in degrees Celsius (°C)
3. Chiller plant efficiency profile
    a. X-axis: time over 24 hours;
    b. Y-axis: Chiller plant efficiency in kW/RT
4. Chiller plant efficiency versus Cooling Load Scatter Plot
    a. X-axis: Cooling Load in Rton;
    b. Y-axis: Chiller plant efficiency in kW/RT
5. Heat Balance percentage error graph
    a. X-axis: Time over 24 hours
    b. Y-axis: Heat balance in percentage (%)

4.4 The charts/ graph stipulated in clause 4.3 shall be superimposed on the same graph for all the days required.

4.5 Summary of the heat balance substantiating test shall be submitted in the following format:

			Requirements	
Type of development	Hotel			
Period	01 June 2011 – 07 June 2011			
Operating hours coverage	24 hours			
Sum of total electrical energy used	60,000 kWh	(A)		
Sum of total cooling produced	84,000 RTh	(B)		
Sum of total heat rejected	110,000 RTh	(C)		
Chiller Plant Efficiency	0.714 kW/RT	(A) / (B)	**< 500RT**	**≥ 500RT**
			0.85kW/RT	0.75kW/RT
Total heat balance data count	10,080	(D)	No. of minutes over defined operating hours	
Data count > +5% error	500	(E)		
Data count < - 5% error	800	(F)		
Data count within ± 5% error	8,780	(G) = (D) – (E) – (F)		
% Heat balance within ± 5% error	87 %	(G) / (D) x 100%	**≥ 80%**	