BCA GREEN MARK

GM NRB: 2015

GREEN MARK FOR NON-RESIDENTIAL BUILDINGS NRB: 2015
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(Above JEM)

Green Mark NRB: 2015 Revision Log

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<th>Revision</th>
<th>Description</th>
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</tr>
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<tr>
<td>R0</td>
<td>Launch for Pilot</td>
<td>02/09/2015</td>
</tr>
<tr>
<td>R1</td>
<td>Revised Version for Implementation</td>
<td>31/08/2016</td>
</tr>
</tbody>
</table>
What is BCA Green Mark?

The Building and Construction Authority (BCA) Green Mark scheme was launched in 2005 and is an internationally recognised green building rating system tailored for the tropical climate. Green Mark sets parameters and establishes indicators to guide the design, construction and operation of buildings towards increased energy effectiveness and enhanced environmental performance.

BCA Green Mark comprises a number of distinct rating tools that together holistically rate the built environment for its environmental performance. These include:

- **New Buildings**: Non-Residential, Residential and Landed Housing
- **Existing Buildings**: Non-Residential, Residential and Schools
- **User Centric**: Office Interior, Retail, Supermarket, Restaurant and Data Centres
- **Beyond Buildings**: Districts, Parks, and Infrastructure

Introducing Green Mark NRB: 2015

Green Mark for Non-Residential Buildings NRB: 2015 is the 5th edition of the Green Mark scheme for new non-residential buildings, such as commercial (office, retail and hotel), industrial and institutional buildings. This version delivers:

- A streamlined rating scheme that addresses sustainability in a more balanced and holistic manner.
- Greater emphasis on climatically contextual design, energy effectiveness, health and wellbeing of building occupants, smart buildings, and a systematic approach to addressing embodied energy and resource usage.
- Recognition of the design processes which respond to site context and facilitate sustainability considerations at the early project stages where there is the greatest opportunity for low cost, high reward options to be implemented.
- A collaborative framework with more than 130 industry members and academics involved in the setting of metrics, assessment methods and performance levels.

The Green Mark NRB: 2015 Criteria should be read in conjunction with the following accompanying handbooks and tools:

- Green Mark NRB: 2015 Technical Guide and Requirements
- BCA Carbon Calculator
- BCA Energy Performance Points Calculator
Why Green Mark NRB: 2015?

Green Mark provides a consistent method to assess and verify buildings for their overall environmental performance, assisting project teams to deliver a more sustainable built environment and encouraging best practices and market transformation. At the same time, it is a design guide that can be referenced to understand the attributes of what makes buildings truly sustainable. Green Mark NRB: 2015 aims to further stretch building outcomes to substantially reduce the environmental impacts and increase the life-cycle quality of projects. At the same time, it provides a platform to recognise and make mainstream the leadership needed to drive creative, organisational & technical improvements to the overall environmental credentials of projects.

Outcomes of Green Mark NRB: 2015

The indicators within the Green Mark criteria are mapped to internationally recognised sustainability outcomes. Driving these outcomes through the Green Mark scheme can ensure buildings awarded under Green Mark will truly be high quality environmentally sustainable developments for our current and future generations.

Climate
Buildings should demonstrate emissions reduction and resilience to the effects of climate change.

Resources
As stewards of the earth’s resources, buildings should use resources in an efficient manner to reduce its environmental footprint over the building life cycle.

Wellbeing
Liveable built environments are vital for our health and well-being.

Ecology
Buildings should consider their wider impact on the biosphere through the integration of nature and protection of natural systems including flora and fauna.
Assessment Process

The BCA Green Mark Certification Process is as follows:

### Application
- Submittal of application with relevant supporting documents for certification upon finalisation of building design.
- Upon acceptance of application and fee payable, a BCA Green Mark Assessor will be assigned for the duration of the project.

### Pre-Assessment (Optional)
- Conducted to aid the project team in understanding the criteria and evaluation of the certification level sought.
- Optional step if the project team is familiar with the criteria (except for incentive projects).

### Assessment
- To be conducted when design and documentary evidences are ready.
- Comprises design and documentary reviews to verify if the building project meets the intents of the criteria and certification level, as well as the prerequisite requirements.
- For projects with potential BCA Green Mark GoldPLUS and Platinum rating, a presentation to BCA panel for evaluation is required.

### Verification
- To be conducted upon project completion.
- Includes review of delivery records, updated documents on green features and building energy performance data. Site inspection and measurement will be conducted.
- For projects with BCA GoldPLUS and Platinum rating, energy savings based on the actual building operating data and parameters will be required to ascertain the energy performance of the building.

## Green Mark NRB: 2015 Ratings

The environmental performance of a building development shall be determined by the numerical scores (i.e. Green Mark points) achieved in accordance with the applicable criteria using the scoring methodology and the prerequisite requirements on the level of building performance as specified in this Green Mark scheme document. Under this assessment framework, points are awarded for incorporating sustainable design features and practices, which would add up to a final Green Mark Score. Depending on the level of building performance and Green Mark Score, the building development will be eligible for certification under one of the ratings, namely BCA Green Mark Gold, GoldPLUS or Platinum. The design of the building development shall also meet all the relevant mandatory requirements regulated under the Building Control Regulations.

The Green Mark Score of the building design is the total of all the numerical scores assigned based on the degree of compliance with the applicable criteria. The following table states the corresponding Green Mark Score to attain the respective Green Mark ratings. Buildings must also fulfil their respective pre-requisite requirements to be awarded Green Mark. The total points scored include the bonus points scored under Advanced Green Efforts.
### BCA Green Mark Award Rating Scores

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<thead>
<tr>
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<th>Green Mark Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Mark Platinum</td>
<td>70 and above</td>
</tr>
<tr>
<td>Green Mark Gold$^\text{PLUS}$</td>
<td>60 to &lt; 70</td>
</tr>
<tr>
<td>Green Mark Gold</td>
<td>50 to &lt; 60</td>
</tr>
</tbody>
</table>

### Criteria Overview

To dovetail the criteria with the sustainable outcomes of Green Mark NRB: 2015, the criteria has been re-structured into 5 sections, with 16 criteria and 52 sustainability indicators. Each of the 4 main sections is equally weighted in terms of points. The total points is 140 points, inclusive of 20 points from Section 5: Advanced Green Efforts.

Within the main criteria, criteria within the grey boxes with the ‘Advanced Green Efforts’ icon are scored under 5.01 Enhanced Performance.
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<td>3.02</td>
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<td>a Sustainable Construction</td>
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<td></td>
<td>b Embodied Carbon</td>
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<td></td>
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<td>3.03</td>
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<td>4.02</td>
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<td>4.03</td>
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0. Pre-requisite Requirements

The pre-requisites for Green Mark NRB: 2015 sets the minimum environmental considerations that a project shall demonstrate based on industry norms. All pre-requisites listed as follows must be fulfilled in order to be eligible to score Green Mark points in the 5 Green Mark sections.

Pre-requisites P.01 to P.15

P.01 to P.15 are parked under the criteria sections. They must be fulfilled by all projects targeting certification.

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<td>3. Resource Stewardship</td>
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<tr>
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<td>P.08 – P.15</td>
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</tbody>
</table>

Minimum Criteria Points Requirements

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Pre-Requisite Requirement</th>
<th>Minimum Points Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.01a</td>
<td>Climatic &amp; Contextually Responsive Brief</td>
<td>Gold: -</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GoldPLUS: 1 pt</td>
</tr>
<tr>
<td>1.01b</td>
<td>Integrative Design Process</td>
<td>-</td>
</tr>
<tr>
<td>1.01e</td>
<td>User Engagement</td>
<td>Green Fit-out Guideline - 1 pt</td>
</tr>
<tr>
<td>1.02b</td>
<td>Integrated Landscape and Waterscape</td>
<td>-</td>
</tr>
<tr>
<td>1.03c</td>
<td>Ventilation Performance – Ventilation Simulation</td>
<td>For GoldPLUS and Platinum projects with ≥ 2,000m² of naturally ventilated occupied spaces, the following wind speeds must be met via ventilation simulation (4 points)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Commercial – 2 pts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Others – 1 pt</td>
</tr>
<tr>
<td>2.03a</td>
<td>Solar Energy Feasibility Study</td>
<td>For buildings with a footprint ≥1,000m² – 0.5 pt</td>
</tr>
<tr>
<td>3.02a</td>
<td>Sustainable Construction</td>
<td>0.5 pt</td>
</tr>
<tr>
<td>3.02b</td>
<td>Embodied Energy</td>
<td>-</td>
</tr>
<tr>
<td>3.02c</td>
<td>Sustainable Products</td>
<td>2 pts</td>
</tr>
<tr>
<td>4.01a(i)</td>
<td>Indoor Air Quality Audit</td>
<td>0.5 pt</td>
</tr>
<tr>
<td>4.01a(ii)</td>
<td>Post Occupancy Evaluation</td>
<td>-</td>
</tr>
<tr>
<td>4.01b(ii)</td>
<td>Enhanced Filtration Media</td>
<td>-</td>
</tr>
<tr>
<td>4.03d</td>
<td>System Handover and Documentation</td>
<td>-</td>
</tr>
</tbody>
</table>

*Complementary methods to compliance are available as described in 1.03c
Energy Savings Requirements

Intent
The quantification and setting of minimum standards for energy savings of a green building can encourage an integrated approach to building design optimisation. By determining the building’s energy usage based on different design options, developers can better understand their impact on total building performance and make cost effective design decisions that can maximise energy savings.

Scope
Applicable to all projects targeting Green Mark GoldPLUS or Platinum rating.

Assessment
The minimum energy savings to be demonstrated for the following rating tiers are as follows:

<table>
<thead>
<tr>
<th>Level of Green Mark Award</th>
<th>Minimum Energy Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>GoldPLUS</td>
<td>25%</td>
</tr>
<tr>
<td>Platinum</td>
<td>30%</td>
</tr>
</tbody>
</table>

For a building with air-conditioned area ≥ 5,000m², an energy model shall be used to demonstrate the building’s designed energy savings compared to a prescribed reference model that reflects prevailing building standards and codes of practice. The simulation shall be conducted in accordance with the Green Mark NRB: 2015 Technical Guide and Requirements - Annex C: Energy Modeling Methodology and Requirements.

For a building with air-conditioned areas < 5,000m², detailed calculations can be provided in place of energy modeling to justify the savings in energy consumption from a more efficient design.

For buildings served by existing DCS plants eligible for Path B as per the requirements outlined in the Green Mark NRB: 2015 Technical Guide and Requirements, the energy savings to be demonstrated (excluding the consumption of the DCS plant) are as follows:

<table>
<thead>
<tr>
<th>Level of Green Mark Award</th>
<th>Cooling Load Savings</th>
<th>Energy Consumption Savings (excluding DCS plant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GoldPLUS</td>
<td>10%</td>
<td>27%</td>
</tr>
<tr>
<td>Platinum</td>
<td>15%</td>
<td>33%</td>
</tr>
</tbody>
</table>

In addition, the normalised Energy Efficiency Index (EEI) based on the proposed model result from the Energy Model shall be computed in accordance with Annex C. The normalised EEI should not exceed the following benchmarks. In instances where the project exceeds the EEI stated, reasoned justification shall be provided. The EEI, overall Energy Use Intensity (EUI) for the building and car park EUI shall also be calculated.

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Benchmark for Normalised Energy Efficiency Index (EEI) (kWh/m²/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office and Institutional</td>
<td>160</td>
</tr>
<tr>
<td>Hotel</td>
<td>260</td>
</tr>
<tr>
<td>Retail</td>
<td>360</td>
</tr>
</tbody>
</table>
1. Climatic Responsive Design

Buildings serve as structures sheltering their occupants from the variable external climate. With this consideration, the built form should be considered to maximise its response to the local tropical climate, and establish a contemporary tropical vernacular. By appreciating the site context, building designers can capitalise on the physical environment and recognise opportunities for the urban built form to maximise responsive design. Consideration of the building’s human centricity and whether it is in sync with its surrounding context should also be given due account. It is paramount for such climatically contextual design to be weaved into the early thinking of building design, and this is enabled through upstream effective leadership, supported by a collaborative process of design with the partnership of relevant stakeholders.

P.01-P.03 + POINTS PREREQUISITES

30 POINTS

1.01 Leadership (10 pts)
1.02 Urban Harmony (10 pts)
1.03 Tropicality (10 pts)

Advanced Green Efforts (8 pts)
**P.01 Envelope and Roof Thermal Transfer**

**Intent**
Minimising thermal heat gain through the building envelope and roof can enhance indoor thermal comfort and reduce the energy needed to condition the indoor environment.

**Scope**
Applicable to building facades and roofs.

**Assessment**
Where the buildings’ aggregate air-conditioned areas exceed 500 m$^2$, as determined in accordance with the formula set out in the *BCA Code on Envelope Thermal Performance for Buildings*, the Envelope Thermal Transfer Value (ETTV) shall not exceed the following limits:

<table>
<thead>
<tr>
<th>Level of Award</th>
<th>Maximum ETTV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>45 W/m$^2$</td>
</tr>
<tr>
<td>GoldPLUS</td>
<td>40 W/m$^2$</td>
</tr>
<tr>
<td>Platinum</td>
<td>38 W/m$^2$</td>
</tr>
</tbody>
</table>

The average thermal transmittance (U-value) for the gross area of the building’s roof shall not exceed the following limits:

<table>
<thead>
<tr>
<th>Roof Weight Group</th>
<th>Weight Range (kg/m$^2$)</th>
<th>Buildings with aggregate air-conditioned area &gt; 500m$^2$</th>
<th>Buildings with aggregate air-conditioned area ≤500m$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>&lt; 50</td>
<td>0.5</td>
<td>0.8</td>
</tr>
<tr>
<td>Medium</td>
<td>50 to 230</td>
<td>0.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Heavy</td>
<td>&gt; 230</td>
<td>1.2</td>
<td>1.5</td>
</tr>
</tbody>
</table>

The limits stipulated do not apply to roofs with skylight for buildings with aggregate air-conditioned area > 500m$^2$. However, the Roof Thermal Transfer Value (RTTV) of such roofs, computed in accordance with the *Code on Envelope Thermal Performance for Buildings*, shall not exceed 50 W/m$^2$.

The roof limits stipulated do not apply to open sided sheds, linkways, covered walkways, store rooms, utility rooms, plant rooms and equipment rooms.
P.02 Air Tightness and Leakage

**Intent**
Minimising air infiltration through the building envelope can reduce the energy required for air-conditioning and enhance occupant thermal comfort.

**Scope**
Applicable to all windows and curtain walls on the building envelope.

**Assessment**

P.03 Bicycle Parking

**Intent**
Providing the necessary infrastructure to encourage cycling as an alternative mode of transport can reduce the energy consumption from vehicular travel.

**Scope**
Applicable to all building developments outlined below.

**Assessment**
The following minimum quantity of bicycle parking lots shall be provided for the development. Lots are to be installed and located in line with LTA’s Code of Practice - Street Work Proposal Relating to Development Works.

<table>
<thead>
<tr>
<th>Land Use Type</th>
<th>Minimum Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civic &amp; Community Institution (Community Institution), Sports &amp; Recreation</td>
<td>GFA of &gt; 1,000m² to 3,000m² - 20 bicycle lots</td>
</tr>
<tr>
<td></td>
<td>For GFA &gt; 3,000m²</td>
</tr>
<tr>
<td></td>
<td>• First 15,000m² - 1 lot per 150m²</td>
</tr>
<tr>
<td></td>
<td>• Subsequent GFA - 1 lot per 500m²</td>
</tr>
<tr>
<td>Commercial, Hotel, White, Business Park, Business Park – White, Business 1 (B1), Business 2 (B2), Business 1 – White, Business 2 – White, Health &amp; Medical Care, Place of Worship, Civic &amp; Community Institution (Civic and/or Cultural Institution)</td>
<td>GFA of &gt; 1,000m² to 3,000m² – 10 bicycle lots</td>
</tr>
<tr>
<td></td>
<td>For GFA &gt; 3,000m²</td>
</tr>
<tr>
<td></td>
<td>• First 15,000m² - 1 lot per 300m²</td>
</tr>
<tr>
<td></td>
<td>• Subsequent GFA - 1 lot per 1,000m²</td>
</tr>
</tbody>
</table>
Leadership (10 pts)

The long-term sustainability of the built environment, economy and society depends on the collective leadership of building owners in driving sustainable buildings in partnership with the end users of the building. Effective leadership is needed to influence and drive creative, organisational and technical improvements to the overall environmental credentials of projects, from the initial stages of the project through to building occupation and operation. Upstream leadership can push the boundary of projects’ fundamental requirements and is the key towards shifting the needle towards climatic responsive design. This is supported by an integrated design process that resonates among the stakeholders, a strong design team and a shared vision of building a sustainable development and how the vision could be achieved.

- 1.01a Climatic & Contextually Responsive Brief (1 pt)
- 1.01b Integrative Design Process (2 pts)
- 1.01c Environmental Credentials of Project Team (2 pts)
- 1.01d Building Information Modeling (2 pts)
- 1.01e User Engagement (3 pts)
1.01a Climatic & Contextually Responsive Brief

**Intent**
Considering the constraints and opportunities for environmental sustainability to set design goals approaches early at the onset of a building project can ensure a more holistic total building performance.

**Scope**
Applicable to all building developments.

**Assessment**
1 point can be scored for a climatic and culturally responsive brief detailed through two parts:

- **Strategic Definition**: Preliminary definition of the client’s sustainable aspirations for the project, and identification of its green potential benchmarked against similar projects. Feasibility studies involving assessments of options against functional requirements and potential constraints should be prepared to rationalise the brief.

- **Preparation and Brief**: Setting of agreed achievable formal sustainability targets for the project. In addition to the project’s targeted Green Mark rating, such targets should involve specific sustainable outcomes and indicators. The selection, deployment and responsibilities of the project team, builders and building operators should be detailed. This includes the identification of at least one member of the team to take the lead in coordinating sustainability efforts and tracking of the targets throughout the project phase.

1.01b Integrative Design Process

**Intent**
Addressing and negotiating between the various needs of all stakeholders involved in a building project to achieve common targets can result in a balanced and optimised sustainable design outcome.

**Scope**
Applicable to all building developments.

**Assessment**
2 points can be scored if the design team demonstrates an integrated design process. This encompasses the establishment of a collaborative framework for the project team during the briefing and design phases to encourage value-added contributions and constructive discussions. This process, which should be conducted in a consultative and non-hierarchical manner, includes the:

- Appointment of all relevant consultants early in the design phase
- Identification of responsible parties within the team to implement relevant sustainability goals and targets
- Detailing of sustainable design methodology action plans and progress
- Addressing of opportunities and challenges with integrative team strategies to achieve the targets
- Organising of design charrettes at key stages within the project design
1.01c Environmental Credentials of Project Team

Intent
A building project team with specialist green credentials can more competently and effectively coordinate the environmental design approach throughout the building design, construction and operation stages.

Scope
Applicable to all building developments.

Assessment
A maximum of 2 points can be scored for the project teams with the following credentials:

- At least 2 of the following are ISO 14001 certified: Architect, M&E engineer, C&S engineer, developer and main contractor - 0.5 point
- At least 2 SGBC Green Services Certified firms – 0.5 point
- Certified Green Mark Manager (GMM) or Green Mark Facilities Manager (GMFM) – 0.25 point
- Green Mark Professional (GMP) or Green Mark Facilities Professional (GMFP) – 0.5 point
- Main builder is a BCA certified Green and Gracious Builder – 0.25 point for Certified and Merit or 0.5 point for Excellent and Star rating

1.01d Building Information Modeling (BIM)

Intent
BIM can be used for coordination and design integration, enabling optimisation of resources and downstream building performance.

Scope
Applicable to all building developments.

Assessment
1 point each can be scored for the following:

- **Collaborative BIM**: The use of a coordinated BIM modeling framework that harmonises the various disciplines’ designs in a 3D environment, to co-ordinate spatial design and reduce clashes during construction.
- **Green BIM**: The use of integrative BIM models to form the base models for environmental analysis and building performance simulations, the results of which can be used to further optimise the building design.
1.01e User Engagement

Intent
This refers to the provision of relevant information and guidance to building occupants to raise awareness on the building’s green features, and on how they can contribute positively to reduce the building’s environmental impact further.

Scope
Applicable to all building developments with occupants.

Assessment
A maximum of 3 points can be scored for the following:

- **Building user guide** – 0.5 point: To be disseminated to all eventual occupants in the building, the user guide should provide a detailed overview of the sustainable design strategies and green features employed in the building, on how they are operated and benefit the user.
- **Green fit out guidelines** – 1 point: To be disseminated to the relevant tenant management/ personnel, the guidelines should detail recommended minimum environmental standards to assist them in making sustainable fit-out decisions.
- **Green lease** – 3 points: To be incorporated into the tenancy agreement, the green lease should establish agreed levels of environmental performance between the landlord and the tenant for ≥ 60% of the net lettable area.

---

**4D, 5D & 6D BIM (Advanced Green Efforts)**

1 point each can be scored for the 3 levels of SMART BIM under *Advanced Green Efforts*:

**4D (Time) BIM** – This links time information to the BIM model for project scheduling and coordination. With real time construction activity on site linked to it, the 4D model can be used to review progress against the construction programme and identify methods to assess delays, make up time and evaluate extensions of time claims.

**5D (Cost) BIM** – This consists of elemental details, finishes, fixtures and equipment within the model linked to data on performance, manufacturers and specifications. The use of integrated scheduling tools can be incorporated to assist in the preparation of cost and quantity schedules and tracking of the project budget.

**6D (Facilities Management) BIM** – This involves the updated as built model of the building complete with the procured fixtures, finishes and equipment data.
1.02

Urban Harmony (10 pts)

With buildings forming part of a larger urban environment, it is important to identify the impact of the physical form of a building, which prefixes its sustainable performance, with respect to its immediate locale and larger context. Designing for a building’s human-centricity looks at how its presence can co-exist in harmony with its surrounding context and positively impact the movement and comfort of the people in its neighbourhood.

- 1.02a Sustainable Urbanism (5 pts)
- 1.02b Integrated Landscape and Waterscape (5 pts)
1.02a Sustainable Urbanism

Intent
Through site analysis and mitigation measures, a sustainable accessible and contextual response can be developed to ensure that the development enhances the urban realm as well as minimises its environmental impact and dis-amenity to the surrounding buildings.

Scope
Applicable to all building developments.

Assessment
A maximum cap of 5 points can be scored under the following sub-criteria:

(i) Environmental Analysis
Points can be scored for either the following conducted prior to the commencement of activities on site to identify the anticipated effects on climate change, flora and fauna, soil, air and water that the development may have. It should identify and implement measures to mitigate any adverse impacts, protect valuable site ecology and/or to improve the site to its original condition.

• Environmental study - 1 point
• Comprehensive Environmental Impact Assessment (EIA) – 2 points

Creation of possible new ecology and natural ecosystems (Advanced Green Efforts)
1 point can be scored if the project can detail strategies in the EIA on how the completed project 'heals the land'. Beyond mitigation measures, it should have a net positive impact by enhancing the site ecology beyond its current state. The regenerative features should be quantified in terms of an overall net improvement versus the building not being constructed and the site remaining in the current context.

(ii) Response to Site Context
A site analysis identifies the relationships between the human and physical geography of the site. It should consider how the urban context, site topography and hydrology, site micro climate, site access and connectivity can inform the design of the urban form and site layout to respond accordingly. Points can be scored for either:

• Level 1 site analysis and design that demonstrates sensitivity to the site condition – 1 point
• Level 2 site analysis optimised design via iterative simulations – 3 points
(iii) Urban Heat Island
By demonstrating measures to mitigate the urban heat island effect through the material selection of the hardscape, softscape and building surfaces, a maximum of 1 point can be scored for:

- ≥ 50% site coverage (at plan view) with mitigation measures – 0.5 point
- ≥ 80% site coverage (at plan view) with mitigation measures – 1 point

(iv) Green Transport
0.5 point each can be scored for the provision of the following:

- Electrical vehicle charging and parking infrastructure: There shall be at least 1 lot per 100 lots (cap at 5 lots)
- Reduction of car parking provision up to 20% below the prevailing car park standard, subject to LTA’s approval of ‘Range Based Car Parking Standard (RCPS)’
- Features to promote bicycle usage

1.02b Integrated Landscape and Waterscape

Intent
Projects are encouraged to integrate a verdant landscape and waterscape into their building design, to enhance the biodiversity around the development and provide visual relief to building occupants and neighbours.

Scope
Applicable to all building developments.

Assessment
A maximum cap of 5 points can be scored under the following sub-criteria:

(i) Greenery Provision
The provision of greenery for the development can be quantified via the Green Plot Ratio (GnPR). Points can be scored as follows:

<table>
<thead>
<tr>
<th>GnPR</th>
<th>Points Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 to &lt;1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>1.0 to &lt;2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>2.0 to &lt;3.0</td>
<td>2.0</td>
</tr>
<tr>
<td>3.0 to &lt;4.0</td>
<td>2.5</td>
</tr>
<tr>
<td>≥ 4.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>
(ii) Tree Conservation
0.5 point each can be scored for the following:

- Preservation of existing trees on-site to prevent disturbance to established habitats.
- Replanting of an equivalent number of similar or native species of equivalent LAI for felled trees.

(iii) Sustainable Landscape Management
1.5 points can be scored for projects certified under NParks Landscape Excellence Assessment Framework (LEAF) certification. For projects not certified under LEAF, 0.5 point each can be scored for the following:

- The adoption of native species of greenery > 50% of the flora selected wherever possible to maintain the local ecosystem
- Projects that scored full points under 1.02a (i) for EIA
- A landscape management plan established that covers:
  - The use of organic composts from horticultural wastes
  - The potential for onsite composting
  - General landscape maintenance and management plan during building occupation

(iv) Sustainable Stormwater Management
Points can be scored for either of the following:

- Projects that have obtained PUB Active, Beautiful and Clean Waters (ABC Waters) certification – 1 point
- Treatment of stormwater run-off from total area through the provision of infiltration or design features before discharge to the public drains, to reduce storm surges and to treat the water
  - ≥ 10% of run-off: 0.5 point
  - ≥ 35% of run-off: 1 point

GnPR ≥ 5 (Advanced Green Efforts)
1 more point can be scored under Advanced Green Efforts if the project has a GnPR ≥ 5.
1.03 Tropicality (10 pts)

Shaping building passive design in consideration of the climatic context, including its orientation, facades as well as interior layout can reduce the building’s heat load and energy usage and enhance effective thermal comfort for its occupants. From a performance point of view, buildings should be highly permeable in areas of natural ventilation and at the same time be shielded against heat ingress.

- 1.03a Tropical Façade Performance (3 pts)
- 1.02b Internal Spatial Organisation (3 pts)
- 1.03c Ventilation Performance (4 pts)
1.03a Tropical Façade Performance

**Intent**
The holistic consideration of façade performance can reduce direct sunlight into the building and minimise thermal heat gain, enhancing indoor comfort and lowering the energy for conditioning the indoor environment.

**Scope**
Applicable to facades and roofs bounding conditioned or non-conditioned spaces.

**Assessment**
A maximum of 3 points can be scored for the façade performance assessed through either:

**Simulation method:** Through building physics software simulation, 1 point can be scored for meeting the notional façade detailed as follows, and for every 5% heat load reduction of the envelope and solar insolation reduction of the fenestrations against the notional façade.

<table>
<thead>
<tr>
<th>Overall Weighted Values</th>
<th>Industrial Buildings</th>
<th>Other building types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weighted Window U-Value</td>
<td>5.4 W/m²K</td>
<td>2.8 W/m²K</td>
</tr>
<tr>
<td>Weighted Wall U-Value</td>
<td>1.5 W/m²K</td>
<td>0.7 W/m²K</td>
</tr>
<tr>
<td>Overall Envelope U-value</td>
<td>2.4 W/m²K</td>
<td>1.6 W/m²K</td>
</tr>
<tr>
<td>Window-to-Wall Ratio (Each façade)</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Total Effective Glass Shading Coefficient (SC₁ x SC₂)</td>
<td>0.6</td>
<td>0.4</td>
</tr>
<tr>
<td>Roof U-Value</td>
<td>1.1 W/m²K</td>
<td>0.8 W/m²K</td>
</tr>
<tr>
<td>Sky light/ Roof window U-Value</td>
<td>4.3 W/m²K</td>
<td>2.2 W/m²K</td>
</tr>
<tr>
<td>RTTV (where there are sky lights for AC areas)</td>
<td>50 W/m²K</td>
<td>50 W/m²K</td>
</tr>
</tbody>
</table>

**Checklist method:** Eligible for industrial buildings with a WWR ≤ 0.25, and other building types with a WWR ≤ 0.5. Points can be scored as follows:

**Non Simulation Checklist for Industrial Buildings:**

<table>
<thead>
<tr>
<th>Overall Weighted Values</th>
<th>Baseline</th>
<th>Points for Improvement</th>
<th>Point cap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envelope U-Value</td>
<td>2.4 W/m²K</td>
<td>0.5 points for every 0.4 W/m²K reduction from baseline</td>
<td>2 pts</td>
</tr>
<tr>
<td>WWR (Excludes Façade openings/ voids)</td>
<td>0.2</td>
<td>0.5 pt for meeting baseline 0.5 pt for every 0.05 reduction from baseline</td>
<td>2 pts</td>
</tr>
<tr>
<td>Glass Shading Coefficient (SC₁)</td>
<td>0.5</td>
<td>1 pt for meeting baseline 0.5 pt for every 0.05 reduction from baseline</td>
<td>2 pts</td>
</tr>
<tr>
<td>Effective Sun Shading</td>
<td>-</td>
<td>≥ 10% effectiveness (North and South) - 1 pt ≥ 30% effectiveness (East and West) - 1 pt</td>
<td>2 pts</td>
</tr>
<tr>
<td>Roof U-Value</td>
<td>1.0 W/m²K</td>
<td>0.5 pt for every 0.1 W/m²K reduction from baseline</td>
<td>2 pts</td>
</tr>
<tr>
<td>Sky light/ Roof window U-Value</td>
<td>4.0 W/m²K</td>
<td>0.5 pt for meeting baseline 1 pt for U-Value of 2 W/m²K</td>
<td>1 pt</td>
</tr>
</tbody>
</table>
Non Simulation Checklist for Other Building Types:

1.03b Internal Spatial Organisation

**Intent**

Adopting passive design strategies in the internal spatial organisation of a building provides opportunities to enhance building performance.

**Scope**

Applicable to all building developments.

**Assessment**

Up to 3 points can be scored for the following:

- Locating non-thermally critical non-air-conditioned spaces, e.g. lift cores, staircases, toilets, electrical plantrooms etc on east and west facing walls to reduce thermal heat gain into occupied spaces – 1 point
- Prorating the number of transient common spaces, e.g. toilets, staircases, corridors, lift lobbies and atriums by the mode of ventilation against the total number of applicable spaces – Up to 2 points

<table>
<thead>
<tr>
<th>Ventilation Mode</th>
<th>Air-Conditioned</th>
<th>Mechanical Ventilation</th>
<th>Natural Ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points</td>
<td>0</td>
<td>0.5</td>
<td>2</td>
</tr>
</tbody>
</table>
1.03c Ventilation Performance

Intent
Naturally ventilated functional areas should be effectively designed to be thermally comfortable and healthy for the building occupants.

Scope
Applicable for naturally ventilated occupied spaces and gathering spaces such as building atria.

Assessment
A maximum 4 points can be scored for this sub-indicator based on the following options:

Ventilation Performance Checklist

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Openings towards prevailing wind directions</td>
<td>0.1 point for every 10% of units or rooms with openings facing towards the prevailing winds (North &amp; South)</td>
<td>1</td>
</tr>
</tbody>
</table>
| Depth of room vs opening | • Single sided ventilation: $W \leq 2H$  
• Cross Ventilation: $W \leq 5H$ | ≥50% of applicable spaces meet - 1 pt or  
≥70% of applicable spaces meet - 2 pts |

Full Ventilation Simulation
Up to 4 points can be scored for ventilation simulations or wind tunnel testing conducted based on Green Mark NRB: 2015 Technical Guide and Requirements Annex A: Computational Fluid Dynamics Simulation Methodology and Requirements. The simulation results and recommendations derived are to be implemented to ensure optimised natural ventilation. More than 70% of applicable naturally ventilated spaces to meet the minimum weighted average wind velocity to score. Where the wind speed result cannot be met, thermal comfort or air quality modeling should be performed and the relevant criteria stated in Annex A met for all naturally ventilated spaces:

<table>
<thead>
<tr>
<th>Points</th>
<th>Minimum weighted Average Wind Velocity</th>
<th>Thermal Comfort</th>
<th>Air Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Moderate (0.2m/s)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
| 4      | Good (0.4m/s)                         | -1.0 < PMV < +1.0 | Air Change Rate ≥4  
Air Exchange Efficiency ≥ 1 |
|        | Very Good (0.6m/s)                    | -0.8 < PMV < +0.8 | Air Change Rate ≥10  
Air Exchange Efficiency ≥ 1.2 |

Wind Driven Rain Simulation (Advanced Green Efforts)
Up to 1 point can be scored for wind driven rain simulation in compliance with Annex A to identify the most effective building design and layout that minimises the impact of wind-driven rain into naturally-ventilated occupied spaces.
2. Building Energy Performance

The built environment is an important contributor towards reducing global carbon emissions and fossil fuel consumption. This section builds on Section 1 – Climatic Responsive Design, and focuses on how building projects can demonstrate the optimisation of building energy systems through energy efficiency, effectiveness and replacement strategies to reduce their environmental impact.

The energy performance of a building is measured through the efficiency of its active mechanical and electrical systems. In the urban tropics, this is mainly attributed to air conditioning systems, artificial lighting and hot water production in some building types. In addition, to consider the energy effectiveness of a building holistically, the extent of use of energy systems in terms of their absolute energy consumption should also be taken into account. Further tapping unto opportunities to utilise renewables in place of fossil energy sources, the energy performance of building projects can be improved significantly.

An Energy Performance Points Calculator in Excel format has been formulated to aid the design team to understand the buildings’ total energy performance, while providing options to reduce energy consumption. This calculator shall be used to compute this section’s points.

P.04-P.06 + POINTS PREREQUISITES

30 POINTS

2.01 Energy Efficiency (11 pts)
2.02 Energy Effectiveness (11 pts)
2.03 Renewable Energy (8 pts)

Advanced Green Efforts (7 pts)
P.04 Air Conditioning Total System and Component Efficiency

Intent

Energy efficient air-conditioning systems with better optimised total system performance require less energy to produce and distribute conditioned air into building spaces.

Scope

Applicable to air-conditioning systems serving the building comfort cooling needs.

Assessment

Where the cooling capacity of any air-conditioning system exceeds 30 kW, the equipment (excluding air distribution) shall comply with the relevant provisions of SS 530 : 2014 - Code of Practice for Energy Efficiency Standard for Building Services and Equipment.

Where the building’s aggregate air-conditioned areas exceed 500 m², the Design Total System Efficiency (DSE) and the efficiency of the cooling and air distribution components shall not exceed the limits in the tables below. For buildings with different systems, the tables will apply for the system with a larger aggregate capacity. The DSE is based on the expected part-load condition over the simulated average annual total cooling load profile for chilled-water systems, and total weighted system efficiency for unitary systems.

a) Air Cooled Chilled-Water System/ Unitary Air-Conditioning System

Relevant equipment: Air-cooled chillers, chilled-water pumps, variable refrigerant flow (VRF) systems, single-split units, multi-split units, air distribution system (e.g. AHUs, PAHUs, FCUs)

<table>
<thead>
<tr>
<th>Green Mark Rating</th>
<th>Peak Building Cooling Load (RT)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;500 RT</td>
<td>≥500RT</td>
</tr>
<tr>
<td></td>
<td>Minimum DSE $\eta_t$ (kW/RT)</td>
<td></td>
</tr>
<tr>
<td>Gold</td>
<td>NA (0.9, N.A.)</td>
<td></td>
</tr>
<tr>
<td>GoldPLUS</td>
<td>1.10 (0.85, 0.25)</td>
<td></td>
</tr>
<tr>
<td>Platinum</td>
<td>1.03 (0.78, 0.25)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\eta_c$, $\eta_a$ shall meet their respective thresholds.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\eta_c$: System kW/ton excluding the air distribution equipment</td>
<td></td>
</tr>
<tr>
<td>$\eta_a$: Air distribution equipment kW/ton</td>
<td></td>
</tr>
<tr>
<td>$\eta_t = \eta_c + \eta_a$</td>
<td></td>
</tr>
</tbody>
</table>

b) Water Cooled Chilled Water System

Relevant equipment: Water-cooled chillers, chilled-water pumps, condenser water pumps, cooling towers, air distribution system

<table>
<thead>
<tr>
<th>Green Mark Rating</th>
<th>Peak Building Cooling Load (RT)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;500 RT</td>
<td>≥500RT</td>
</tr>
<tr>
<td></td>
<td>Minimum DSE $\eta_t$ (kW/RT)</td>
<td></td>
</tr>
<tr>
<td>Gold</td>
<td>NA (0.75, N.A.)</td>
<td>NA (0.68, NA)</td>
</tr>
<tr>
<td>GoldPLUS</td>
<td>0.95 (0.7, 0.25)</td>
<td></td>
</tr>
<tr>
<td>Platinum</td>
<td>0.93 (0.68, 0.25)</td>
<td>0.9 (0.65, 0.25)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\eta_c$, $\eta_a$ shall meet their respective thresholds.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\eta_c$: System kW/ton excluding the air distribution equipment</td>
<td></td>
</tr>
<tr>
<td>$\eta_a$: Air distribution equipment kW/ton</td>
<td></td>
</tr>
<tr>
<td>$\eta_t = \eta_c + \eta_a$</td>
<td></td>
</tr>
</tbody>
</table>
c) **District Cooling System (DCS)** – Within or outside gazetted zones, operated by supplier of district cooling services registered under the Energy Conservation Act

Relevant equipment: DCS plant (e.g. chillers, chilled-water pumps, condenser water pumps, cooling towers, network pumps, thermal storage, heat exchangers, renewable energy or energy recovery systems within the plant vicinity), building air-distribution system

<table>
<thead>
<tr>
<th>Green Mark Rating</th>
<th>Minimum DSE $\eta_t$ (kW/RT)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>0.9 (0.65, N.A.)</td>
<td>$(\eta_c, \eta_a)$ shall meet their respective thresholds. $\eta_c$: DCS system kW/ton $\eta_a$: Building’s air distribution equipment and chilled-water pumps. $\eta_t = \eta_c + \eta_a$</td>
</tr>
<tr>
<td>GoldPLUS</td>
<td>0.9 (0.65, 0.25)</td>
<td></td>
</tr>
<tr>
<td>Platinum</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*For DCS plants serving the building that were commissioned before October 2016, the supplier can meet the requirements under alternative Path B stipulated in the GM NRB: 2015 Technical Guide and Requirements instead.

**P.05 Lighting Efficiency and Controls**

**Intent**

Energy efficient lighting with adequate control strategies require less energy to illuminate a space.

**Scope**


**Assessment**

The maximum lighting power budget for artificial lighting and lighting controls shall comply with Clause 7 of SS 530: 2014. In hotel buildings, a control device shall be installed in every guestroom to automatically switch off the lighting when unoccupied.

**P.06 Vertical Transportation Efficiency**

**Intent**

Energy efficient vertical transportation systems require less energy to transport passengers in buildings.

**Scope**

Applicable to all lifts and escalators, except typologies where such technology is not available.

**Assessment**

Lifts and escalators shall be equipped with AC variable voltage and variable frequency (VVVF) motor drive and sleep mode features.
2.01

Energy Efficiency (11 pts)

Air-conditioning, lighting and receptacle loads are typically the highest energy consuming building mechanical systems. Additionally, given the relatively large area of carparks in many developments, carparks also constitute a significant energy use. Using more efficient systems can reduce their contribution to the building total energy consumption.

- 2.01a Air Conditioning Total System Efficiency (5 pts)
- 2.01b Lighting Efficiency (3 pts)
- 2.01c Carpark System Efficiency (2 pts)
- 2.01d Receptacle Load Efficiency (1 pt)
2.01a Air Conditioning Total System Efficiency

**Intent**
The use of energy efficient air-conditioning systems can optimise their total system performance, and reduce the energy needed to produce and distribute conditioned air into building spaces.

**Scope**
Applicable to all the air-conditioning systems serving the building comfort cooling needs, including the air distribution equipment.

**Assessment**
The Energy Performance Points Calculator shall be used to calculate the percentage improvement of the weighted total design system efficiency of all the various air conditioning systems used in the project, against the code baseline. The figure should be based on the operational design load determined by the simulated average annual total cooling load profile. A maximum of 5 points can be scored as follows:

<table>
<thead>
<tr>
<th>Peak Building Cooling Load (RT)</th>
<th>Total Design System Efficiency (kW/RT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;500 RT</td>
<td>1.08</td>
</tr>
<tr>
<td>≥500 RT</td>
<td>0.98</td>
</tr>
</tbody>
</table>

Points scored = 0.2 x (% improvement from baseline)

For district cooling plants under Path B scenario, where the plant is excluded from the computation, the baseline reference for the building air distribution equipment can be taken as 0.28 kW/ton for the purposes of points computation here.

2.01b Lighting System Efficiency

**Intent**
The use of energy efficient lighting can reduce the energy needed to illuminate a space.

**Scope**
Applicable to building interior lighting and landscape lighting, including tenant lighting provision. Carpark and emergency lighting shall be excluded from the calculation.

**Assessment**
The Energy Performance Points Calculator shall be used to calculate the percentage improvement of the building’s weighted lighting power budget against the code baseline in SS 530 : 2014 - Code of Practice for Energy Efficiency Standard for Building Services and Equipment. A maximum of 3 points can be scored as follows:

- Points scored = 0.1 x (% improvement from baseline)

The lighting should be designed to the recommended lux levels in SS 531 – 1 : 2006 (2013)– Code of Practice for Lighting of Workplaces.
2.01c Carpark System Efficiency

Intent
The use of energy efficient carpark ventilation and lighting systems can reduce the energy needed for carpark operations.

Scope
Applicable to buildings with carparks. For building projects with no carpark, full points can be scored here.

Assessment
The Energy Performance Points Calculator shall be used to generate the savings of the carpark lighting and ventilation systems against code. A maximum of 2 points can be scored as follows:

• Points scored = 0.05 x (% improvement from baseline)

2.01d Receptacle Load Efficiency

Intent
The use of energy efficient receptacle equipment can reduce their energy consumption.

Scope
Applicable to non-speculative buildings.

Assessment
Where the procurement of energy efficient receptacle plug loads and process equipment can be committed and quantified at the design stage, their aggregate savings against BCA’s reference receptacle power budget can be generated using the Energy Performance Points Calculator. A maximum of 1 point can be scored as follows:

• Points scored = 0.025 x (% improvement from baseline)
2.02 Energy Effectiveness (11 pts)

To consider energy effectiveness of a building holistically, the extent of use of energy systems in buildings terms of their absolute energy consumption should be taken into account. Understanding total building energy performance allows developers to work with the design team to evaluate the strategies to reduce the design building consumption from first principles, e.g. by considering the necessity of use of energy systems within spaces to adequately fulfil functional end user requirements alongside the optimisation of such systems. The elements of the building’s energy consumption are calculated and compared to a notional static reference defined by the Energy Performance Points Calculator. The Calculator is built on normalised fixed assumptions (e.g. operating hours, cooling W/m²) for the purposes of Green Mark points computation and comparison across projects. The energy consumption figures and savings generated are indicative representations of the actual building performance. They are not necessarily expected to correlate with that generated by dynamic energy modeling simulations which is based on a code reference model.

- 2.02a Building Energy (11 pts)
2.02a Building Energy

Scope
Applicable to all buildings.

Assessment
The Energy Performance Points Calculator* shall be used to generate the percentage improvement of the design energy consumption of the base building against the notional reference. The consumption should exclude carpark and receptacle loads. A maximum of 11 points can be scored as follows:

- Points scored = \( \frac{\text{% improvement from baseline}}{3} \)

*Note: In addition to the Energy Performance Points Calculator, energy modeling (for buildings with air-conditioned areas ≥ 5000m²) or detailed calculations (for buildings with air-conditioned area < 5000m²) shall be performed to demonstrate that minimum energy savings for GoldPLUS and Platinum ratings are met, as per 0. Pre-requisite Requirements.

Further Improvement in Design Energy Consumption Beyond Points Cap (Advanced Green Efforts)

Beyond the points cap, further points can be scored for improvement of the design energy consumption against the notional reference based on the above formula, up to a maximum of 2 points.
Renewable Energy (8 pts)

After considering energy efficiency and effectiveness, replacement of fossil energy use with renewables should also be looked into. This indicator focuses on driving the creation of opportunities for generation and utilisation of renewable energy. It aims to spur and acknowledge efforts by buildings to work towards the vision of zero energy or net positive energy low-rise buildings and low energy high-rise buildings. Note: Renewable energy and solar energy are used synonymously here as the context of Singapore’s tropical climate, coupled with limited natural resources, warrants solar energy as the most viable renewable energy option.

- 2.03a Solar Energy Feasibility Study (0.5 pt)
- 2.03b Solar Ready Roof (1.5 pts)
- 2.03c Adoption of Renewable Energy (6 pts)
2.03a Solar Energy Feasibility Study

Intent
The evaluation of a building footprint’s potential in harnessing solar energy can raise awareness on viable solar opportunities in the development and assist building developers in their decision making to adopt photovoltaics.

Scope
Applicable to all building developments.

Assessment
0.5 point can be scored for a solar feasibility report detailing the following aspects:

- Roof characteristics and shading considerations
- Technical solar energy generation potential
- Economics of solar installation
- Roof access and safety requirements
- Roof spatial optimisation recommendations

2.03b Solar Ready Roof

Intent
Designing roofs to be ready for photovoltaic installation facilitates ease of their deployment should building developers decide to do so at later stages of a project/ during building operation.

Scope
Applicable to projects that scored under 2.03a Solar Energy Feasibility Study. Where solar panels are installed under 2.03c Adoption of Renewable Energy, the area coverage of the feasible roof area by the panels can be counted towards compliance under this indicator.

Assessment
The project shall demonstrate its roof design for solar readiness for at least 50% of feasible roof area determined through 2.03a. 0.5 points each can be scored for the following:

- **Structural readiness**: Roof designed to accommodate optimised easy structural installation of solar panels on rooftop spaces, and included proof that the building and roof can support any additional static and wind load imposed by future PV systems
- **Electrical readiness**: Provisions to accommodate optimised easy electrical installation of solar panels on rooftop spaces
- **Spatial readiness**: Roof designed to optimise the available non-shaded rooftop area for solar panels - adoption of roof spatial optimisation recommendations outlined in 2.03a Solar Energy Feasibility Study
2.03c Adoption of Renewable Energy

**Intent**
On-site generation of renewable energy can reduce the building development’s power consumption from the grid and carbon emissions.

**Scope**
Applicable to building developments with on-site generation of renewable energy.

**Assessment**
The Energy Performance Points Calculator shall be used to calculate savings from replacement of the building electricity consumption through the use of renewable energy.

Points can be scored up to a cap of 6 points based on the following:

<table>
<thead>
<tr>
<th>Expected Energy Efficiency Index (EEI) [kWh/m²/yr]</th>
<th>% Replacement of Building Electricity Consumption by Renewable Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 120</td>
<td>1 point for every 0.5%</td>
</tr>
<tr>
<td>80 ≤ EEI &lt; 120</td>
<td>1 point for every 1.0%</td>
</tr>
<tr>
<td>50 ≤ EEI &lt; 80</td>
<td>1 point for every 1.5%</td>
</tr>
<tr>
<td>&lt; 50</td>
<td>1 point for every 2.5%</td>
</tr>
</tbody>
</table>

**Further Electricity Replacement by Renewables (Advanced Green Efforts)**
A maximum of 5 more points beyond the points cap for further percentage electricity replacement by renewable energy can be scored.
3. Resource Stewardship

With global use of resources increasing in the backdrop of the limited carrying capacity of the Earth, it is imperative that we work towards conserving the Earth’s resources for future generations. “Resource Stewardship” in the built environment refers to the responsible use and protection of the environment through conservation and sustainable practices. This section rewards projects for the responsible use and conservation of resources from the stages of construction through to building operations and occupancy. Resources covered include water, construction materials, construction and operational waste.

P.07 + POINTS PREREQUISITES
30 POINTS

3.01 Water (8 pts)
3.02 Materials (18 pts)
3.03 Waste (4 pts)

Advanced Green Efforts (7 pts)
P.07 Water Efficient Fittings

Intent
The use of water efficient fittings can reduce the building’s potable water consumption.

Scope
Applicable to all building developments with water fittings installed.

Assessment
The project shall demonstrate the use of water efficient fittings that meet minimum requirements as detailed in the following table:

<table>
<thead>
<tr>
<th>Type of Water Fittings</th>
<th>Prescribed Minimum WELS rating</th>
<th>Applicable Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basin Taps &amp; Mixers</td>
<td>3 Ticks WELS rating</td>
<td>Public/ staff/ school toilets</td>
</tr>
<tr>
<td></td>
<td>2 Ticks WELS rating</td>
<td>Other areas</td>
</tr>
<tr>
<td>Sink Taps &amp; Mixers</td>
<td>2 Ticks WELS rating</td>
<td>All areas</td>
</tr>
<tr>
<td>Shower Taps, Mixers or Showerheads</td>
<td>2 Ticks WELS rating</td>
<td>Public/ staff/ school shower facilities</td>
</tr>
<tr>
<td>Dual Flush Flushing Cisterns</td>
<td>2 Ticks WELS rating</td>
<td>All areas</td>
</tr>
</tbody>
</table>

Exemptions can be granted on a case-by-case basis, where there are special functional needs. As for all other water fittings such as flush valves, bib taps that are not listed in the above table shall comply with the mandatory standards stipulated in the Singapore Standard CP 48 : 2005 – Code of Practice for Water Services.
3.01 Water (8 pts)

With increasing occurrences of droughts and dry spells attributed to varying weather phenomenon and global warming, bouts of water shortage globally is an ever imminent threat. As Singapore has limited water catchment resources, it is crucial to implement good water management in order to ensure the long term sustainability of Singapore’s water system. Considering water efficient, monitoring and potable water replacement strategies in the building design can reduce potable water consumption and raise awareness on responsible use of water during building operation.

- 3.01a Water Efficient Systems (3 pts)
- 3.01b Water Monitoring and Leak Detection (2 pts)
- 3.01c Alternative Water Sources (3 pts)
3.01a Water Efficient Systems

Intent
The design of water efficient mechanical systems and strategies can minimise potable water consumption in building operations.

Scope
Applicable to all buildings with landscape irrigation, cooling towers or water fittings.

Assessment
(i) Landscape Irrigation
0.5 point each can be scored for the following, capped at 1 point:

- Every 25% of the landscape areas that are served by water efficient irrigation systems with features such as automatic sub-soil drip irrigation system with moisture or rain sensor control.
- Every 20% of the landscape areas that comprises drought tolerant plants.

(ii) Water Consumption of Cooling Towers
1 point each can be scored for the following:

- Provision of cooling tower water treatment system along with effective basin filtration system that can help increase solubility of water and facilitate 7 or more cycles of concentration (CoC) at acceptable water quality.
- Provision of devices to reduce heat rejection required through the cooling towers.

Better Water Efficient Fittings (Advanced Green Effort)
1 point can be scored should the project demonstrate the use of better WELS rated water efficient fittings used for 100% of the applicable water fittings as prescribed in P.07 whilst ensuring user requirements are not compromised.

3.01b Water Monitoring

Intent
Better control and monitoring can facilitate setting of consumption reduction targets. Making the monitored information accessible to end users can facilitate user engagement programmes and promote behavioural changes with regard to water management and use.

Scope
Applicable to all buildings with potable water usage.
Assessment

(i) Water monitoring and leak detection
0.5 point each can be scored for the following:

- Provision of private meters for all major water uses in the development
- Provision of smart remote metering system with alert features for leak detection

(ii) Water Usage Portal and Dashboard
0.5 point each can be scored for the following:

- Provision of water management portal, dashboard or other equivalent forms that display metered data, trending of water consumption and relevant parameters which facilitate better management of water consumption during building operation.
- Provision of water management portal, dashboard or other equivalent forms for individual tenants to monitor their own water usages and consumption.

3.01c Alternative Water Sources

Intent
The use of alternative water sources can reduce potable water consumption for general application and use.

Scope
Applicable to all buildings with potable water usage.

Assessment
Where alternative water sources are used for general application, for example landscape irrigation, toilet flushing, cooling tower make-up water or washing of external areas/ carpark areas, up to a maximum of 3 points can be scored based on the types of water recycling systems used as well as the extent of reduction in potable water usage:

- AHU condensate collection where > 50% of total condensate is collected – 1 point
- NEWater supply – 1 point
- On-site recycled water – 1 point
- Rainwater harvesting – 1 point
Buildings are resource intensive in their construction and fit-out, and incur a significant carbon footprint. Adopting sustainable construction design and practices, considering embodied energy from a life cycle approach as well as giving priority to sustainable fit-out systems can reduce the environmental impact of the building.

- 3.02a Sustainable Construction (8 pts)
- 3.02b Embodied Carbon (2 pts)
- 3.02c Sustainable Products (8 pts)
3.02a Sustainable Construction

Intent
To encourage the adoption of building designs, building structures and construction practices that are environmentally friendly and sustainable.

Scope
Applicable to all structural and non-structural components constituting the building superstructure.

Assessment

(i) Conservation and Resource Recovery
For projects built on sites with existing building structures, 1 point can be scored where either:

- The existing structures are conserved and not demolished.
- The existing structures are demolished with an enhanced demolition protocol, where a recovery rate of > 35% crushed concrete waste from the demolished building is sent to approved recyclers with proper facilities.

(ii) Resource Efficient Building Design
Up to 4 points can be scored here:

Concrete Usage Index (CUI): Points scored are as follows:

<table>
<thead>
<tr>
<th>Project’s CUI (m^3/m^3)</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 0.60</td>
<td>0.5</td>
</tr>
<tr>
<td>≤ 0.50</td>
<td>1</td>
</tr>
<tr>
<td>≤ 0.45</td>
<td>1.5</td>
</tr>
<tr>
<td>≤ 0.40</td>
<td>2</td>
</tr>
<tr>
<td>≤ 0.35</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Adoption of sustainable building systems: Points can also be scored based upon the extent of use of sustainable building systems as a percentage of the constructed floor area (CFA) as follows:

<table>
<thead>
<tr>
<th>Sustainable Building Systems</th>
<th>Points awarded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.5 points</td>
</tr>
<tr>
<td>Pre-stressed Concrete Elements</td>
<td>Total coverage area ≥ 25% of CFA</td>
</tr>
<tr>
<td>Hollow Core or Voided Concrete Elements</td>
<td></td>
</tr>
<tr>
<td>Light Weight Concrete Elements</td>
<td></td>
</tr>
<tr>
<td>High Strength Concrete Elements (Concrete grade &gt;60MPa)</td>
<td></td>
</tr>
<tr>
<td>Structural Steel Elements</td>
<td></td>
</tr>
<tr>
<td>Composite Structural Elements</td>
<td></td>
</tr>
<tr>
<td>Engineered Timber Elements</td>
<td></td>
</tr>
<tr>
<td>Prefabricated Prefinished Volumetric Construction units</td>
<td></td>
</tr>
<tr>
<td>Precast Concrete Elements</td>
<td></td>
</tr>
<tr>
<td>Leave-in Formwork</td>
<td></td>
</tr>
<tr>
<td>Others (to be accepted by BCA on case-by-case basis)</td>
<td></td>
</tr>
</tbody>
</table>
Use of BIM to calculate CUI (Advanced Green Efforts)

1 point can be scored where BIM is used to compute CUI.

(iii) Low Carbon Concrete

A cap of 3 points can be scored here.

Clinker content – Points can be scored for the use of concrete containing clinker ≤ 400 kg/m$^3$ for grades up to C50/60 for ≥ 80% of the applicable superstructural concrete by volume as follows.

<table>
<thead>
<tr>
<th>Concrete Categories*</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncertified concrete</td>
<td>0.5</td>
</tr>
<tr>
<td>SGBC-certified 1-Tick concrete</td>
<td>1.0</td>
</tr>
<tr>
<td>SGBC-certified 2-Tick concrete</td>
<td>1.5</td>
</tr>
<tr>
<td>SGBC-certified 3-Tick concrete</td>
<td>2.0</td>
</tr>
</tbody>
</table>

*Note: SGBC-certified concrete is deemed to have fulfilled the requirement of clinker content ≤ 400 kg/m$^3$

Replacement of coarse and fine aggregates – 0.5 point can be scored for every 5% replacement by mass of coarse and fine aggregates with recycled concrete aggregates (RCA) and/or washed copper slag (WCS) from approved sources for the superstructure concrete mix. The usage should not fall below 1.5% x GFA for RCA and/or 0.75% x GFA for WCS for points scoring.

3.02b Embodied Carbon

Intent

BCA’s Carbon Calculator is a tool to help developments identify their carbon debt and quantify their environmental impact and embodied energy, as well as allow benchmarking of projects over time.

Assessment

A maximum of 2 points can be scored for the use of BCA Carbon Calculator to compute the embodied carbon footprint of the development:

- Declaration of Concrete, Glass and Steel – 1 point
- Declaration of additional materials – Up to 1 point (0.25 pt per material)

Provide Own Emission Factors with Source Justification (Advanced Green Efforts)

Up to 1 point can be scored for the provision of own material emission factors (0.25 pt per material).

Compute the Carbon Footprint of the Entire Development (Advanced Green Efforts)

2 points can be scored for computation of the carbon footprint of the entire development and a detailed carbon footprint report based on all the materials used within the development.
3.02c Sustainable Products

Intent
The environmental performance of materials covered here includes their recycled content and environmental impact during production and resource extraction. The intent is to encourage the specification of resource efficient and environmentally friendly products for use in the fit-out of a building, taking a functional system approach to focus on greening major fit-out materials whilst allowing for flexibility in design as well as recognising designs with optimal/ minimal material use.

Scope
Applicable to non-structural building components. Structural components are excluded.

Assessment
A maximum cap of 8 points can be scored for (i) and (ii).

(i) Functional Systems
Points can be awarded for the specification and use of green products certified by approved local certification bodies, namely the Singapore Green Building Council and the Singapore Environment Council, within the 6 main functional system categories of the building as follows:

### Non-Speculative Buildings/ Speculative Buildings with Tenanted Areas Included

<table>
<thead>
<tr>
<th>Functional System Category</th>
<th>External Wall</th>
<th>Internal Wall</th>
<th>Flooring</th>
<th>Doors</th>
<th>Ceiling</th>
<th>Roofing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Group (Coverage: ≥ 60%)</td>
<td>1 pt</td>
<td>1 pt</td>
<td>1 pt</td>
<td>1 pt</td>
<td>0.5 pt</td>
<td>0.5 pt</td>
</tr>
<tr>
<td>Finishes Group (Coverage: ≥ 60%)</td>
<td>2 pt</td>
<td>2 pt</td>
<td>2 pt</td>
<td>0.5 pt</td>
<td>0.5 pt</td>
<td>0.5 pt</td>
</tr>
</tbody>
</table>

### Speculative Buildings with Tenanted Areas Excluded

<table>
<thead>
<tr>
<th>Functional System Category</th>
<th>External Wall</th>
<th>Internal Wall</th>
<th>Flooring</th>
<th>Doors</th>
<th>Ceiling</th>
<th>Roofing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Group (Coverage: ≥ 80%)</td>
<td>1 pt</td>
<td>0.5 pt</td>
<td>0.5 pt</td>
<td>0.5 pt</td>
<td>0.25 pt</td>
<td>0.5 pt</td>
</tr>
<tr>
<td>Finishes Group (Coverage: ≥ 80%)</td>
<td>2 pt</td>
<td>1 pt</td>
<td>1 pt</td>
<td>0.25 pt</td>
<td>0.25 pt</td>
<td>0.5 pt</td>
</tr>
</tbody>
</table>

All products (only if used) within a Group for the stipulated coverage must be green certified to score for that Group. Additionally, in order to score for a Finishes Group, projects must score for the respective Base Group first. Detailed examples may be found in the GM NRB: 2015 Technical Guide and Requirements.

(ii) Singular Sustainable Products outside of Functional Systems
Where sustainable hardscape, building services and M&E products certified by an approved local certification body are used, 0.25 point can be scored per product for ≥ 80% of the applicable use, capped at 2 points.

### Sustainable Products with Higher Environmental Credentials (Advanced Green Effort)

Up to 2 points can be scored for the use of products certified to higher tiers of environmental performance.

<table>
<thead>
<tr>
<th>Singapore Green Building Product Certification Rating</th>
<th>Points per product (≥ 80% of the applicable use)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Good (2-ticks)</td>
<td>0.25</td>
</tr>
<tr>
<td>Excellent (3-ticks)</td>
<td>0.5</td>
</tr>
<tr>
<td>Leader (4-ticks)</td>
<td>1.0</td>
</tr>
</tbody>
</table>
3.03

Waste (4 pts)

It is estimated that 2.2 billion tonnes of waste will be generated globally in 2025 (Source: World Bank). Singapore’s output of solid waste has increased significantly over the years, from 1,260 tonnes per day in 1970, to a high of 8,402 tonnes per day in 2015 (Source: NEA). Waste is an indicator of excess as it means we are using more than we need and depleting precious raw materials which could be by our future generations.

To minimise waste generation, it is crucial to use resources (other than building materials) consumed during the construction process efficiently, as well as provide adequate facilities and systems to manage waste during building operation.

- 3.03a Environmental Construction Management Plan (1 pt)
- 3.03b Operational Waste Management (3 pts)
3.03a Environmental Construction Management Plan

Intent
An effective and holistic management plan can facilitate better environmental performance of the construction process and promote waste minimisation.

Scope
Applicable to all buildings.

Assessment
1 point can be scored for effective implementation of an environmental construction management plan on construction sites through specific target setting, monitoring of energy and water use and construction waste minimisation measures.

3.03b Operational Waste Management

Intent
Appropriate collection and recycling provisions can facilitate the segregation of recyclable consumer waste at source. Provisions for the treatment of horticultural or wood waste for buildings with landscaping can promote their reuse and recycling as well.

Scope
Applicable to all buildings.

Assessment
1 point each can be scored for the provision of the following:

- Facilities for the collection and storage of different recyclables such as paper, glass, metal and plastic in commingled or sorted form.
- Facilities or systems for food waste to be treated and recycled, for buildings generating large volumes of food waste.
- Facilities or systems for the placement of horticultural or wood waste for recycling.

The recycling facilities or systems provided should be applicable to the building type and occupancy base and located at the convenience of use for building users.
Most of us spend a substantial proportion of our time within buildings, where we are psychologically, physiologically and emotionally affected by our surrounding environment. Aspects of a healthy indoor environment include better air quality, effective daylighting, quality artificial lighting, pleasant acoustics, inclusivity as well as biophilic design features that evokes the experience of nature. Designing for healthy buildings can be a sound economic investment that reaps healthy economic returns, with measures to improve the indoor environment leading to manifold monetary savings from improved health and well-being. A healing, positive environment nurtures healthier and happier occupants. In spaces where people work and study, this can result in increased work quality and productivity output. For social, recreational and commercial spaces, this can translate to an enhanced consumer/visitor experience and encourage more frequent patronage and human traffic.

At the same time, managing a building’s indoor environmental quality well necessitates operating the building smartly. Smart controls, direct access to building data and early fault detection allow the facility management team to gain a good understanding of the building’s health. This enables necessary intervention and optimisation measures to suit the occupants’ health and well-being.

P.08-P.15 + POINTS PREREQUISITES
30 POINTS

4.01 Indoor Air Quality (10 pts)
4.02 Spatial Quality (10 pts)
4.03 Smart Operations (10 pts)

Advanced Green Efforts (9 pts)
P.08 Thermal Comfort

**Intent**
The air-conditioning system should be designed to serve its intended purpose of providing a thermally comfortable space for occupants.

**Scope**
Generally applicable to all air conditioning systems serving occupied spaces of building developments.

**Assessment**
The normal design dry-bulb temperature for comfort air-conditioning shall be within 23°C - 25°C, and resultant relative humidity ≤ 65% in accordance with SS 553 : 2016 - *Code of Practice for Air-Conditioning and Mechanical Ventilation in Buildings*.

P.09 Minimum Ventilation Rate

**Intent**
The provision of adequate ventilation in a building is of fundamental importance to ensure the health of the occupants. Insufficient ventilation can cause a build-up in the concentration of carbon dioxide and other contaminants emitted indoors.

**Scope**
Applicable to air-conditioning or mechanical ventilation systems in regularly occupied spaces of all building developments.

**Assessment**
The building’s air-conditioning and mechanical ventilation systems shall be designed to provide appropriate minimum quantum of outdoor air rates as stated in Table 1 and Table 5 of SS 553 : 2016.

P.10 Filtration Media for Times of Pollution

**Intent**
The effective removal of harmful pollutants in outdoor air from the building ventilation system through high efficiency filters can enhance indoor air quality and the health and well-being of the occupants.

**Scope**
Applicable to air handling units (AHUs) or systems for dedicated treatment of outdoor air in air-conditioned building developments.
Assessment
AHUs or dedicated outdoor air units in the building shall be designed to accommodate fine dust filters of least a rating of Minimum Efficiency Reporting Value (MERV) 14 (ASHRAE 52.2: 2012) or F8 (EN779: 2012), when the outdoor pollution level is in the unhealthy range in accordance with MOH’s guidelines, as stipulated in SS 553: 2016.

P.11 Low Volatile Organic Compound (VOC) Paints

Intent
Limiting the use of high-emitting building and furnishing materials can improve the indoor environmental quality for the health and well-being of occupants.

Scope
Applicable to all indoor paints including primers, sealers, base coats and top coats.

Assessment
Low VOC paints certified by an approved local certification body shall be used for at least 90% of the total painted internal wall areas.

P.12 Refrigerants

Intent
Controlling the use and release of ozone depleting substances and greenhouse gases can reduce their potential damage to the ozone layer and curb global warming.

Scope
Applicable to all air conditioning systems within building developments.

Assessment
Air conditioning systems shall use refrigerants with ozone depleting potential (ODP) of 0 or global warming potential (GWP) of less than 100.

A refrigerant leak detection system shall also be installed in critical areas of plant rooms containing chillers and/or other equipment using refrigerants.
P.13 Sound Level

**Intent**

Minimising noise and vibration from mechanical and electrical equipment can ensure a basic level of acoustic comfort for occupant health and wellbeing.

**Scope**

Applicable to mechanical and electrical equipment serving occupied spaces of building developments.

**Assessment**

The relevant equipment as aforementioned shall be designed to comply with the recommended ambient sound levels in Table 4 of SS 553 : 2016.

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P.14 Permanent Instrumentation for the Measurement and Verification of Chilled Water Air-Conditioning Systems

**Intent**

Better energy management and monitoring of chilled water air-conditioning systems can ensure their operational efficiency can be optimised and maintained throughout the equipment lifespan.

**Scope**

Applicable to chilled-water air-conditioning systems serving the building with aggregate cooling capacity exceeding 30 kW. This applies also to district cooling systems (DCS) operated by suppliers of district cooling services registered under the Energy Conservation Act.

**Assessment**

Permanent instrumentation to monitor water cooled chilled water plant efficiency shall also be provided. The installed instrumentation shall have the capability to calculate resultant efficiency (i.e. kW/RT) within 5% of its true value, in accordance with ASHRAE Guideline 22 and AHRI Standard 550/590. Each measurement system shall include the sensor, any signal conditioning, the data acquisition system and wiring connecting them. The following are to be complied with where applicable:

- Location and installation of the measuring devices to meet the manufacturer’s recommendation.
- All data logging with capability to trend at 1 minute sampling time interval, and recorded to the 3rd decimal digit.
- Computation and display of air-side efficiency, water-side efficiency and total system efficiency.
• Full-bore magnetic in-line flow meters, with 1% uncertainty and capable of electronic in-situ verification to within ±2% of its original factory calibration, shall be provided for chilled-water and condenser water loop. Where circumstances do not allow the installation of magnetic in-line flow meters, ultrasonic flow meters may be used.

• Temperature sensors shall be provided for chilled water and condenser water loop with end-to-end measurement uncertainty within ±0.05°C over the entire measurement/calibration range. Thermo-wells shall be installed in a manner that enables the sensors to be in direct contact with fluid flow. Each temperature measurement location shall have 2 spare thermo-wells located at both sides of the sensor for verification of measurement accuracy.

• Dedicated power meters (of IEC Class 1 or equivalent) and associated current transformers (Class 0.5 or equivalent) shall be provided for monitoring of the power consumption of 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)

P.15 Electrical Sub-Metering & Monitoring

Intent
Monitoring major energy uses in the building can enable audit and continuous improvement to optimise use and avoid energy wastage.

Scope
Applicable to all building developments with GFA of 5,000m² or more.

Assessment
Subsystem measurement devices with remote capability shall be provided, linked to a monitoring system and measure and trend energy consumption data of:

• Each of the following energy sub systems:

<table>
<thead>
<tr>
<th>Use (Sum of all loads)</th>
<th>Sub-systems thresholds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lift &amp; escalator</td>
<td>Sum of all feeders &gt; 50 kVA</td>
</tr>
<tr>
<td>Heater, including heat pump</td>
<td>&gt; 50 kWth</td>
</tr>
<tr>
<td>Process loads</td>
<td>Connected loads &gt; 50 kVA</td>
</tr>
<tr>
<td></td>
<td>Connected gas or district services load &gt; 75 kW</td>
</tr>
<tr>
<td>Mechanical ventilation</td>
<td>The subsystem’s load &gt; 15kW</td>
</tr>
<tr>
<td>VRF systems (CUs, FCUs)</td>
<td>No threshold</td>
</tr>
</tbody>
</table>

• Each tenancy or floor, as well as high energy load areas exceeding 50kVA such as car park, data centres, IT closets and process areas.
Indoor Air Quality (10 pts)

Contemporary research has shown that poor air quality is an attributing factor to sick building syndrome symptoms and respiratory illnesses, which can have detrimental effects on business productivity and performance as well as the wellbeing of the occupants. As people spend longer hours in buildings, research has also indicated that the cost of poor indoor environmental quality could well be even higher than most other costs. It is important to ensure good air quality to reduce the risk of illnesses within building occupied spaces where occupants are expected to work or remain in for an extended period of time.

- 4.01a Occupant Comfort (2 pts)
- 4.01b Outdoor Air (3 pts)
- 4.01c Indoor Contaminants (5 pts)
4.01a Occupant Comfort

Intent
The testing and evaluation of indoor air quality parameters is crucial to ensure occupant comfort. Engaging building occupants completes the feedback loop, and is essential for the management and improvement of operational practices in high-performing green buildings.

Scope
Applicable for normally occupied spaces air-conditioned for comfort purposes.

Assessment

(i) Indoor Air Quality (IAQ) Surveillance Audit
0.5 or 1 point can be scored respectively for an IAQ surveillance audit based on the indicative or reference methods described in SS 554 : 2016 Code of Practice for Indoor Air Quality for Air-Conditioned Buildings, and committed to be conducted for the building within one year after occupancy or after reasonable occupancy has been reached.

(ii) Post Occupancy Evaluation
0.5 point can be scored if a Post Occupancy Evaluation (POE) questionnaire is committed to be conducted within a year after building occupancy or after reasonable occupancy has been reached to assess occupant wellbeing and interactions with their indoor environment. Appropriate corrective actions should also be committed to be taken to improve the quality of the indoor environmental conditions if required.

(iii) Indoor Air Quality Display
0.5 point can be scored for the provision of display panels for temperature and relative humidity information at each floor/tenancy, to raise awareness among building occupants on the internal conditions of the space.

Indoor Air Quality Trending (Advanced Green Effort)
Up to 2 points can be scored for the provision of monitoring and trend logging for the following:

- Provision for monitoring and trend logging of temperature and relative humidity through a centralised system – 0.5 point
- Provision for monitoring and trend logging of common indoor air pollutants, such as formaldehyde, at each floor - 1.5 point
4.01b Outdoor Air

Intent
Insufficient ventilation in conditioned spaces can cause a build-up in the concentration of indoor contaminants.

Scope
Applicable to all building developments with air conditioning systems supplying outdoor air to occupied spaces. Full points can be scored here for buildings with no air-conditioned spaces.

Assessment
(i) Ventilation Rates
A maximum of 1.5 points can be scored for the:
- Measurement and monitoring of outdoor airflow volume in accordance with desired ventilation rates at precool units (e.g. PAHUs and PFCUs) or all AHUs and FCUs - 0.5 point or 1 point respectively
- Use of demand control ventilation strategies such as carbon dioxide sensors or equivalent devices to regulate the quantity of fresh air and ventilation in accordance with the space requirements – 0.5 point

(ii) Enhanced Filtration Media
0.5 point or 1 point can be scored for the permanent provision of Minimum Efficiency Rating Value (MERV 14, ASHRAE 52.2 or F8/EN779 class of filter or equivalent) to all PAHUs or to all PAHUs and AHUs respectively.

(iii) Dedicated Outdoor Air System
0.5 point can be scored for the provision of a dedicated outdoor air system, such as precool units, to encourage effective treatment of outdoor air for cooling and dehumidification.

4.01c Indoor Contaminants

Intent
Indoor contaminant pollution control at source and air treatment strategies can safeguard the health of building occupants.

Scope
Applicable to buildings with relevant ventilations systems.
Assessment

(i) Local Exhaust and Air Purging System
1 point each can scored for the provision of:

- Local isolation and exhaust systems to remove the source of pollutants
- Air purging system to replace contaminated indoor air with outdoor fresh air

(ii) Ultraviolet Germicidal Irradiation (UVGI) System
0.5 point can be scored for the provision of UVGI system in AHUs and FCUs to control airborne infective microorganisms.

(iii) More Stringent VOC Limits for Interior Fittings and Finishes
A maximum of 2 points can be scored through the specification and use of products certified SGBP Very Good or above, of which the VOC emission rate standards meet more stringent VOC emission limits. All products with VOC content within a Functional System for ≥ 80% of applicable areas must be SGBP Very Good or above to score for that System.

<table>
<thead>
<tr>
<th>Functional System</th>
<th>Other Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Wall</td>
<td>Internal Wall</td>
</tr>
<tr>
<td>1 pt</td>
<td>1 pt</td>
</tr>
</tbody>
</table>

(iv) Use of Persistent Bio-cumulative and Toxic (PBT) free lighting
0.5 point can be scored for the use of PBT-reduced or free luminaries for ≥ 90% of light fittings in the project.

Refrigerants with Low Global Warming Potential (Advanced Green Effort)
Points can be scored for the use of refrigerants with Ozone Depleting Potential (ODP) of 0 as well as low global warming potential (GWP) as follows:

- GWP < 700 - 0.5 point or
- GWP < 10 - 1 point
Spatial Quality (10 pts)

The spatial quality of a building is assessed through the experiential value of both the physical and social qualities of the spaces within the development. Although many spatial quality indicators are qualitative, there are a number of commonly agreed upon indicators that act as a reliable proxy to determine the projects spatial quality which can enhance the indoor environment and wellbeing of the occupants and visitors to the building. These include creating access to quality daylight and artificial lighting, ensuring spaces are acoustically comfortable and inclusive as well as incorporating design features that evoke a connection to nature.

- 4.02a Lighting (6 pts)
- 4.02b Acoustics (2 pts)
- 4.02c Wellbeing (2 pts)
4.02a Lighting

Intent
Natural lighting has been linked to the positive mental wellbeing of building occupants. It connects enclosed indoor environments with the external natural environment. In the tropics, special care must be taken to maximise effective daylight while minimising visual discomfort and maintaining the façade’s thermal efficiency. This is made possible by incorporating effective daylight design strategies at the beginning of the design process. Where daylight is not possible, adherence to minimum quality standards for artificial lighting provisions ensures well-lit and comfortable spaces for occupants.

Scope
Applicable to common spaces and occupied spaces of building developments.

Assessment
Up to 6 points can be scored for the following:

(i) Effective Daylighting and Potential for Visual Discomfort

Effective daylighting for common areas – 2 points
Up to 2 points can be scored by prorating the number of daylit transient common spaces with daylighting controls against the total number of applicable spaces. The applicable areas are toilets, staircases, corridors, lift lobbies, atriums and carparks.

Effective daylighting for occupied spaces – 4 points

<table>
<thead>
<tr>
<th>Method</th>
<th>Percentage of occupied spaces with access to effective daylighting (3 points)</th>
<th>Effective Mitigation of Overlit Areas (1 point)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Simulated Daylight Availability Tables: Simplified method for standard designs to guide concept stage design in identifying design strategies for optimised daylight design.</td>
<td>Points can be scored as follows based on the percentage of total occupied areas that can achieve the specific Daylight Autonomy (DA) requirement of $D_{AN,50%}$ (without overlighting), as outlined in the Green Mark NRB: 2015 Technical Guide and Requirements Annex B: Effective Daylighting Simulation and Pre-Simulated Daylight Availability Tables Methodology and Requirements. Effectively daylit areas shall be integrated with automated lighting controls.</td>
<td>1 point can be scored for the adoption of suitable mitigation strategies for overlit spaces.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 to &lt; 35 %</td>
<td>0.5</td>
</tr>
<tr>
<td>35 to &lt; 55 %</td>
<td>1</td>
</tr>
<tr>
<td>55 to &lt; 75 %</td>
<td>2</td>
</tr>
<tr>
<td>$\geq$75%</td>
<td>3</td>
</tr>
</tbody>
</table>

1 point can be scored where mitigation measures to effectively address overlighting are included into the simulation model in accordance with Annex B.
4.02a (ii) Quality of Artificial Lighting

Points can be scored for the following attributes of lighting used in occupied spaces, capped at 1 point (90% of the applicable functional areas should be served by the relevant luminaires to score):

- Good light-output over life with a minimum lifespan rating of L70 ≥ 50,000 life hours - 0.5 point
- Regular colour (temperature) uniformity. In these occupied areas where LEDs luminaires are used, they must have Standard Deviation of Colour Matching (SDCM) of ≤ 3 steps based on MacAdam Ellipse - 0.5 point
- Lighting designed to avoid flicker and stroboscopic effects, by using high frequency ballasts for fluorescent luminaries and LED lighting with driver output frequency < 200Hz and < 30% flicker - 0.5 point
- Meeting the minimum colour rendering index (Ra or CRI) in Clause 5 of SS 531 – 1 : 2006 (2013) – Code of Practice for Lighting of Workplaces - 0.5 point
- LED Luminaires certified under SGBP scheme - 1 point

4.02b Acoustics

Intent

An improved acoustical performance for normally occupied spaces can enhance the aural comfort of its occupants, facilitating communication, reducing unwanted sound and aiding in speech privacy.

Scope

Applicable to occupied spaces of building developments.

Assessment

(i) Sound Transmission Reduction

0.5 point can be scored for projects that demonstrate that the acoustic performance of the internal partitions between adjoining spaces will be constructed to achieve the following performance levels:

<table>
<thead>
<tr>
<th>Description</th>
<th>Sound Transmission Class (STC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between general office spaces</td>
<td>40 - 50</td>
</tr>
<tr>
<td>Spaces where confidential speech are required/ Between mechanical and equipment spaces and occupied spaces:</td>
<td>50 – 60</td>
</tr>
</tbody>
</table>

Equivalent sound transmission metrics may also be used to qualify the range.

(ii) Acoustic Report

1.5 points can be scored for an acoustic design and verification report adhering to the requirements in the *GM NRB: 2015 Technical Guide and Requirements*. 
4.02c Wellbeing

**Intent**
Wellbeing refers to the state of being comfortable, healthy or happy. Providing nurturing, healing and inclusive spaces can enhance the building occupant and user’s environment, and overall wellbeing. This includes integrating within buildings places of respite, nature access, architecture that invoke a connection to nature as well as accessible and inclusive spaces.

**Scope**
Applicable to all building developments.

**Assessment**
A maximum cap of 2 points can be scored for the following:

**(i) Biophilic Design**
Points can be scored for architecture that reinforces the attributes and experience of nature to nurture the human-nature relationship:

- The provision of accessible sky gardens, sky terraces, internal courtyards and rooftop gardens as areas for respite – 1 point
- The provision for at least 5% of the common areas or functional spaces to have fixed indoor planting – 0.5 point
- Building design that adopt biomimicry designs – 1 point
- Building design that takes after any natural shapes and forms/ creates ecological attachment to the place – 0.25 point
- Provision of images of nature for 5% of common areas – 0.25 point

**(ii) Universal Design (UD) Mark**
The BCA UD Mark accords recognition to developments that adopt a user-centric philosophy in their design, operations and maintenance. Points can be scored for projects being awarded either:

- UD Mark Certified/ Gold Award – 0.5 point
- UD Mark GoldPLUS/ Platinum Award – 1 point
4.03

Smart Building Operations
(10 pts)

The use of automation, data and behavioural science can enable building professionals to optimise equipment and related processes in order to maintain equipment efficiency and building comfort requirements. A three-level taxonomy is defined to classify the maturity of smartness as a framework, namely basic monitoring of data, using feedback from data to control demand, and finally advanced integration and analytics of data. Additionally, a proper handover to the facilities and operations team is of fundamental importance to ensure that the systems work as per their intended function and that sustainable design is translated into actual operational performance.

- 4.03a Energy Monitoring (3 pts)
- 4.03b Demand Control (3 pts)
- 4.03c Integration and Analytics (3 pts)
- 4.03d System Handover and Documentation (1 pt)
4.03a Energy Monitoring

Intent
Tracking a building’s energy use with the data presented in a relevant manner to engage its occupants can have an effect in helping to manage building energy consumption. Related to this ideal of sharing building data openly is the need to apply open standards to future-proof the building’s management system and to facilitate data exchange between subsystems.

Scope
Applicable to all buildings.

Assessment
(i) Energy Portal and Dashboard
1 point each can be scored for the provision of energy portals/dashboards in the form of digital displays or web-based/mobile application for:

- Common areas, or web-based and mobile applications
- Tenanted areas, showing the energy consumption in their respective leased spaces

(ii) BAS and Controllers with Open Protocol
1 point can be scored for using BACnet, Modbus or any other non-proprietary protocol as the network backbone for the building management system, with the system being able to provide scheduled export of a set of any chosen data points to commonly used file formats.

Permanent M&V for VRF Systems (Advanced Green Effort)
An additional 2 points can be awarded for provision of permanent measuring instruments for monitoring of energy efficiency performance of Variable Refrigerant Flow (VRF) condensing units and air distribution subsystem. The installed instrumentation shall have the capability to calculate resultant system efficiency (i.e. kW/RT or COP) within 10% uncertainty. Each measurement system shall include the sensor, any signal conditioning, the data acquisition system and wiring connecting them. All data are to be logged at 5 minute sampling time interval, and recorded to at least 1 decimal point, and data shall be available for extraction for verification purposes.

4.03b Demand Control

Intent
Using occupancy based controls to monitor the usage of spaces and vary temperature, ventilation and lighting demand while maintaining room temperature effectiveness, good indoor environmental quality and lighting quality, can significantly reduce building energy consumption. The energy savings from such controls can be taken into account under the Energy Performance Points Calculator under Part 2 Building Energy Performance.
Scope
Applicable to buildings.

Assessment
(i) ACMV Demand Control
A maximum of 2 points can be scored for the use of the following controls to regulate the temperature and/or airflow of spaces served by air-conditioning and/or mechanical ventilation systems:

- Binary sensing controls for ≥ 80% of all transient and/or all occupied areas – 0.5 point per respective area
- Occupancy-based sensing controls for ≥ 80% of all transient and/or all occupied areas – 1 point per respective area

(ii) Lighting Demand Control
0.5 point each can be scored for the use of occupancy/vacancy sensors to moderate brightness of the luminaries for ≥ 80% of transient and occupied areas respectively.

4.03c Integration and Analytics

Intent
The innovative and integrative use of data can optimise workflow or attain persistence of high performance and energy efficiency in a building. Basic integration and use of sensor data can optimise and operate the building in an informed and effective manner. The use of advanced integration and analytics can provide enhanced efficacy in lowering energy use, increase asset reliability, and improve the user experience.

Scope
Applicable to all buildings.

Assessment
A maximum of 3 points can be scored for the following:

(i) Basic Integration and Analytics
Assessment
0.5 point each can be scored for basic integration and analytics features such as (but not limited to):

- Basic fault detection and diagnostics (FDD) of sensors, e.g. faulty, stuck or miss-calibrated sensors.
- Provision of adaptive control algorithms based on outdoor weather conditions.
- Equipment exceptions monitoring, e.g. abnormal set point, detecting equipment that run beyond intended operating hours.
(ii) Advanced Integration and Analytics

1 point each can be scored for advanced integration and analytics features such as (but not limited to):

- Advanced detection and diagnostics of deviation from normal expected behaviour of a network of HVAC equipment for root causes of equipment or system-wide faults or inefficiencies.
- Prioritise equipment maintenance using machine condition monitoring.
- De-silo building subsystems to optimise resource use or improve the user experience.
- Demand response control to curtail energy use subject to equipment constraints and occupants’ comfort.
- Use of BIM or similar applications that provide location-based visualisation of the building’s state.

Additional Advanced Integration and Analytical Features (Advanced Green Effort)

An additional 1 point can be scored for additional advanced integration and analytical features beyond the points cap.

4.03d System Handover and Documentation

Intent

Design and delivery integration is essential to delivering an operationally energy efficient building. Control systems should be properly tested and verified and to ensure operational continuity from construction to building maintenance and operation. These criteria indicate the presence of a quality assurance plan to maintain the desired energy efficiency and indoor comfort.

Assessment

1 point can be scored for a proper system verification and handover of higher-order functional and system level performance of buildings control systems, mechanical systems and electrical systems. The project shall demonstrate a commitment to comply to verification requirements and show evidence of relevant schedules and documentation.

Expanded Post Occupancy Performance Verification by a 3rd Party (Advanced Green Effort)

0.5 point can be scored per energy subsystem (e.g. lighting controls, mechanical ventilation, hot water system, heat recovery system, renewable energy system) up to 2 points, where the owner engages an independent competent professional (either a BCA registered Energy Auditor or a Professional Engineer (PE) (Mech/Elect)) to verify the operational performance and provide recommendations on system performance enhancement. This should be conducted within one year from the building’s TOP.

Energy Performance Contracting (Advanced Green Effort)

1 point can be scored for engaging an Energy Performance Contracting (EPC) firm (accredited by SGBC) to implement and deliver energy efficiency, renewable energy and/or energy recovery projects with an energy performance contract wherein the EPC firm’s remuneration is based on demonstrated energy savings. Operational system efficiency should be guaranteed over a minimum of 3 years.
5. Advanced Green Efforts

The Green Mark NRB: 2015 Advanced Green Efforts section recognises the implementation of industry leading performance or innovative strategies, designs or processes that demonstrate exceptional levels of sustainability. The 20 points in this section are bonus points that can be added to the base Green Mark score to help projects demonstrate their holistic environmental performance and achieve higher levels of Green Mark award.

The enhanced performance criteria has indicators placed within the 4 main sections of Climatic Responsive Design, Building Energy Performance, Resource Stewardship and Smart and Healthy Building that we have identified as practices that are pioneering initiatives in sustainable design.

The remaining criteria within this section recognise projects that undertake sustainability with the view of market transformation, such as demonstrating cost neutrality. Other criteria recognise broader aspects of sustainability including socio-economic indicators or global sustainability benchmarking that address issues outside of green building rating tools.

20 POINTS

5.01 Enhanced Performance (15 pts)
5.02 Demonstrating Cost Effective Design (2 pts)
5.03 Complementary Certifications (1 pt)
5.04 Social Benefits (2 pts)
5.01 Enhanced Performance

**Intent**
Points can be awarded based on the Advanced Green Efforts indicators that are highlighted within the Green Mark NRB: 2015 criteria. Alternatively, where projects can demonstrate substantial performance to a specific sustainability indicator or outcome addressed within Green Mark beyond what is specified in the criteria, points can be awarded on a case by case basis.

**Assessment**
BCA will cap the points at 15 points for enhanced performance indicators per project. Submission requirements for assessment shall follow the guidance for each enhanced performance indicator within the main Green Mark sections.

5.02 Demonstrating Cost Effective Design

**Intent**
Projects that can demonstrate that they have achieved high levels of environmental performance without an increased capital expenditure are of great interest to promote market transformation and encourage the mass market to drive towards higher levels of environmental sustainability.

**Assessment**
1 or 2 points respectively can be scored for demonstration of cost effective or cost neutral design beyond the norm through a detailed quality surveyor’s report of the building.

5.03 Complementary Certifications

**Intent**
Green Mark is an assessment tool that assesses the environmental sustainability of a building. However, the consideration of sustainability indicators beyond those relevant to the built environment is also important.

**Assessment**
1 point can be scored where the project demonstrates that it is certified through a local or international complementary certification or rating tool that assesses the project beyond the environmental indicators within Green Mark NRB: 2015.
5.04 Social Benefits

Intent
While Green Mark focuses on environmental sustainability, this criterion rewards projects that are able to demonstrate that their project contributes to social sustainability.

Assessment
A maximum of 2 points can be scored for projects that demonstrate their social benefits or how social sustainability has been incorporated into the project. This can (but not limited to) include efforts that demonstrate enhanced considerations to further wellbeing, welfare, community integration as well as the purchase of clean energy (e.g. solar energy) through third party leasing contracts.
### Prerequisite Requirements

**Prerequisites P.01 to P.15:** Parked under main criteria  
**Minimum Points Prerequisites**  
**Energy Modeling Prerequisite**

### Elective Requirements

**Part 1 - Climatic Responsive Design**  
<table>
<thead>
<tr>
<th>Requirement</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.01 Envelope and Roof Thermal Transfer</td>
<td>30 points</td>
</tr>
<tr>
<td>P.02 Air Tightness and Leakage</td>
<td></td>
</tr>
<tr>
<td>P.03 Bicycle Parking</td>
<td></td>
</tr>
</tbody>
</table>

**1.01 Leadership**  
<table>
<thead>
<tr>
<th>Sub-requirement</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.01a Climatic &amp; Contextually Responsive Brief</td>
<td>1 point</td>
</tr>
<tr>
<td>1.01b Integrative Design Process</td>
<td>2 points</td>
</tr>
<tr>
<td>1.01c Environmental Credentials of Project</td>
<td>2 points</td>
</tr>
<tr>
<td>Team 1.01d Building Information Modeling</td>
<td>3 points</td>
</tr>
<tr>
<td>4D, 5D &amp; 6D BIM (Advanced Green Efforts)</td>
<td>3 points</td>
</tr>
<tr>
<td>1.01e User Engagement</td>
<td>3 points</td>
</tr>
</tbody>
</table>

**1.02 Urban Harmony**  
<table>
<thead>
<tr>
<th>Sub-requirement</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.02a Sustainable Urbanism</td>
<td>5 points (capped)</td>
</tr>
<tr>
<td>(i) Environmental Analysis</td>
<td>2 pts</td>
</tr>
<tr>
<td>(ii) Response to Site Context</td>
<td>1 pt</td>
</tr>
<tr>
<td>(iii) Urban Heat Island (UHI)</td>
<td>3 pts</td>
</tr>
<tr>
<td>(iv) Green Transport</td>
<td>1 pt</td>
</tr>
<tr>
<td>1.02b Integrated Landscape and Waterscape</td>
<td>5 points (capped)</td>
</tr>
<tr>
<td>(i) Green Plot Ratio (GnPR)</td>
<td>3 pts</td>
</tr>
<tr>
<td>GnPR ≥ 5.0 (Advanced Green Efforts)</td>
<td>1 pt</td>
</tr>
<tr>
<td>(ii) Tree Conservation</td>
<td>1 pt</td>
</tr>
<tr>
<td>(iii) Sustainable Landscape Management</td>
<td>1.5 pts</td>
</tr>
<tr>
<td>(iv) Sustainable Storm Water Management</td>
<td>1 pt</td>
</tr>
</tbody>
</table>

**1.03 Tropicality**  
<table>
<thead>
<tr>
<th>Sub-requirement</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.03a Tropical Façade Performance</td>
<td>3 points</td>
</tr>
<tr>
<td>Greenery on the East and West façade (Advanced Green Efforts)</td>
<td>1 pt</td>
</tr>
<tr>
<td>Thermal Bridging (Advanced Green Efforts)</td>
<td>1 pt</td>
</tr>
<tr>
<td>1.03b Internal Spatial Organisation</td>
<td>3 points</td>
</tr>
<tr>
<td>1.03c Ventilation Performance</td>
<td>4 points</td>
</tr>
<tr>
<td>Wind Driven Rain Simulation (Advanced Green Efforts)</td>
<td>1 pt</td>
</tr>
</tbody>
</table>
### Part 2 – Building Energy Performance

<table>
<thead>
<tr>
<th>Section</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 2 – Building Energy Performance</td>
<td>30 points</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.04   Air Conditioning Total System and Component Efficiency</td>
<td></td>
</tr>
<tr>
<td>P.05   Lighting Efficiency and Controls</td>
<td></td>
</tr>
<tr>
<td>P.06   Vertical Transportation Efficiency</td>
<td></td>
</tr>
</tbody>
</table>

#### 2.01 Energy Efficiency

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.01a Air Conditioning Total System Efficiency</td>
<td>5 points</td>
</tr>
<tr>
<td>2.01b Lighting System Efficiency</td>
<td>3 points</td>
</tr>
<tr>
<td>2.01c Carpark System Energy</td>
<td>2 points</td>
</tr>
<tr>
<td>2.01d Receptacle Energy</td>
<td>1 point</td>
</tr>
</tbody>
</table>

#### 2.02 Energy Effectiveness

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.02a Building Energy</td>
<td>11 points</td>
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<tr>
<td>Further Improvement in Design Energy Consumption Beyond Points Cap (Advanced Green Efforts)</td>
<td>2 pts</td>
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#### 2.03 Renewable Energy

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<tr>
<th>Subsection</th>
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<tbody>
<tr>
<td>2.03a Solar Energy Feasibility Study</td>
<td>0.5 point</td>
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<tr>
<td>2.03b Solar Ready Roof</td>
<td>1.5 points</td>
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<tr>
<td>2.03c Adoption of Renewable Energy</td>
<td>6 points</td>
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<tr>
<td>Further Electricity Replacement by Renewables (Advanced Green Efforts)</td>
<td>5 pts</td>
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### Part 3 – Resource Stewardship

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<tr>
<td>Part 3 – Resource Stewardship</td>
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<tr>
<td>P.07   Water Efficient Fittings</td>
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#### 3.01 Water

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<tr>
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<tbody>
<tr>
<td>3.01a Water Efficient Systems</td>
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<tr>
<td>(i) Landscape irrigation</td>
<td>3 points</td>
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<tr>
<td>(ii) Water Consumption of Cooling Towers</td>
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<tr>
<td>Better Water Efficient Fittings (Advanced Green Efforts)</td>
<td>2 pts</td>
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<tr>
<td>3.01b Water Monitoring</td>
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<tr>
<td>(i) Water Monitoring and Leak Detection</td>
<td>1 pt</td>
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<tr>
<td>(ii) Water Usage Portal and Dashboard</td>
<td>1 pt</td>
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<tr>
<td>3.01c Alternative Water Sources</td>
<td>3 points</td>
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#### 3.02 Materials

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<thead>
<tr>
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<tbody>
<tr>
<td>3.02a Sustainable Construction</td>
<td></td>
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<tr>
<td>(i) Conservation and Resource Recovery</td>
<td>8 points</td>
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<tr>
<td>(ii) Resource Efficient Building Design</td>
<td>1 pt</td>
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<tr>
<td>Use of BIM to calculate CUI (Advanced Green Efforts)</td>
<td>4 pts</td>
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<tr>
<td>(iii) Low Carbon Concrete</td>
<td>1 pt</td>
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<tr>
<td>3.02b Embodied Carbon</td>
<td></td>
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<tr>
<td>Provide Own Emission Factors with Source Justification (Advanced Green Efforts)</td>
<td>3 pts (capped)</td>
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<tr>
<td>Compute the Carbon Footprint of the Entire Development (Advanced Green Efforts)</td>
<td>2 pts</td>
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<tr>
<td>3.02c Sustainable Products</td>
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<tr>
<td>(i) Functional Systems</td>
<td>8 points (Capped)</td>
</tr>
<tr>
<td>(ii) Singular Sustainable Products outside of Functional Systems</td>
<td>12.5 pts</td>
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<tr>
<td>Sustainable Products with Higher Environmental Credentials (Advanced Green Efforts)</td>
<td>2 pts</td>
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<tr>
<td>3.03 Waste</td>
<td>4 points</td>
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<td>--------------------------------</td>
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<tr>
<td>3.03a Environmental Construction Management Plan</td>
<td>1 point</td>
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<tr>
<td>3.03b Operational Waste Management</td>
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**Part 4 – Smart & Healthy Building**  
30 points

- P.08 Thermal Comfort
- P.09 Minimum Ventilation Rate
- P.10 Filtration Media for Times of Pollution
- P.11 Low Volatile Organic Compound (VOC) Paints
- P.12 Refrigerants
- P.13 Sound Level
- P.14 Permanent Instrumentation for the Measurement and Verification of Chilled Water Air-Conditioning Systems
- P.15 Electrical Sub-Metering & Monitoring

**4.01 Indoor Air Quality**  
10 points

- 4.01a Occupant Comfort  
  (i) Indoor Air Quality (IAQ) Surveillance Audit  
  (ii) Post Occupancy Evaluation  
  (iii) Indoor Air Quality Display

  *Indoor Air Quality Trending (Advanced Green Efforts)*  
  2 pts

- 4.01b Outdoor Air  
  (i) Ventilation Rates  
  (ii) Enhanced Filtration Media  
  (iii) Dedicated Outdoor Air System

- 4.01c Indoor Contaminants  
  (i) Local Exhaust and Air Purging System  
  (ii) Ultraviolet Germicidal Irradiation (UVGI) System  
  (iii) More Stringent VOC Limits for Interior Fittings and Finishes  
  (iv) Use of Persistent Bio-cumulative and Toxic (PBT) free lighting

  *Refrigerants with Low Global Warming Potential (Advanced Green Efforts)*  
  2 pts

**4.02 Spatial Quality**  
10 points

- 4.02a Lighting  
  (i) Effective daylighting for common areas  
  (ii) Effective daylighting for occupied spaces  
  (iii) Quality of Artificial Lighting

- 4.02b Acoustics  
  (i) Sound Transmission Reduction  
  (ii) Acoustic Report

- 4.02c Wellbeing  
  (i) Biophilic Design  
  (ii) Universal Design (UD) Mark

  6 points (capped)
  2 pts
  4 pts
  1 pt
  2 points
  0.5 pt
  1.5 pt
  3 pts
  1 pt
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<tr>
<th>4.03  Smart Building Operations</th>
<th>10 points</th>
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<tr>
<td>4.03a  Energy Monitoring</td>
<td></td>
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<tr>
<td>(i) Energy Portal and Dashboard</td>
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<tr>
<td>(ii) BAS and Controllers with Open Protocol</td>
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<tr>
<td><strong>Permanent M&amp;V for VRF Systems (Advanced Green Effort)</strong></td>
<td>2 pts</td>
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<tr>
<td>4.03b  Demand Control</td>
<td></td>
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<tr>
<td>(i) ACMV Demand Control</td>
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<tr>
<td>(ii) Lighting Demand Control</td>
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<tr>
<td>4.03c  Integration and Analytics</td>
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<tr>
<td>(i) Basic Integration and Analytics</td>
<td>0.5 pt per feature</td>
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<td>(ii) Advanced Integration and Analytics</td>
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<tr>
<td><strong>Additional Advanced Integration and Analytical Features (Advanced Green Effort)</strong></td>
<td></td>
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<tr>
<td>4.03d  System Handover and Documentation</td>
<td>1 pt</td>
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<tr>
<td><strong>Expanded Post Occupancy Performance Verification by a 3rd Party (Advanced Green Effort)</strong></td>
<td>2 pts</td>
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<tr>
<td><strong>Energy Performance Contracting (Advanced Green Effort)</strong></td>
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<tr>
<th>Part 5 – Advanced Green Efforts</th>
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<tbody>
<tr>
<td>5.01  Enhanced Performance</td>
<td></td>
</tr>
<tr>
<td>5.02  Demonstrating Cost Effective Design</td>
<td>2 points</td>
</tr>
<tr>
<td>5.03  Complementary Certifications</td>
<td>1 point</td>
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<tr>
<td>5.04  Social Benefits</td>
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</table>
References

Energy Modeling Requirements


P.01 Envelope and Roof Thermal Transfer

P.02 Air Tightness and Leakage


P.03 Bicycle Parking

1.01a Climatic & Contextually Responsive Brief


1.01b Integrative Design Process

1.01c Environmental Credentials of Project Team


1.01d Building Information Modeling

1.01e User Engagement

1.02a Sustainable Urbanism


1.02b Integrated Landscape and Waterscape


1.03a Tropical Façade Performance


1.03c Ventilation Performance
2.02 Energy Effectiveness


2.03 Renewable Energy


P.07 Water Efficient Fittings/ 3.01 Water


3.02a Sustainable Construction


3.02b Embodied Carbon


3.02c Sustainable Products


3.03 Waste


P.08 Thermal Comfort

P.08 Thermal Comfort


P.09 Minimum Ventilation Rate


P.10 Filtration Media for Times of Pollution


P.11 Low Volatile Organic Compound (VOC) Paints


P.12 Refrigerants


P.13 Sound Level


P.14 Permanent Instrumentation for the Measurement and Verification of Air Conditioning Systems


P.15 Electrical Sub-Metering % Monitoring


4.01a Indoor Air Quality


4.02a Lighting

[75] BCA Singapore 'Green Mark NRB: 2015 Technical Guide and Requirements Annex B: Effective Daylighting Simulation and Pre-Simulated Daylight Availability Tables Methodology and Requirements'


4.02b Acoustics

4.02b Acoustics


4.02c Wellbeing


[84] CS E09:2012 - Guidelines on Planting of Trees, Palms and Tall Shrubs on Rooftop; National Parks Board


4.03a Energy Monitoring


4.03b Demand Control


4.03d System Handover and Documentation


Acknowledgements

The launch of Green Mark for Non-Residential Buildings: NRB 2015 is indeed a monumental achievement, and is a result of our extensive industry collaboration across the construction value chain. We would like to extend our sincerest gratitude to all internal and external stakeholders for their invaluable support and contribution towards the development of Green Mark NRB: 2015 that will enable us to develop a sustainable environment for our current and future generations.

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