

BCA Green Mark 2015

For New Buildings (Non Residential)

Benjamin Henry Towell (BCA)

Building and Construction Authority

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

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   - Resource Stewardship
   - Smart & Healthy Building
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5. Q&A

BCA Green Mark

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

Version 1 (2005) – 1st tropical green building rating tool

Version 2 (2007) – Introduction of Energy Modelling & pre-requisites

Version 3 (2008) Inclusion of CFD

Version 4 (2010) Pre-requisites outside of Energy Efficiency

Version 4.1 (2012) Refinement of v4 and M&V.

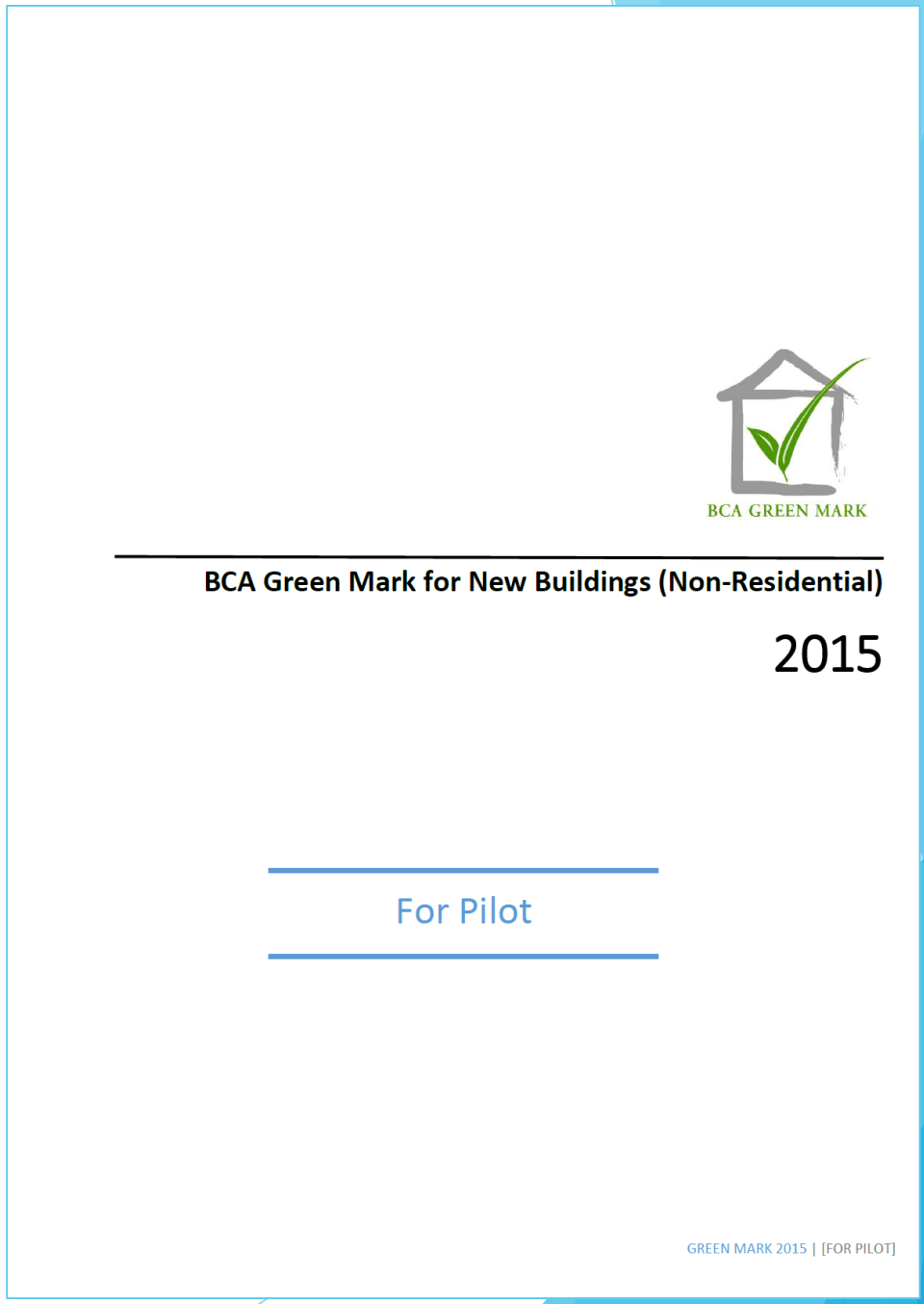
Green Mark 2015 for New Buildings (Non-Residential)- Re-imagining the tropical green building rating tool



Green Mark 2015

- A streamlined & robust criteria
- Greater recognition to climatically contextual design & tropical vernacular
- Accessible design guide for sustainability benchmarking
- The most transparent & collaborative version of Green Mark

To provide a platform to recognise and make mainstream the 'leadership' needed to drive creative, organisational & technical improvements to the overall environmental credentials of projects



Green Mark 2015 Document

Introduction to Green Mark

Sustainability Outcomes of Green Mark certification

Rationale for each section

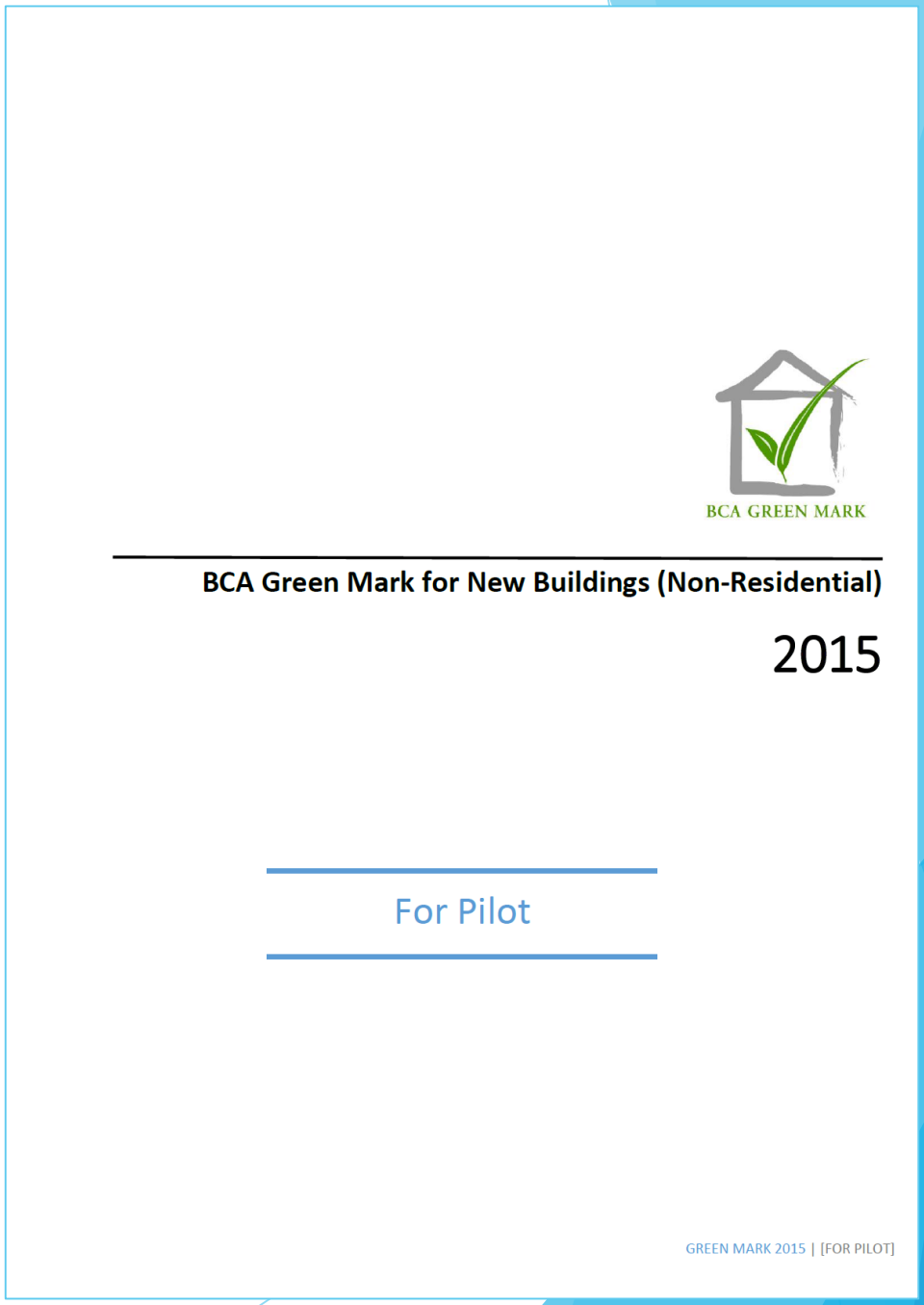
Intent of each criteria

Details of the sustainability indicator

- Scope
- Assessment
- Guidance notes (Design & Verification)
- Useful References

Separate guides and Green Mark tools and templates for industry use

All freely available for download and use for everyone



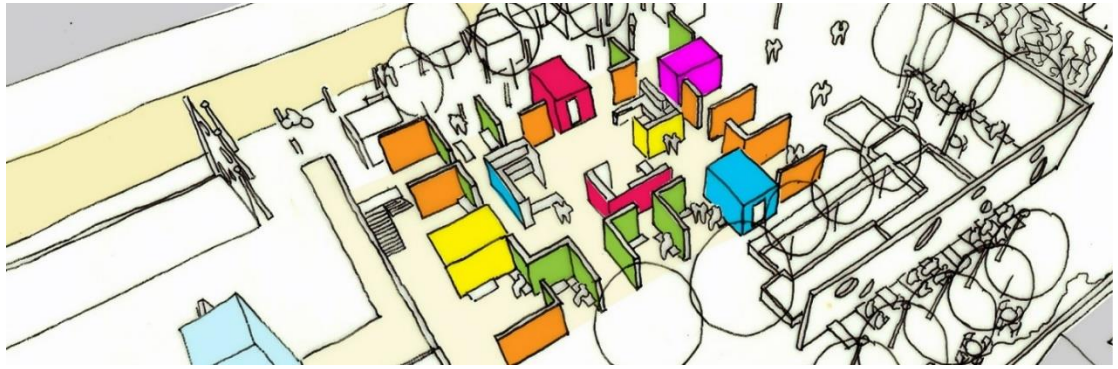
Outcomes of Green Mark 2015

Climate Responsiveness

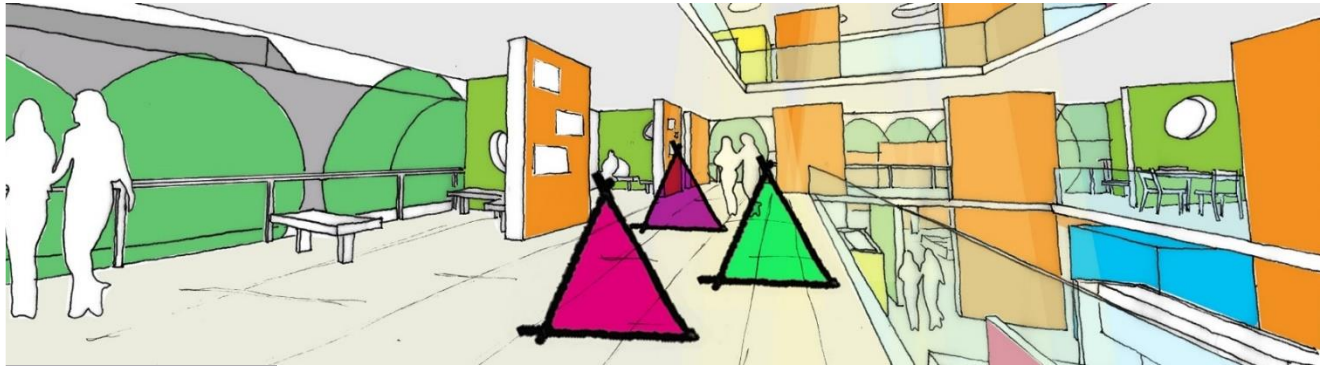


Conservation of Ecological Systems





Resource Stewardship



Health and Wellbeing

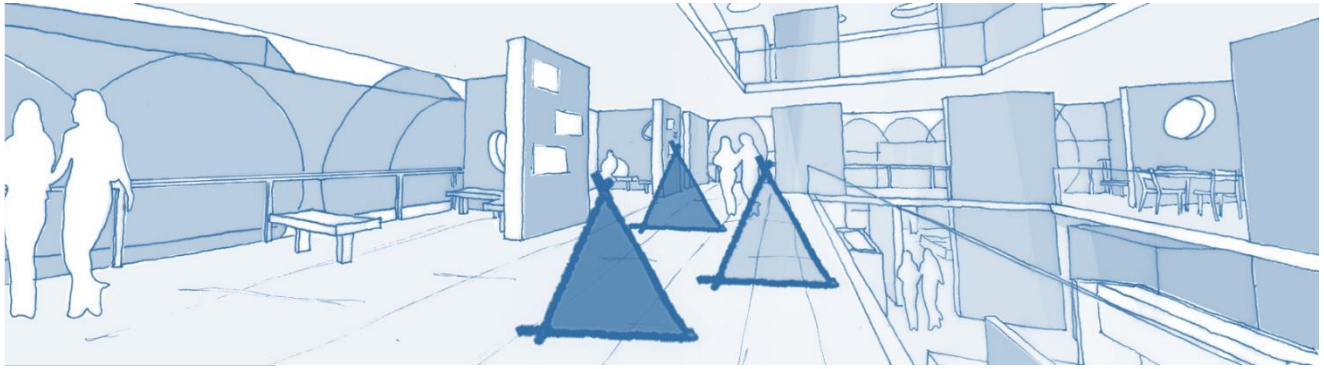
Outcomes of Green Mark 2015

Climate Responsiveness



- Emissions reduction
- Resilience to Climate change
- Contextual design
- Low carbon technology
- Environmental Leadership

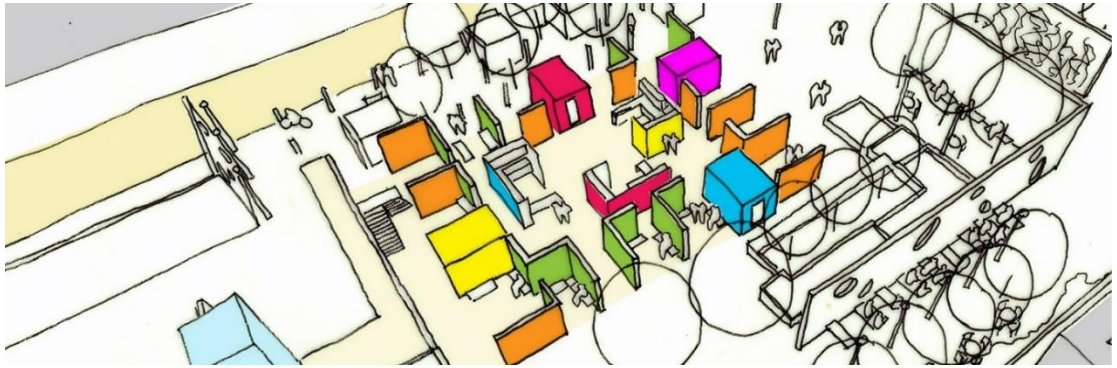




Outcomes of Green Mark 2015







- Reduction of Environmental footprint (Design & As-Built)
- Building Life cycle consideration
- Effective management (energy, water, waste)
- Choice of construction materials, methods
- Embodied carbon

Resource Stewardship

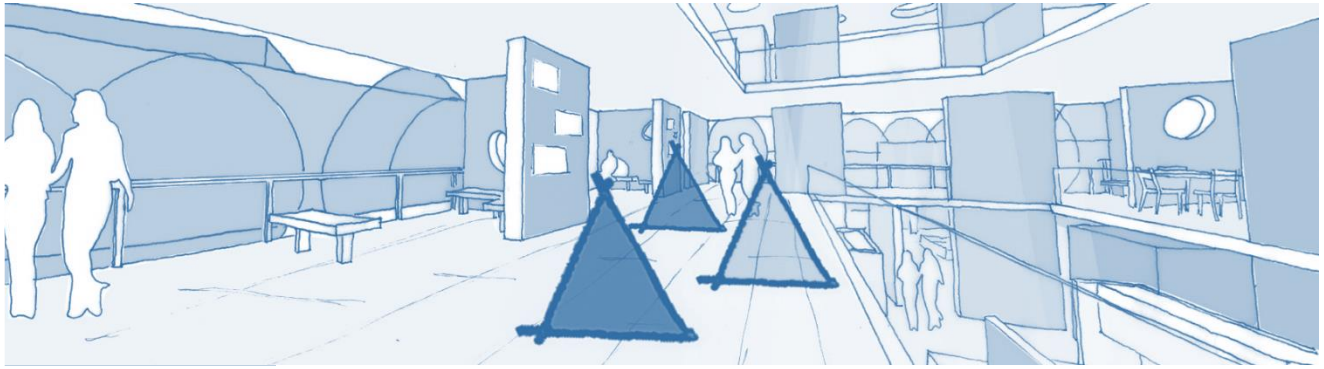
Outcomes of Green Mark 2015

- Impact on the biosphere
- Integration of nature
- Protection of natural systems (life cycle)

Conservation of Ecological Systems





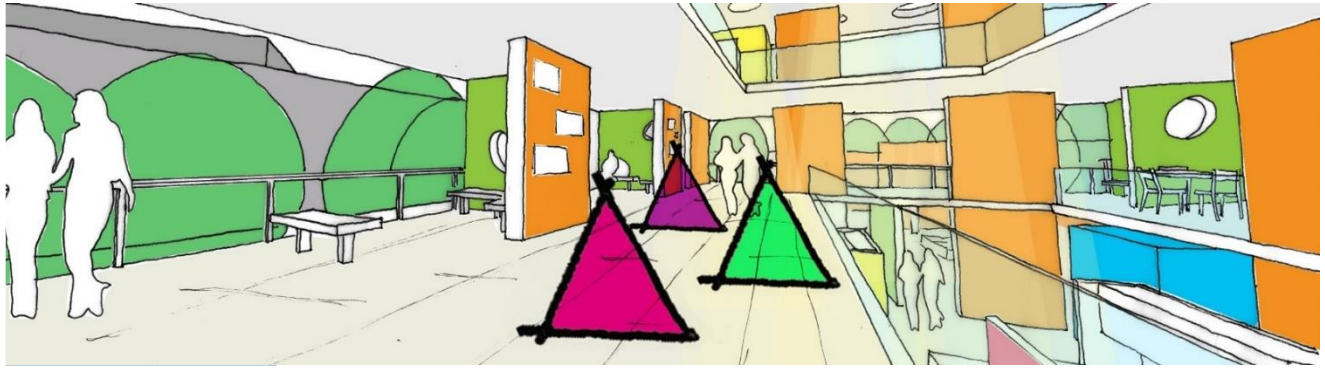


Outcomes of Green Mark 2015





- Visual, Aural and Thermal Comfort
- Fit for purpose and accessible to all
- Vibrancy & Liveability
- People centric / user centric design
- Healthy air



Health and Wellbeing

Green Mark 2015

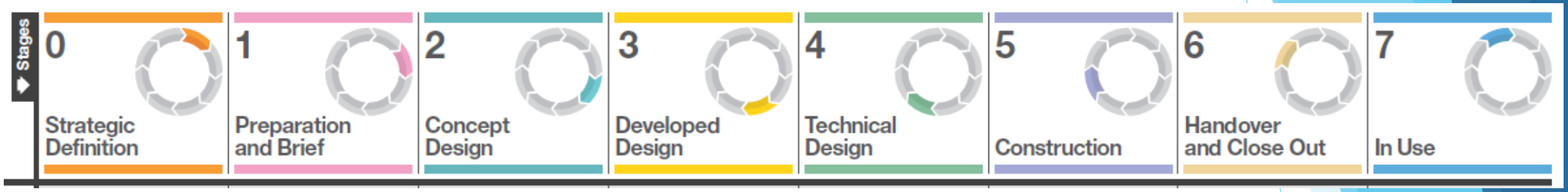
Green Mark has been extensively restructured:

- 4 sustainability outcomes
- 5 Scored Sections
- 16 Green Mark Criteria
- 79 Sustainability Indicators
- 120 Points + Advanced Green Efforts

For Green Mark 2015 in Singapore – only 3 ratings for awards as Certified is a regulatory requirement. These 3 levels represent Good Practice, Better Practice and Best (Global leading) Practice

Green Mark Score	Green Mark Rating
70 and above	Green Mark Platinum
60 to < 70	Green Mark Gold^{PLUS}
50 to < 60	Green Mark Gold
Green Mark Certified is equivalent to the BCA Regulation for Environmental Sustainability	

Green Mark 2015 - Sections



Climatic Responsive Design:

Building Energy Performance:

Resource Stewardship:

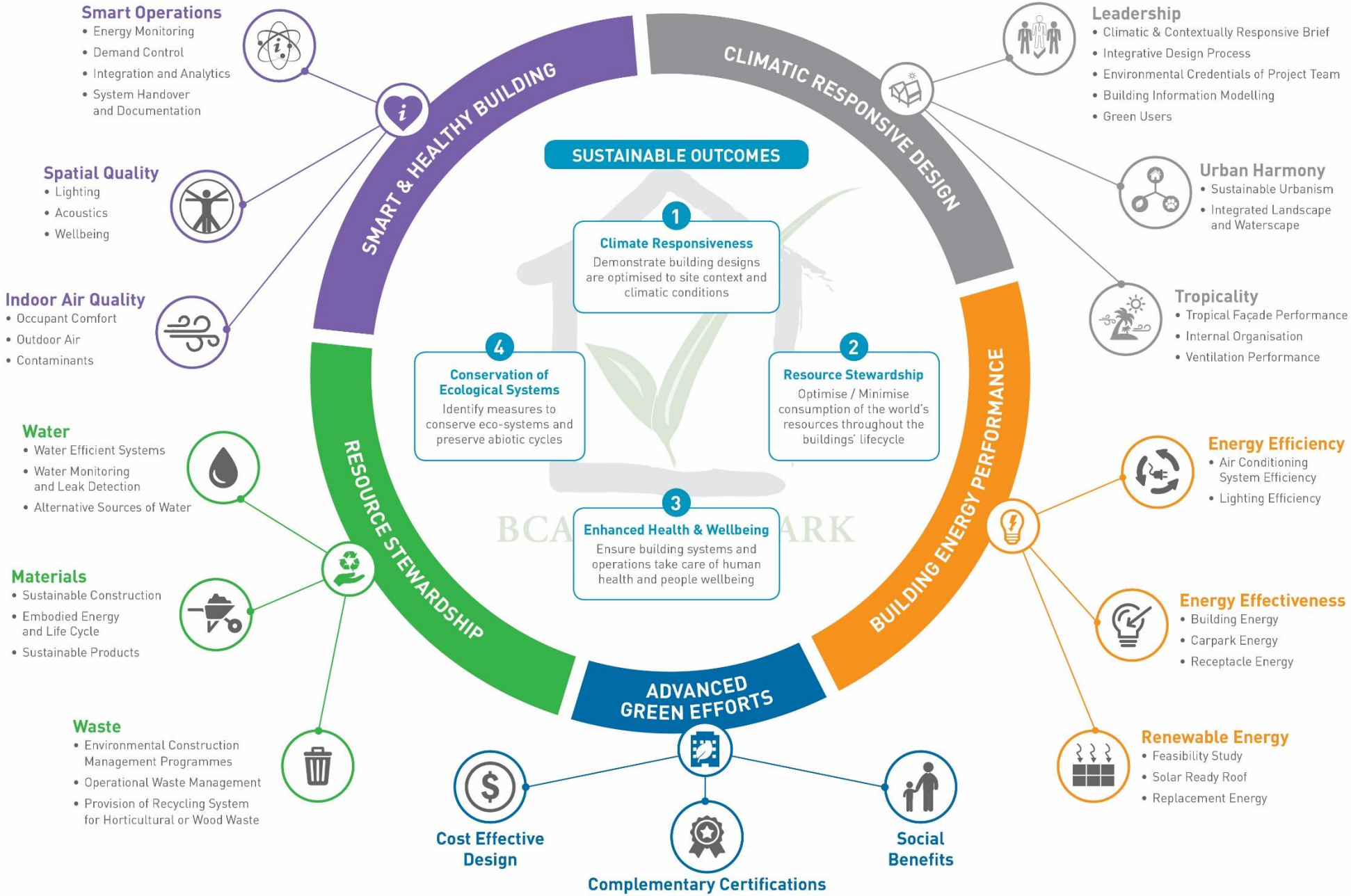
Smart & Healthy Building:

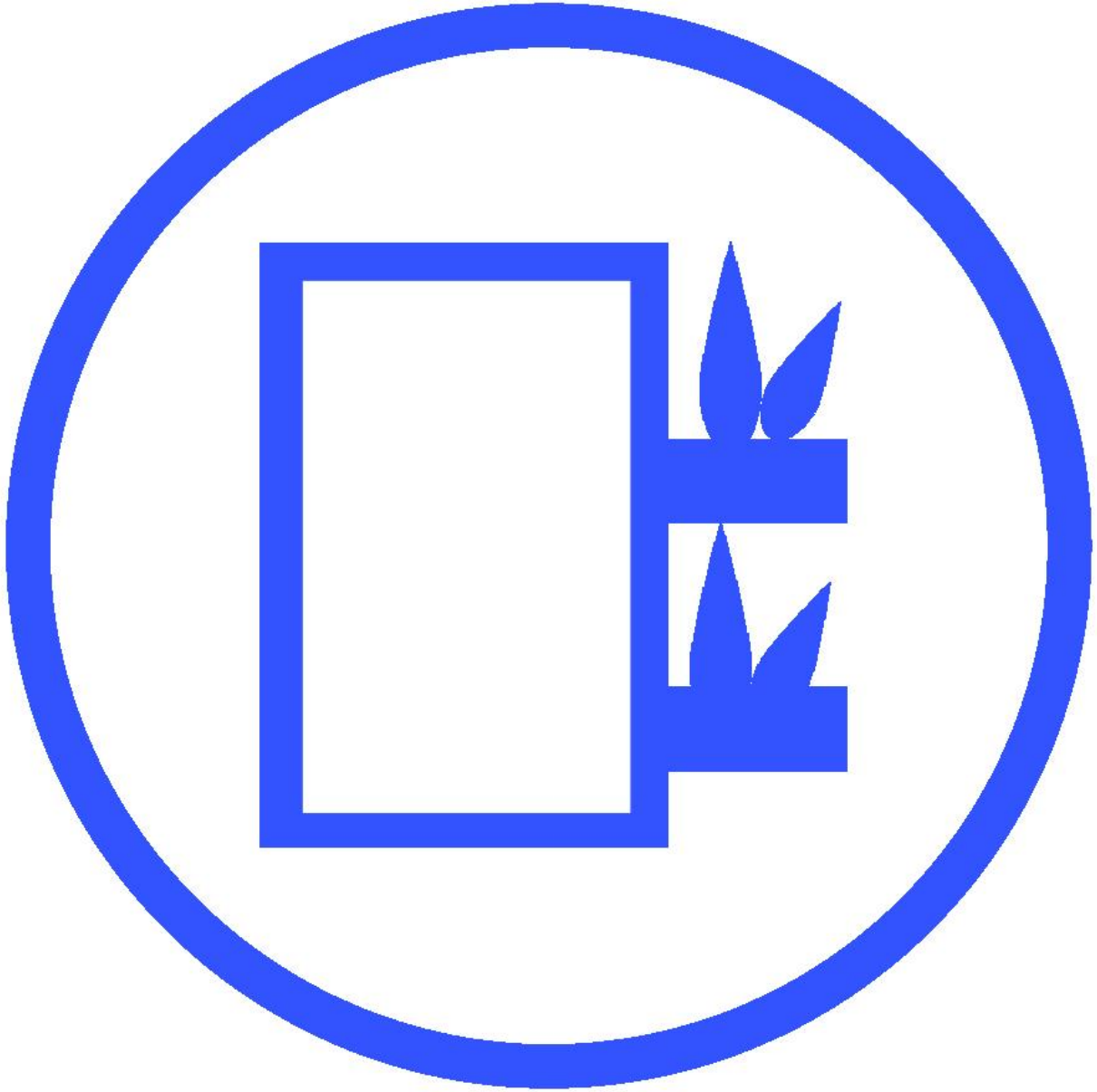
Advanced Green Efforts:

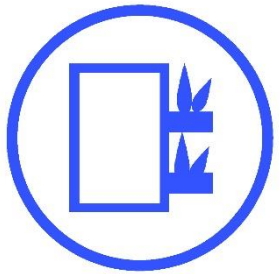
BCA GREEN MARK

Reference – RIBA Plan of Work 2013

GM 2015 CRITERIA AND INDICATORS







0.Pre-requisite Requirements

- 22 **Pre-requisite requirements** before points can be scored in sections 1-5
  - Covers building as usual environmental practices
  - Ensures minimum environmental performance is considered and achieved.

- Additional minimum performance requirements for Gold, Gold^{PLUS} and Platinum

Pre-Requisite Requirements for All

P	Pre-Requisite Requirements for All Projects
P01	Envelope Thermal Transfer Value (ETTV)
P02	Maximal Thermal Transmittance for Roof
P03	Air tightness and leakage
P04	Air Conditioning Design System Efficiency
P05	Permanent Instrumentation for the Measurement and Verification of Air Conditioning Systems
P06	District Cooling System Efficiency
P07	Energy Recovery Systems
P08	Refrigerants
P09	Minimum Ventilation Rate
P10	Filtration Media for Times of Pollution
P11	Thermal Comfort
P12	Minimum Illuminance Levels
P13	Artificial Lighting
P14	Visible Flicker
P15	Vertical Transportation Efficiency
P16	Electrical Sub-Metering & BMS
P17	Energy Systems Controls
P18	Water Efficient Fittings
P19	Cycle of Concentration for Cooling Towers
P20	Low VOC Paints
P21	Sound Level
P22	Bicycle Parking

Pre-Requisite Requirements Gold – Platinum

P	Referenced Indicator	Pre-Requisite Requirement	Gold	Gold^{PLUS}	Platinum
-	-	Comply with pre-requisites P.01 - P.22	✔	✔	✔
P23	1.01a	Climatic & Contextually Responsive Brief		✔ (1)	✔ (1)
P24	1.01b	Integrative Design Process			✔ (2)
P25	1.01e	Green Fit Out Guidelines		✔ (1)	✔ (1)
P26	1.02c	Greenery		✔	✔
P27	1.03c	Ventilation Performance		✔ (4)	✔ (4)
P28	2.01a	Air Conditioning Total System Efficiency		✔	✔
P29	2.03a	Renewable Energy Feasibility Study	✔ (0.5)	✔ (0.5)	✔ (0.5)
P30	3.02a	Sustainable Construction	✔ (0.5)	✔ (1.5)	✔ (3)
P31	3.02b	Embodied Energy		✔ (1)	✔ (1)
P32	3.02c	Sustainable Products	✔ (2)	✔ (3)	✔ (4)
P33	4.01a (i)	Indoor Air Quality Audit	✔ (0.5)	✔ (0.5)	✔ (0.5)
P34	4.01a (ii)	Post Occupancy Evaluation		✔ (0.5)	✔ (0.5)
P35	4.01b (ii)	Enhanced Filtration Media		✔ (0.5)	✔ (0.5)
P36	4.03d	System Handover and Documentation		✔ (1)	✔ (1)
P37	-	Energy Modelling		✔	✔
P38	-	Energy Efficiency Benchmarking		✔	✔

ETTV

Level of Award	Maximum ETTV
Certified	45W/m^2
Gold	45W/m^2
GoldPlus	40W/m^2
Platinum	38W/m^2

ETTV has been tightened for all non residential projects, 45W/m^2 will form the baseline when Green Mark 2015 becomes effective

Air Conditioning Efficiency

Cooling system Efficiency

- Similar to version 4.1 – based on Design System Efficiency values
- Minor tweaks to efficiency values
- Unitary systems calculation derived from total weighted COP (NEA method)
- Chilled water systems derived DSE (kW/RT) based on the calculation of the system power input (kWh) over the total building simulated operational design load (RTh)
- Update to permanent M&V to include power meters to the air distribution system and to include measurement of dry bulb and RH along the cooling towers
- Energy Calculator shall be used to show DSE

Air Conditioning Efficiency

Minimum Design System Efficiency of Water Cooled Chilled Water Plants

Green Mark Rating	Building Cooling Load (RT)	
	<500 RT	≥500RT
	Minimum Design System Efficiency (kW/RT)	
Certified	0.8	0.7
Gold	0.75	0.68
GoldPlus	0.7	0.65
Platinum	0.68	0.65

For Singapore projects that are aiming for Green Mark Awards, Gold (Good Practice) is the minimum level. Future building regulations shall require the certified level of performance.

Air Conditioning Efficiency

Minimum Design System Efficiency of Air Cooled Chilled Water Plants or Unitary Systems

Green Mark Rating	Building Cooling Load (RT)	
	<500 RT	≥500RT
	Minimum Design System Efficiency (kW/RT)	
Certified	0.9	0.8
Gold	0.9	EQUIVALENT TO WATER COOLED SYSTEMS
GoldPlus	0.85	
Platinum	0.78	

Unitary operational load is calculated based on the weighted operational installed capacity of the system (excluding standby units), calculated in the same manner as the weighted COP,

i.e. $RT_{Weighted} = 0.4 \times RT_{100\%} + 0.6 \times RT_{50\%}$

Air Conditioning Efficiency

Important for **Unitary Systems**

- CU's MUST be installed to manufactures best practice
- BCA **will look at this** as a part of the verification
- SIZING FOR OPERATIONAL LOADS (BCA may ask to see the efficiency at notional loads to test the design)





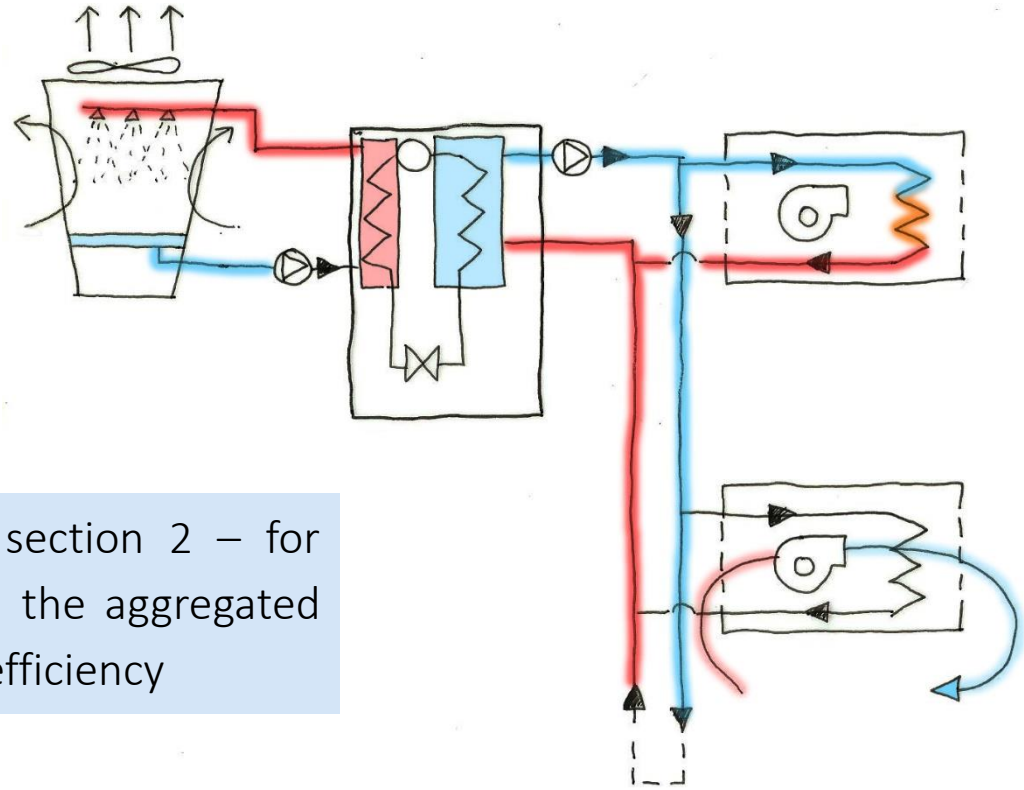
Proper distance between units
Proper opportunity for heat reject (no short circuiting)
Proper allowance for fresh air.

Critical consideration for Green Mark certification when using unitary systems.

Air Conditioning Total System Efficiency

Gold^{PLUS} and Platinum

- Total system efficiency – a single metric that combines the efficiencies for the air and water-side of air-conditioning systems (or air + refrigerant side)



This metric is used in section 2 – for points scoring based on the aggregated air conditioning system efficiency

Air Conditioning Total System Efficiency

Table P.28-1 Air Conditioning Total System Efficiency for Water Cooled Chilled Water plants

	Building Cooling Load (RT)	
	<500RT	≥500RT
	Minimum Design System Efficiency including air distribution system (kW/RT)	
Gold^{PLUS}	0.95	0.9
Platinum	0.93	0.9

Table P.28-2 Air Conditioning Total System Efficiency for Air Cooled Chilled Water plants & Unitary Systems

	Building Cooling Load (RT)	
	<500RT	≥500RT
	Minimum Design System Efficiency including air distribution system (kW/RT)	
Gold^{PLUS}	1.10	Total System Efficiency must demonstrate equivalency with Table P.28-1
Platinum	1.03	

The air distribution system efficiency for Gold^{PLUS} and Platinum projects should not exceed 0.25kW/RT

Sub-Metering and BMS

All buildings ≥5,000m^2 (Air conditioned area)

- Subsystem measurement devices with remote capability (including power meters or flow meters) shall be provided, linked to a BMS/EMS and shall measure and trend energy consumption data of:

Use (total of all loads)	Sub-systems thresholds
Lift & Escalator	Sum of all feeders > 50 kVA
Heater, including heat pump	> 50 kW_{th}
Process loads	Connected loads > 50 kVA Connected gas or district services load > 75 kW
Unitary air-conditioning system (including VRF systems)	No threshold
Mechanical ventilation	The subsystem's load > 15kW

- AND separate tenancy areas, each floor (office, retail, data centres), car parks etc (>50kVA)

Water Efficiency

Type of Water Fittings	Prescribed Minimum WELS ratings	Applicable Areas
Basin Taps & Mixers	Excellent WELs rating	Public/Staff/School Toilets
	Very Good WELs rating	Other Areas *Exception : Hospital Wards & Operating Theatre*
Sink Taps & Mixers	Very Good WELs rating	All Areas *Exception : Hospital Wards & Operating Theatre*
Shower Taps, Mixers or Showerheads	Very Good WELs rating	Public/Staff/School Shower facilities
Dual Flush Flushing Cisterns	Very Good WELs rating	All areas

All projects no matter the level of award

Environmental Protection

Bicycle parking – for a cycling ready city – future LTA regulation

Building Category	Requirements
Community, Sports and Recreational facilities	For Gross Floor Area (GFA) of >1,000m^2 to 3,000m^2 – 20 bicycle lots shall be provided For GFA >3,000m^2 • First 15,000m^2 - 1 lot per 150m^2 • Subsequent GFA: 1 lot per 500m^2
All Other Building Types	For GFA of >1,000m^2 to 3,000m^2 – 10 bicycle lots shall be provided For GFA >3,000m^2 • First 15,000m^2 - 1 lot per 300m^2 Subsequent GFA: 1 lot per 1,000m^2

All projects no matter the level of award

Bicycle parking

Example:

Community Building 14,000m2 GFA
= 14,000/150 = 93.3333 = 93 Lots Required.

Industrial Building, 17,200m2 GFA
= 15,000/300 = 50 Lots
+ 2,200/1000 =2.2 lots

Provide 52 lots.

Only consider whole numbers – eg 16.7 round down to 16 lots.

Environmental Protection

Greenery Provision for Gold^{PLUS} and Platinum

- Or Minimum points for indicator 1.02c – *integrated landscape and waterscape*

	Commercial GnPR	Industrial GnPR
Gold^{PLUS}	2.5	1.5
Platinum	3	2







IEQ

Low VOC internal paints

- Low VOC content paints certified by an approved local certification body





Lighting Quality

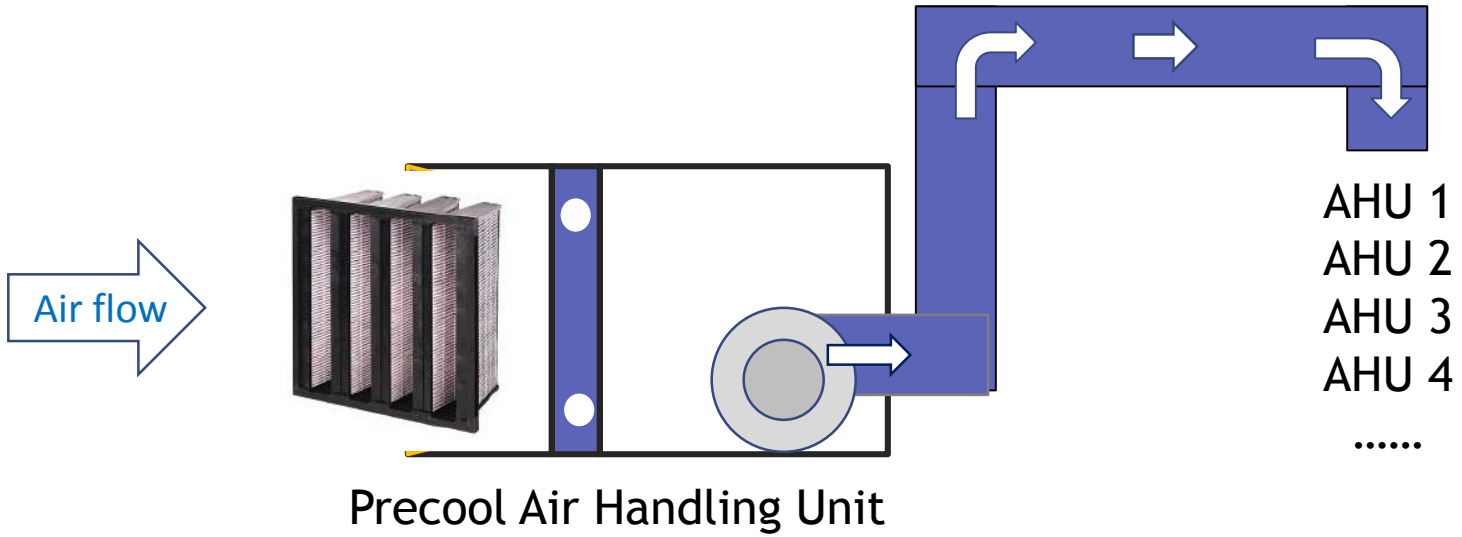
- Minimum illuminance levels **SS 551**: 2006
- Visible flicker free lighting for all functional (occupied) spaces

IEQ

Filtration Media SS 553: 2015 and SS 554: 2015

- MERV 14 / F8 filters to be installed in times of poor outdoor air quality
- Gold^{PLUS} and Platinum to have permanent MERV 14 / F8 filters or equivalent for treatment of outdoor air.

- Properly check the testing report of electronic air cleaners for MERV 14 equivalent performance, air speed should be 2.5 m/s
- During the verification, a walkthrough to AHU rooms should be conducted to check proper installation of filters (electronic air cleaners must be switched on)



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IEQ – P09 Minimum Ventilation Rate

- Check AHU/PAHU schedule to ensure designed OA amount is higher than required OA amount
- Indicate designed OA amount in the drawings (design or schematic)
- Get QP mechanical to sign the drawings

Worked Example

AHU	Area type	Area served (m2)	SS553 table 1 (l/s/m2)	Required OA amount (l/s)	Designed OA amount (l/s)	PAHU
AHU 1-1	Lobby	300	0.3	90	120	PAHU 1
AHU 1-2	Office	500	0.6	300	350	PAHU 2
AHU 2-1	Office	400	0.6	240	300	PAHU 1
AHU 2-2	Office	400	0.6	240	300	PAHU 2
AHU 3-1	Office	400	0.6	240	300	PAHU 1
AHU 3-2	Office	400	0.6	240	300	PAHU 2
AHU 4-1	Office	400	0.6	240	300	PAHU 1
AHU 4-2	Office	400	0.6	240	300	PAHU 2

PAHU	Required OA amount (l/s)	Designed OA amount (l/s)
PAHU 1	1020	1100
PAHU 2	1250	1300

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IEQ

Acoustics

- Ambient sound levels for internal spaces (all levels of award)
- QP to design and declare

Area	Average dBA
Cinema's , Theatres	25
Private Offices	35
Open Offices	45
Conference Rooms	35
Classrooms	35
Hotel Guestrooms	35
Places of Public Resort (e.g. shops)	45

SS 530: 2014

Energy Efficiency Benchmarking

Based on Energy Modelling result for Gold^{PLUS} and Platinum

- EEI benchmark for higher award projects that projects should demonstrate that they are better than (i.e. lower than).

Building Type	Benchmark for Energy Efficiency Index (EEI) (kWh/m2/yr)
Office and Institution	160
Hotel	260
Retail	360

- Updated EEI – Excludes Car park energy consumption

Energy modelling guidelines also exclude car park from the energy savings of the base building. – 25% and 30% energy savings must be demonstrated against updated Singapore standards and BCA guidelines. Approximately a 4-6% increase in Energy Efficiency



1.Climatic Responsive Design



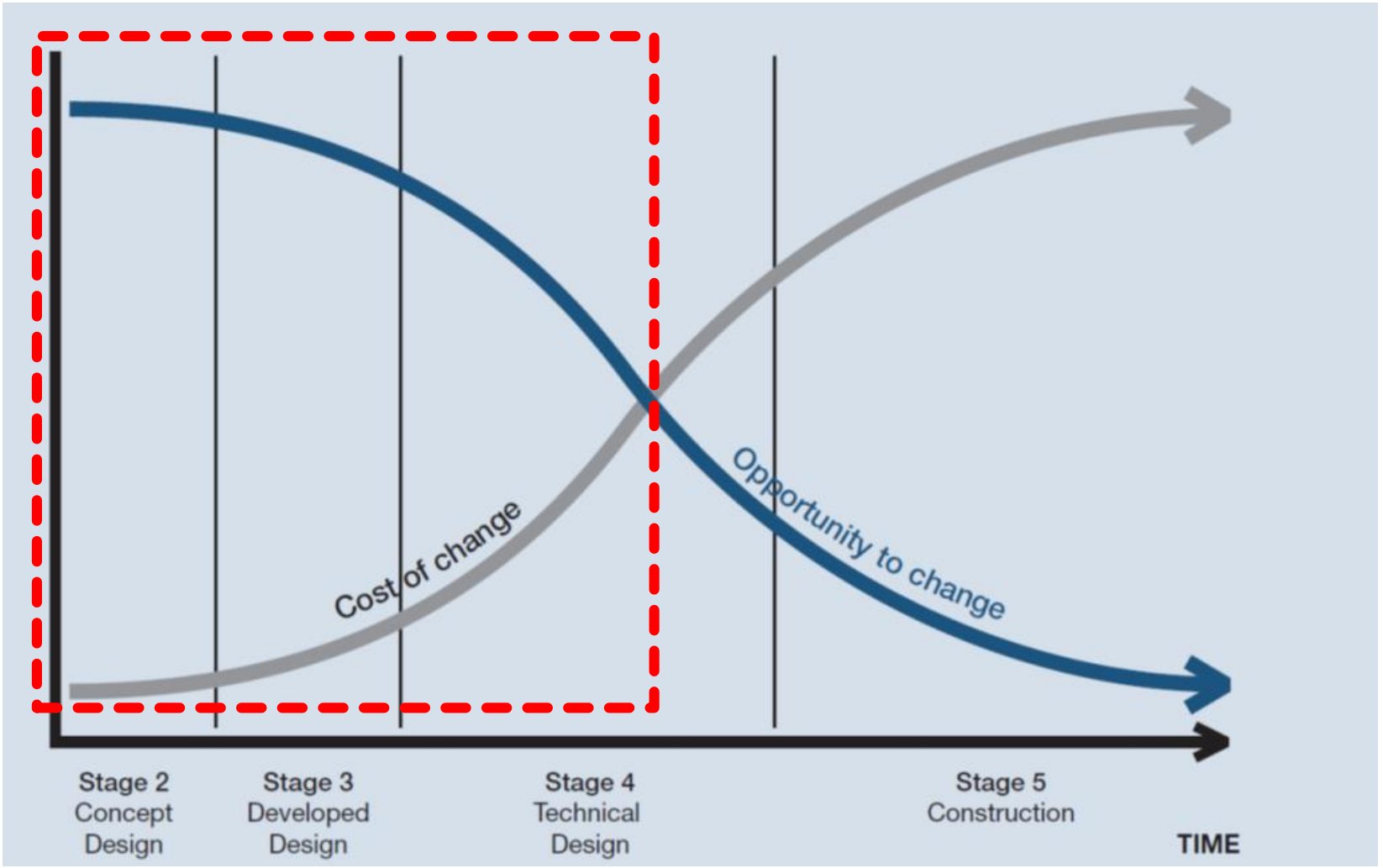
Leadership
(10 points)

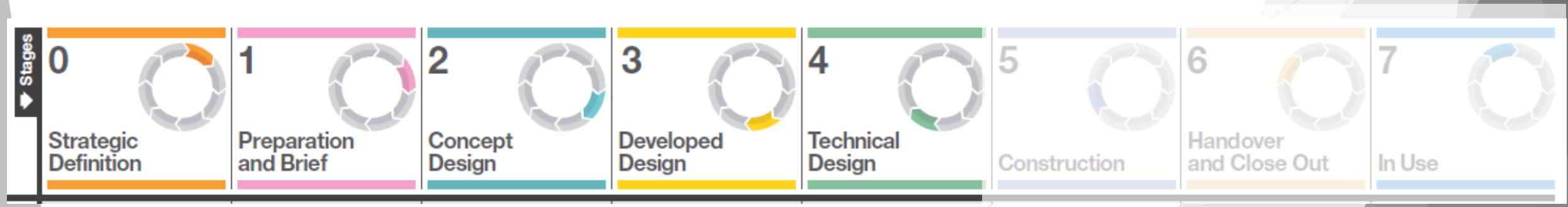


Urban Harmony
(10 points)



Tropicality
(10 points)


Cost of change
Opportunity to change
Stage 2
Concept
Design
Stage 3
Developed
Design
Stage 4
Technical
Design
Stage 5
Construction
TIME


Stages
0
Strategic
Definition
1
Preparation
and Brief
2
Concept
Design
3
Developed
Design
4
Technical
Design
5
Construction
6
Handover
and Close Out
7
In Use



1.01 - Leadership

1.01	Leadership	10
1.01a	Climatic and Contextually Responsive Brief	1
1.01b	Integrative Design Process	2
1.01c	Environmental Credentials of Project Team	2
1.01d	Building Information Modelling	2
1.01e	User Engagement	3



1.01a - Climatic Responsive Brief

1.01a Rationale:

Without a robust brief the **DESIGN STAGES (2,3,4)** cannot begin productively, and can take a direction that is not suitable or aligned to the clients goals and objectives.

At this stage the following should be conducted by project teams:

- What are the desired outcomes – are these the right outcomes for the project?
- How will these outcomes be achieved
- Is there a better way of achieving said outcomes?
- What are the skills and expertise required of the project team necessary?
- How will the outcomes be tracked and measured



1.01a - Climatic Responsive Brief

1.01a BRIEF:

- Strategic Definition
  - Clear statement of sustainable outcomes & benchmarks targeted
  - Generic framework of global corporate targets is NOT enough.

- Preparation and Brief
  - Setting of agreed sustainability targets (specific outcomes and indicators to measure these)
  - Details of selection criteria for project team appointments.
  - Identify the co-ordinating party to ensure the delivery of sustainability efforts at design, construction and handover

1.01a - Climatic Responsive Brief

HEALTH & WELLBEING
Put people's well-being first

ENERGY
Be powered by clean energy

WATER
Create more usable water than we consume

WASTE
Eliminate waste

INNOVATION
Recognise, reward and invest in innovation

RESPONSIBLE INVESTMENT
Always consider environmental, social and economic and governance outcomes

TRAINING, SKILLS & EMPLOYMENT
Invest in people today for their tomorrow

MATERIALS & SUPPLY CHAIN
Engage with suppliers to ensure we use and buy materials responsibly

COMMUNITY DEVELOPMENT
Create places where people prosper

RESILIENCE & ADAPTATION
Build resilient and prepared communities

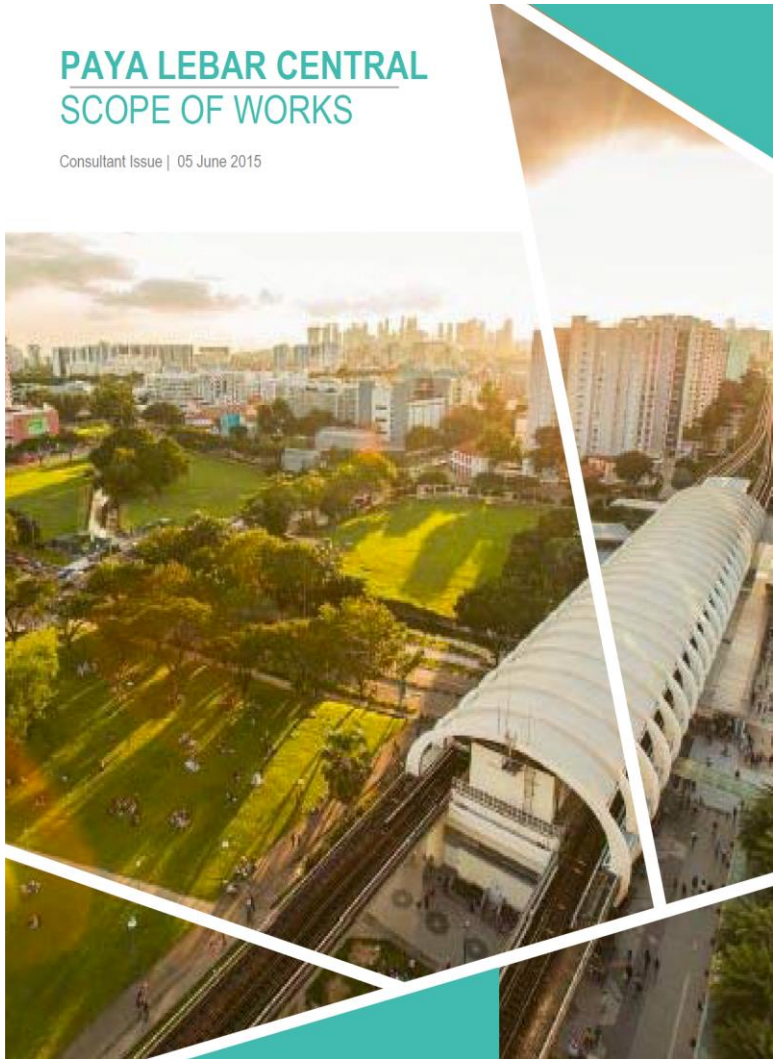
DIVERSITY
Advance diversity and inclusiveness

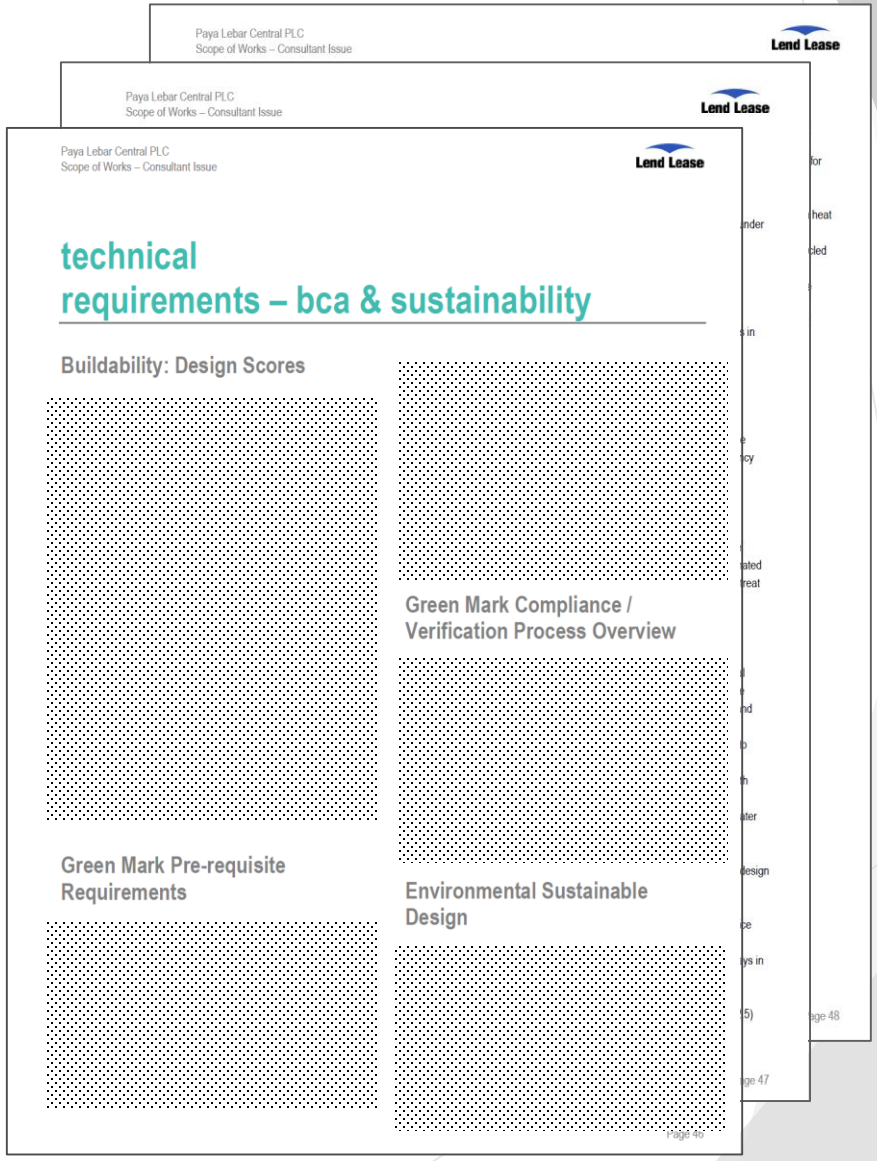
NATURE
Respect and value the natural environment



Distillation of global / corporate targets to the specific project – including details of what shall be included, what should be investigated and what can be looked at.

1.01a - Climatic Responsive Brief



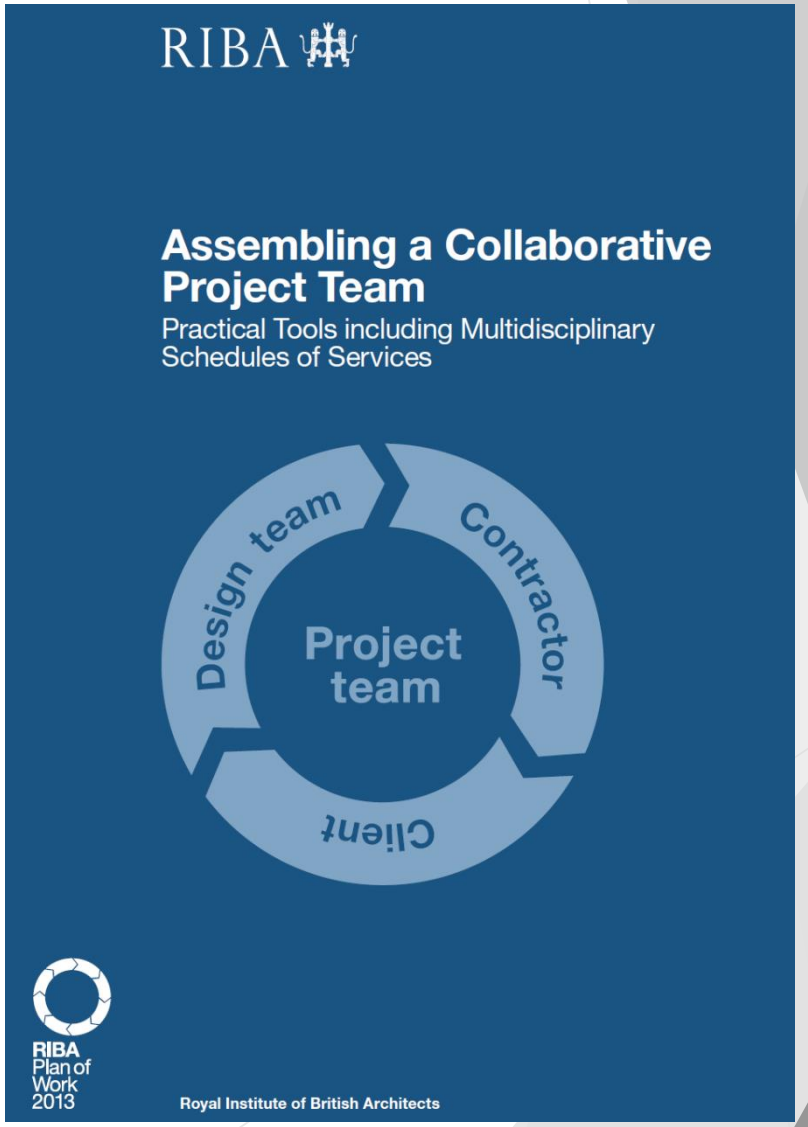


1.01b – Integrative Design Process

Integrative design process will vary based on the size, scale of the project, the experience of the client, and the leadership (be it Architect, Client, PM).

Effective integrative design does **not** mean that all parties must be present from day one, however key professionals and stakeholders relevant to the project must be involved at the relevant milestones of the design phases.

A great reference for professionals has been produced by the RIBA ---------->



1.01b – Integrative Design Process

<u>What do we want to see?</u>

- Photographs of charrette(s) / slides used
- Short charrette report at <u>2</u> key stages eg:
  - *Project definition*
  - *Concept design*
  - *Detailed design*

- Evidence that sustainability targets are being jointly explored, evaluated and some implemented





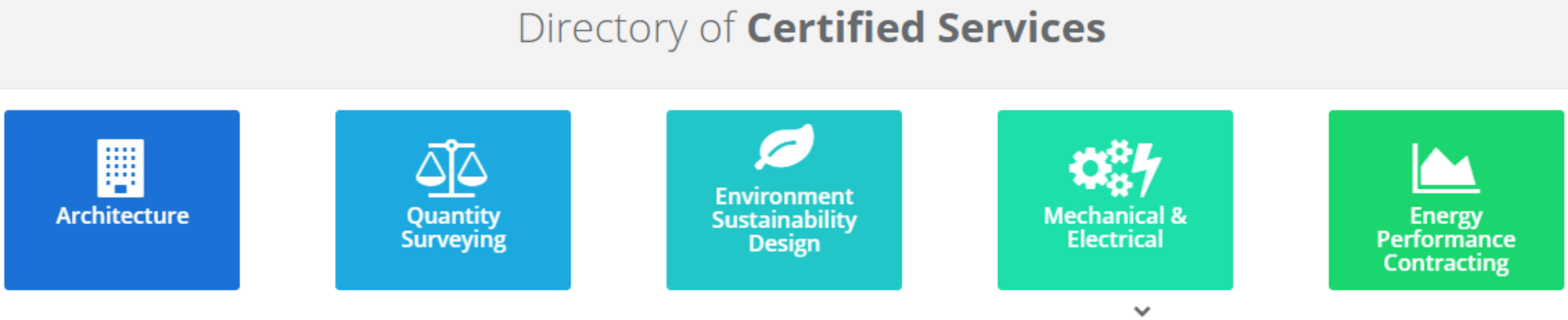
1.01c – Environmental Credentials

Rationale:

Green expertise of firms and individuals is crucial to ensure the capability of those who are delivering the project in meeting the sustainability objectives.

Criteria	Points
Green Individuals	0.5
Green and Gracious Builder	0.5
Green Companies	1.5
	Cap at 2 points

1.01c – Environmental Credentials



SGBC has a Green Services Certification Scheme for consultants.
This can help companies brand themselves with Singapore's development of green buildings, and be used as an international way of demonstrating their Singapore green track record for overseas jobs.

SINGAPORE GREEN BUILDING SERVICES
SGBC

1.01d - BIM

Advanced Green Efforts (Enhanced Performance)

3D Lonely BIM (Regulation)

3D Integrated BIM

4D (Time) BIM
- Linking attributes to the construction programme

5D (Cost) BIM
- Specifications and quantity schedules

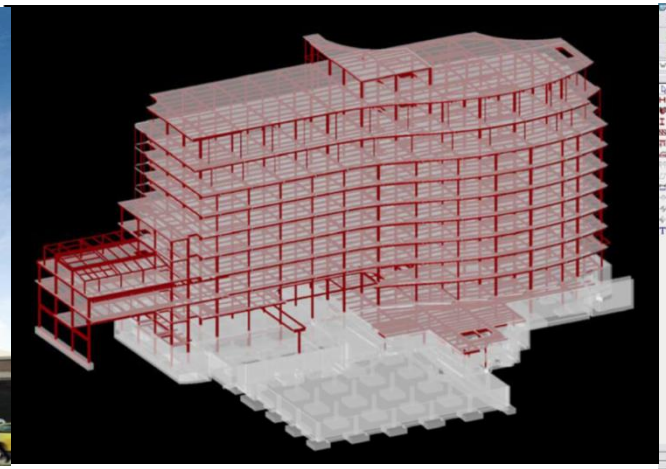
6D (FM) BIM
- data for maintenance and repairs
- Building performance analytics

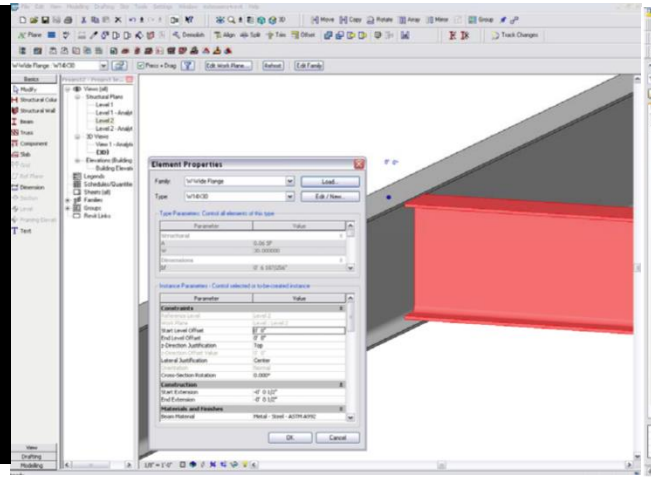
BIM for DfMA

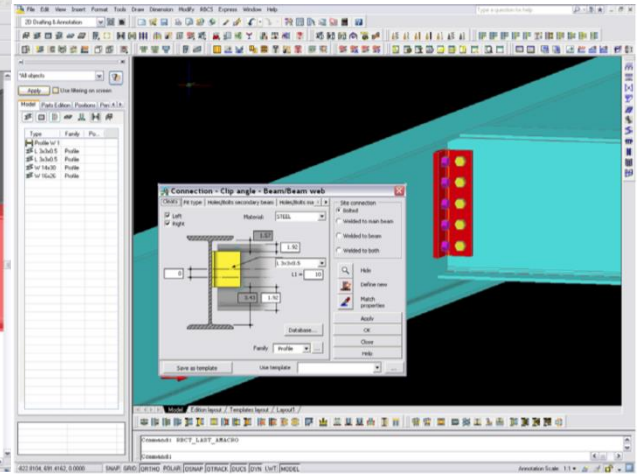
BIM for Design Co-ordination

BIM for Performance Based Simulation











1.01d – BIM

Integrative BIM:

1 point – co-ordinated use of BIM minimally between Architect, C&S and MEP engineers.

1 point – use of BIM for iterative environmental analysis / building performance analysis (eg Rhino Scripts, Green Building Studio, 3rd party environmental analysis plug-ins, IFC / gbmxl exports)

NOTE: this need not be to the same level as our CFD, Energy Modelling or Daylighting Simulation requirements under separate credits as are designed to be quick, informative and lead to positive design optimisation at early stages of the design process!

1.01d – BIM

Integrative BIM Evidence:

- BIM Manual for the project
- BIM model
- Environmental simulation / design reports / evidence of iterative design.*

**The evidence can be the working reports given to the client or project team, presentations to the project team or formal reports used for billing purposes and need not be specially prepared for Green Mark assessment*

Schedule A: Appendix 1
3D/BIM Requirements for Consultants

Contents

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Example courtesy of Lend Lease

1.01e – User Engagement

(i) Building User Guide

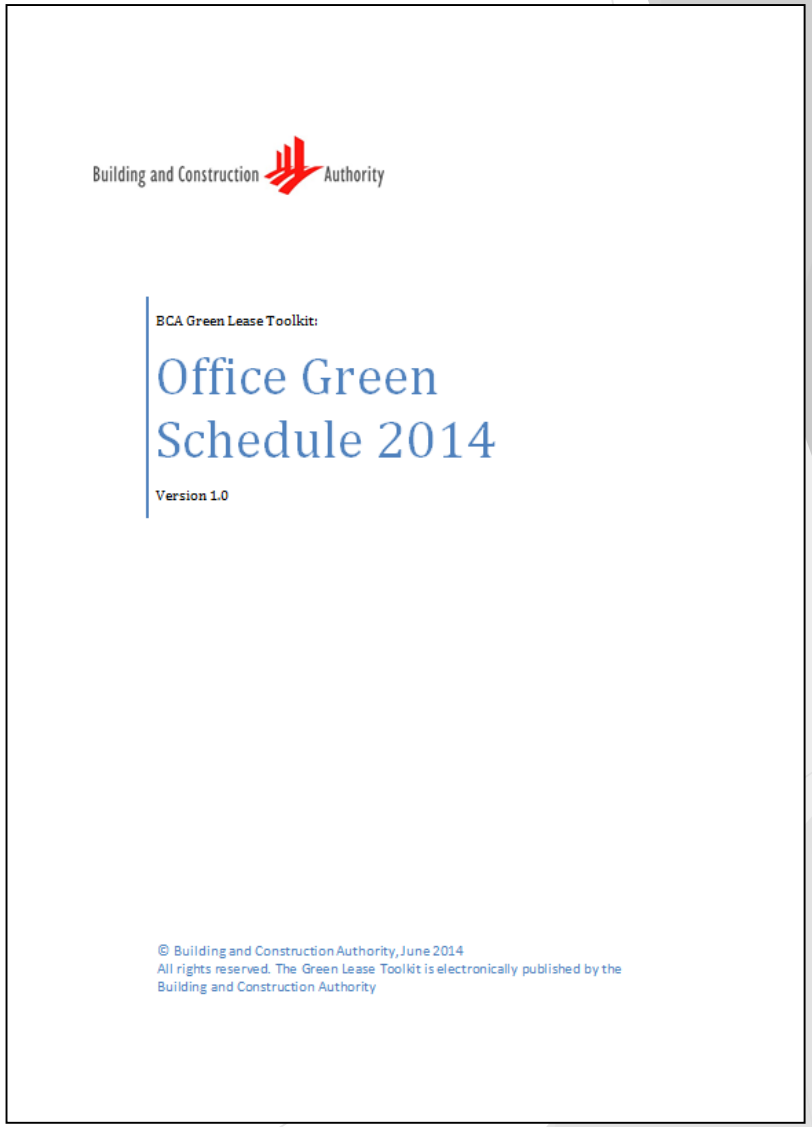
Green Mark 2015 User guide template

(ii) Green fit out guidelines

Pre-requisite for Gold^{PLUS} and Platinum Projects.

(iii) Green Lease

Comprehensive Green Lease (or equivalent) for ≥60% NLA



1.02 – Urban Harmony

1.02	Urban Harmony	10
1.02a	Sustainable Urbanism	5
1.02b	Integrated Landscape and Waterscape	5



1.02a – Sustainable Urbanism

Response to Site Context :

Site Analysis

- *Urban context*
- *Site micro climate (sun/wind/acoustics/views/air)*
  - *Sketch analysis (L1) OR*
  - *Simulation based (L2)*
- *Site access and connectivity*
- *Urban form & Massing*

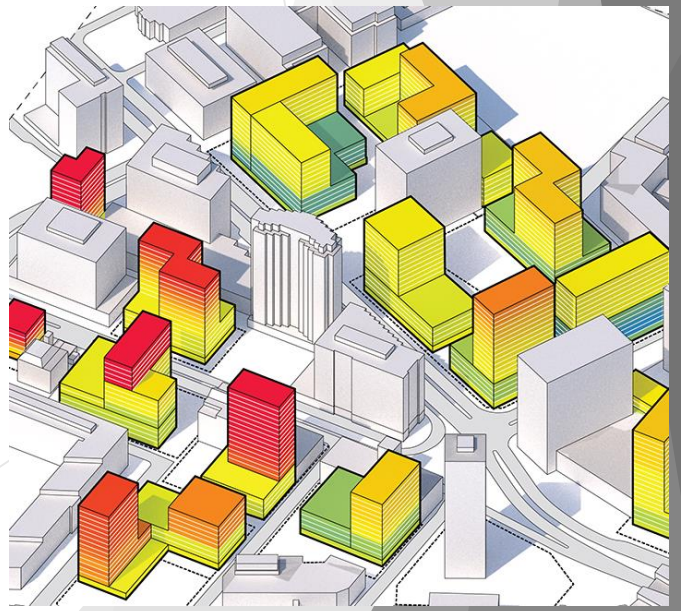
EIA

Report of the EIA results and recommendations fro mitigation measures to ecological protection

Urban Heat Island:

- Simple assessment based site plan view
- % site area – deemed to comply are green areas and PV systems
- Roof & hardscape to meet prescribed SRI values to score.





1.02a (i) – EIA

Environmental Impact Statement:

1 point – for an EIA to be conducted

Evidence should be the submission of a copy of the EIA

1 point for implementation of the recommended mitigation measures for the protection of site ecology during construction – *NOTE Replacement is **not** able to compensate the points for features of identified value removed in the construction process or site clearance*

Evidence is the submission of photographs of the onsite measures and reports where available.

1.02a (i) – EIA

Table 1.02a-1 Outline of the EIA

- The proposed development and its need
- The existing environment of the site
- The impacts of the proposed development and its alternatives on the environment covering:
  - Climate Change
  - Flora and Fauna (including aquatic life)
  - Soil
  - Air
  - Water
- The recommendations and measures to mitigate any adverse impacts and / or opportunities to improve the site beyond its original condition before the development, i.e. how the ecological features or areas of the site are to be adequately protected from damage or disturbance during the construction activities from site clearance and preparation through to practical completion and handover.
- A non-technical summary

1.02a (ii) – Response to Site Context

1 point – for LEVEL 1 Site Analysis

3 Points – for a LEVEL 2 Site Analysis

Submission of a site analysis report should be submitted for this following table 1.02a-2 in the criteria.

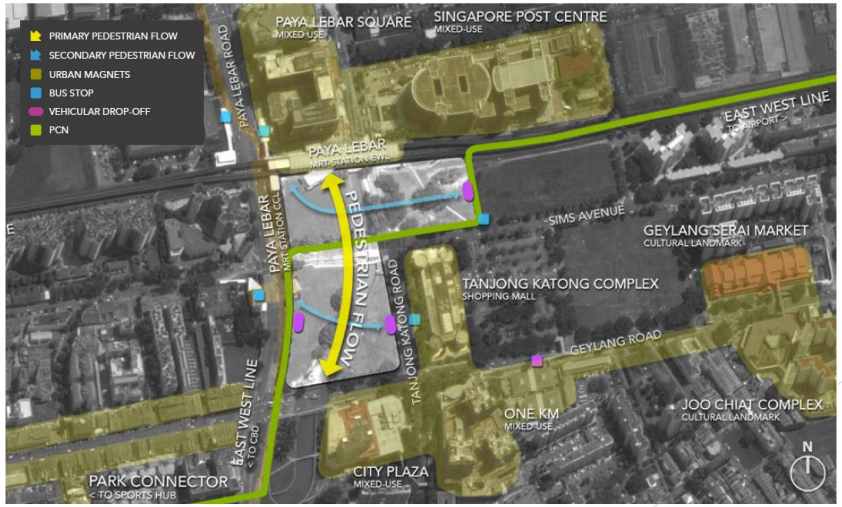
Note there is overlap with the EIA, thus where an EIA is conducted these sections need not be reproduced to score here.

1.02a (ii) – Response to Site Context

All Levels:

- Non technical summary
- Urban Context – sketch / written description of urban form, land use, view corridors, urban grain, near by amenities.
- Site topography and Hydrology (can be included in the EIA)





Example courtesy of Lend Lease

1.02a (ii) – Response to Site Context

LEVEL 1:

Site Micro Climate:

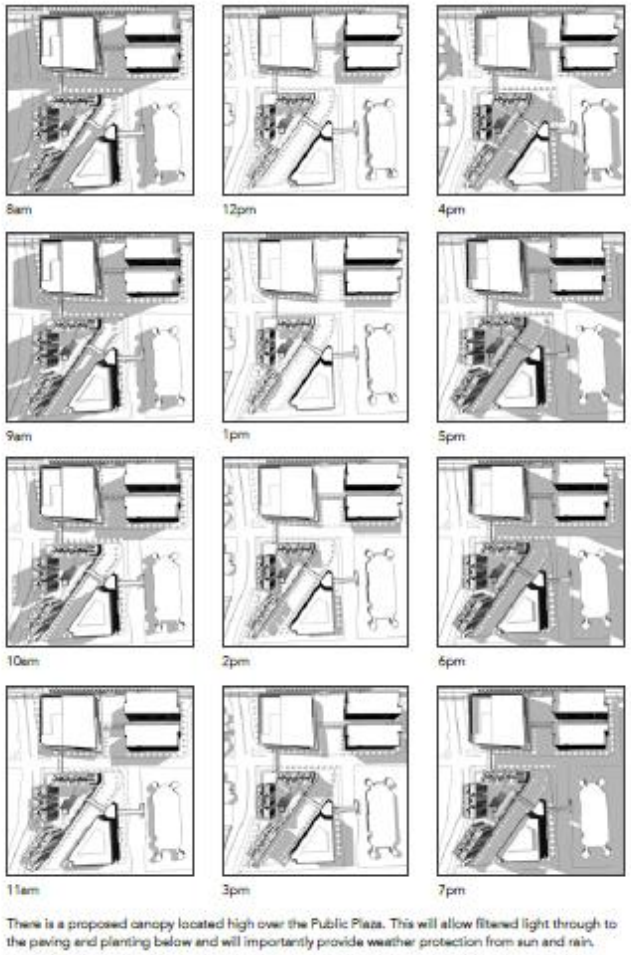
- Sketch on plan and photographs of the key micro climatic conditions of the site and the subsequent design response

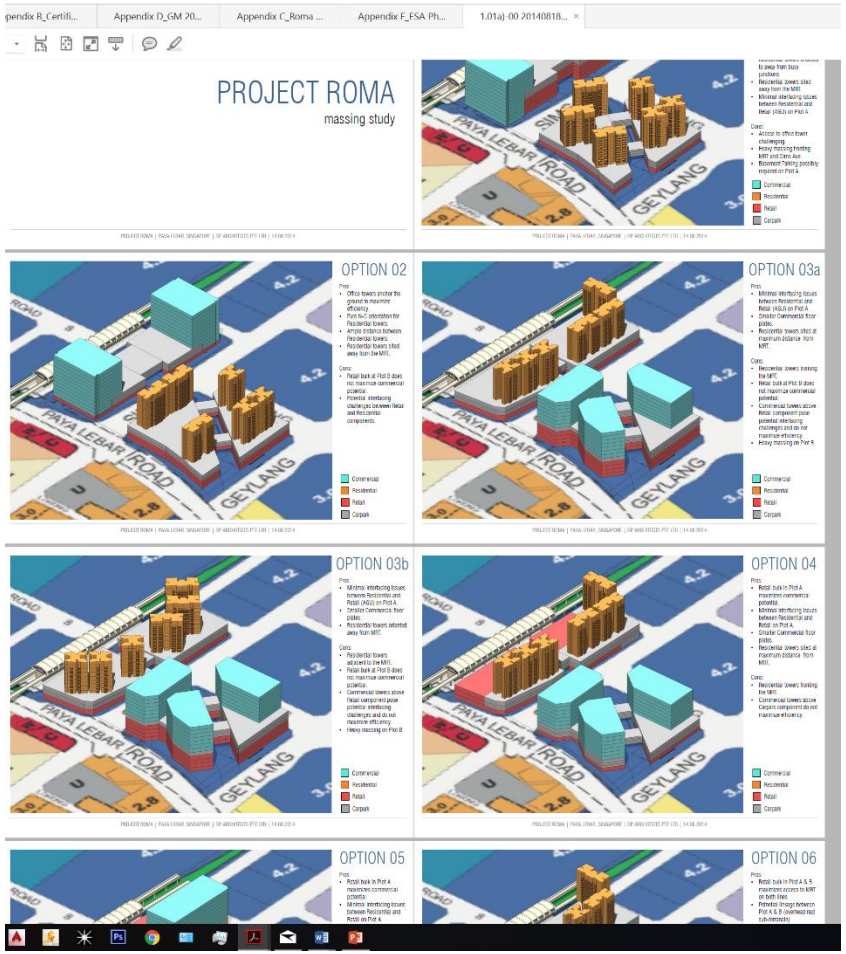
Site Access and Connectivity:

- Concept design studies demonstrating the massing on site, potential connectivity to existing parks, gardens, public transit nodes, adjacent buildings and cycling infrastructure

1.02a (ii) – Response to Site Context

LEVEL 1:



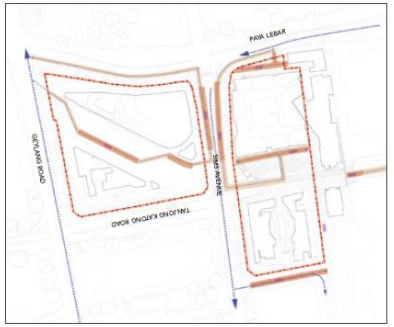




PEDESTRIAN NETWORK



VEHICULAR NETWORK



FIRE ENGINE ACCESS

Example courtesy of Lend Lease

1.02a (ii) – Response to Site Context

LEVEL 2:

Site Micro Climate:

- Macro level simulations such as solar analysis, wind analysis.
- Quantifiable analytics and design modifications through simplified simulations at the site level that will influence the design response and location, form of the building

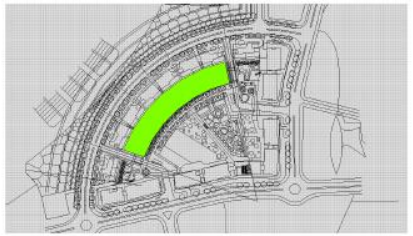
Site Access and Connectivity:

- Simulations of the proposed building masses and outdoor amenities demonstrating how the urban form has been optimised

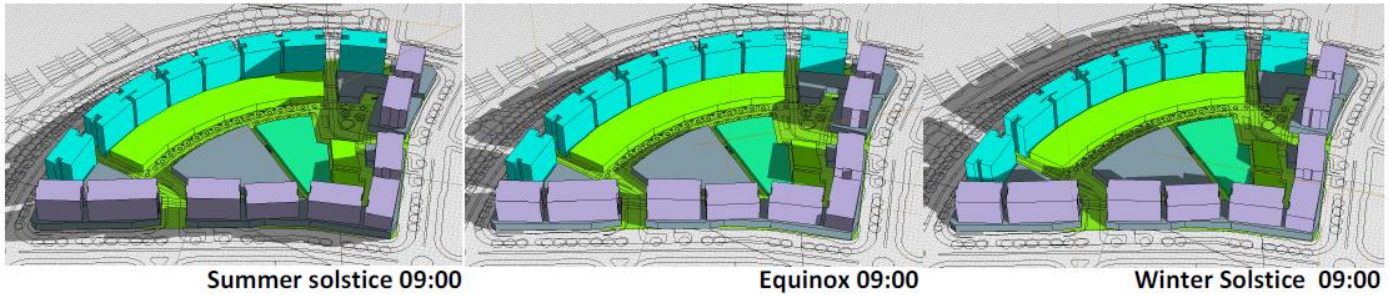
1.02a (ii) – Response to Site Context

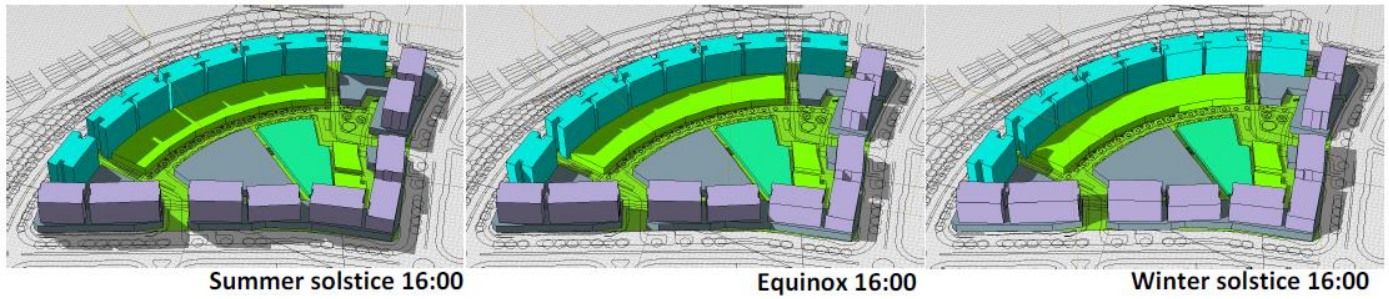
LEVEL 2:

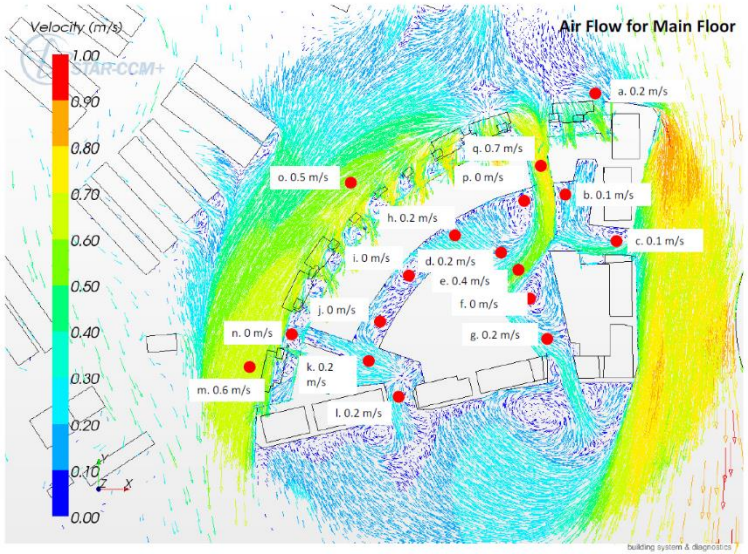
Residential garden receives sunlight in the morning, while west sun in the afternoon is blocked by the residential tower. Therefore, It is a good location for outdoor activities

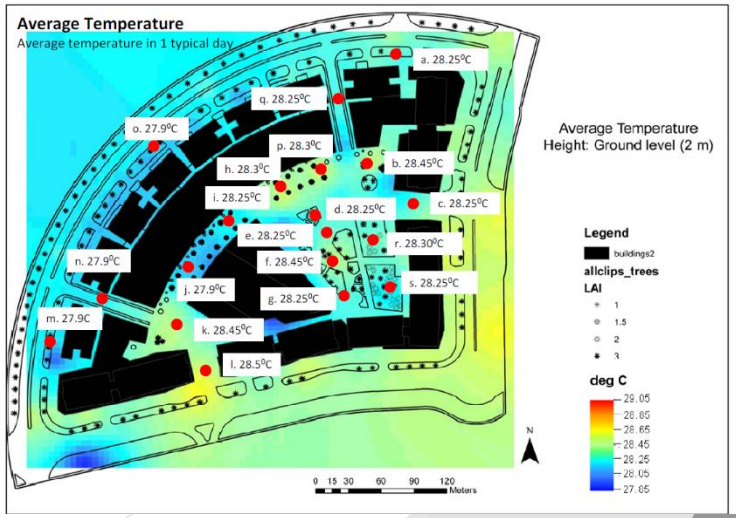


RESIDENTIAL GARDEN





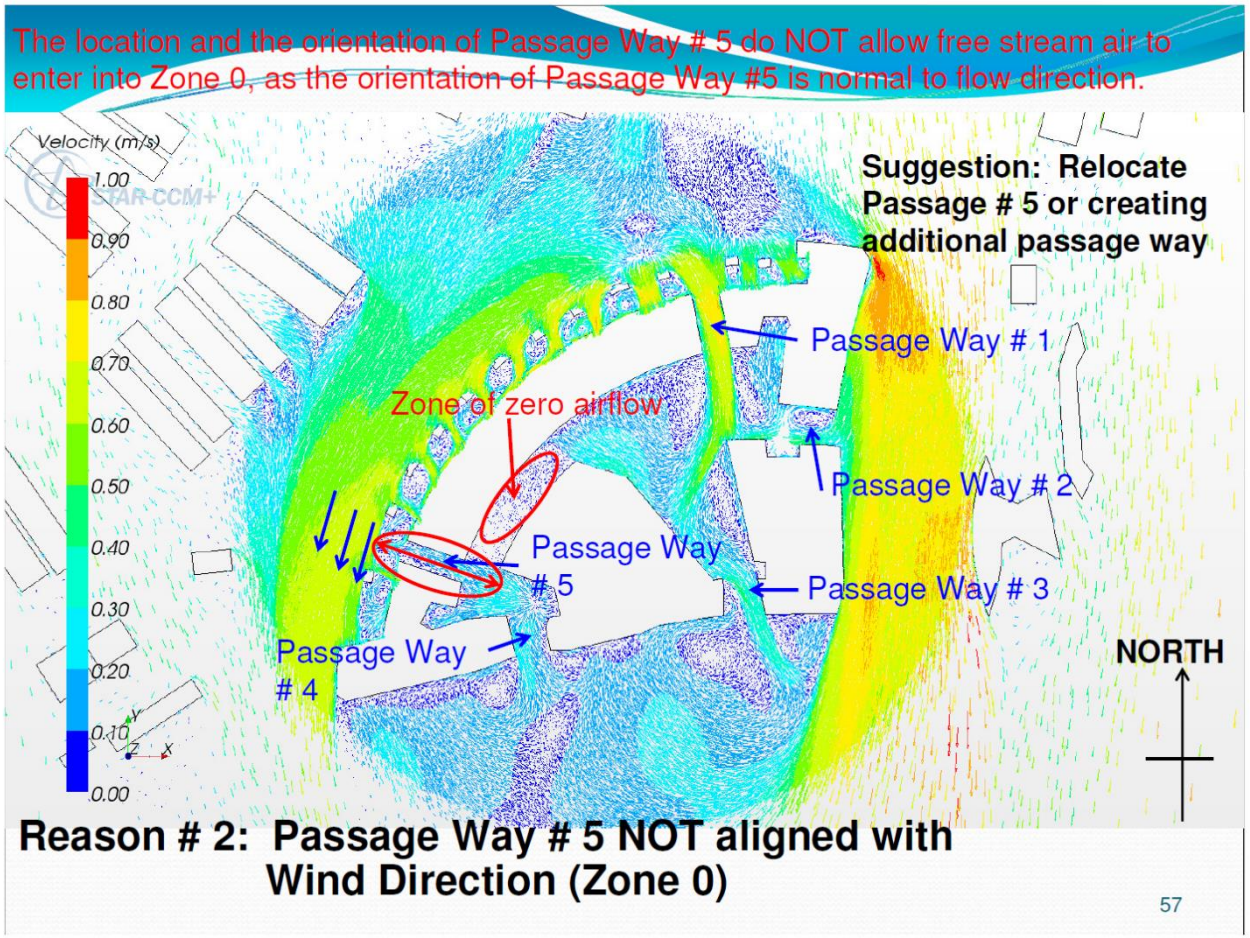


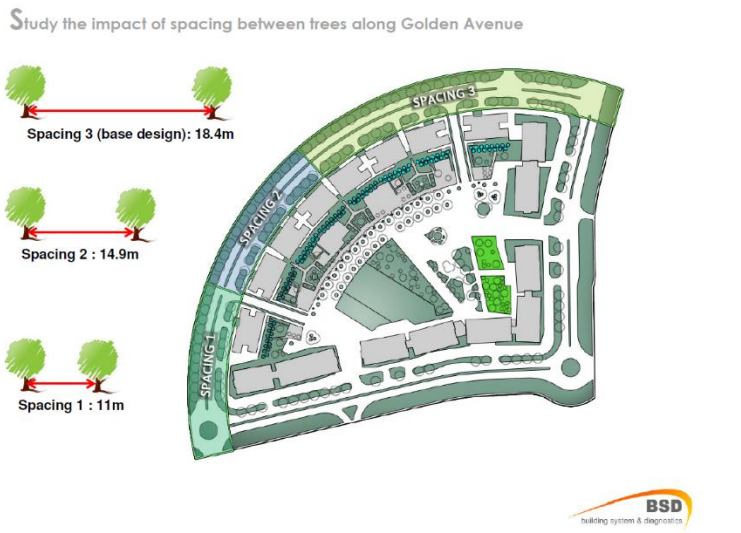


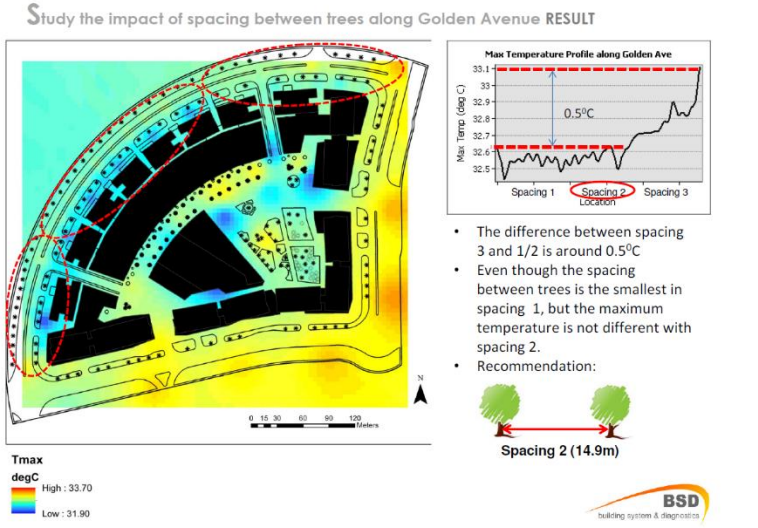
Example courtesy of BSD

1.02a (ii) – Response to Site Context

LEVEL 2:







Example courtesy of BSD

1.02b – Integrated Landscape and Waterscape

(i) Greenery Provision

Pre-requisite for Gold^{PLUS} and Platinum

(ii) Tree Conservation

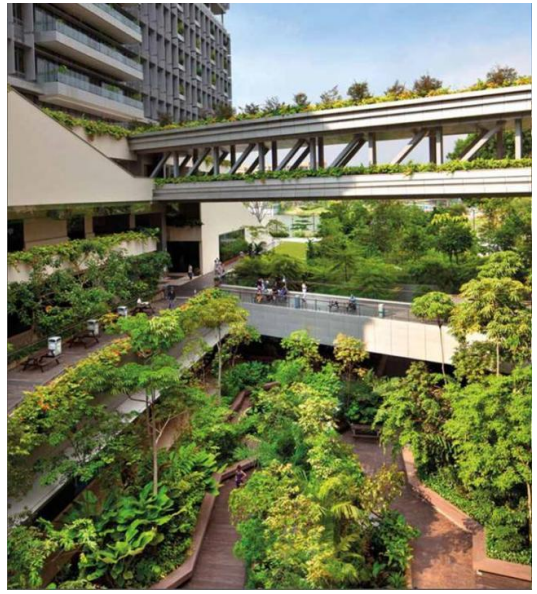
Including replacement of felled trees.

(iii) Sustainable Landscape Management

Use of NParks LEAF certification

(iv) Sustainable Stormwater Management

Use of PUB ABC Waters certification









1.02a (iii) – Urban Heat Island

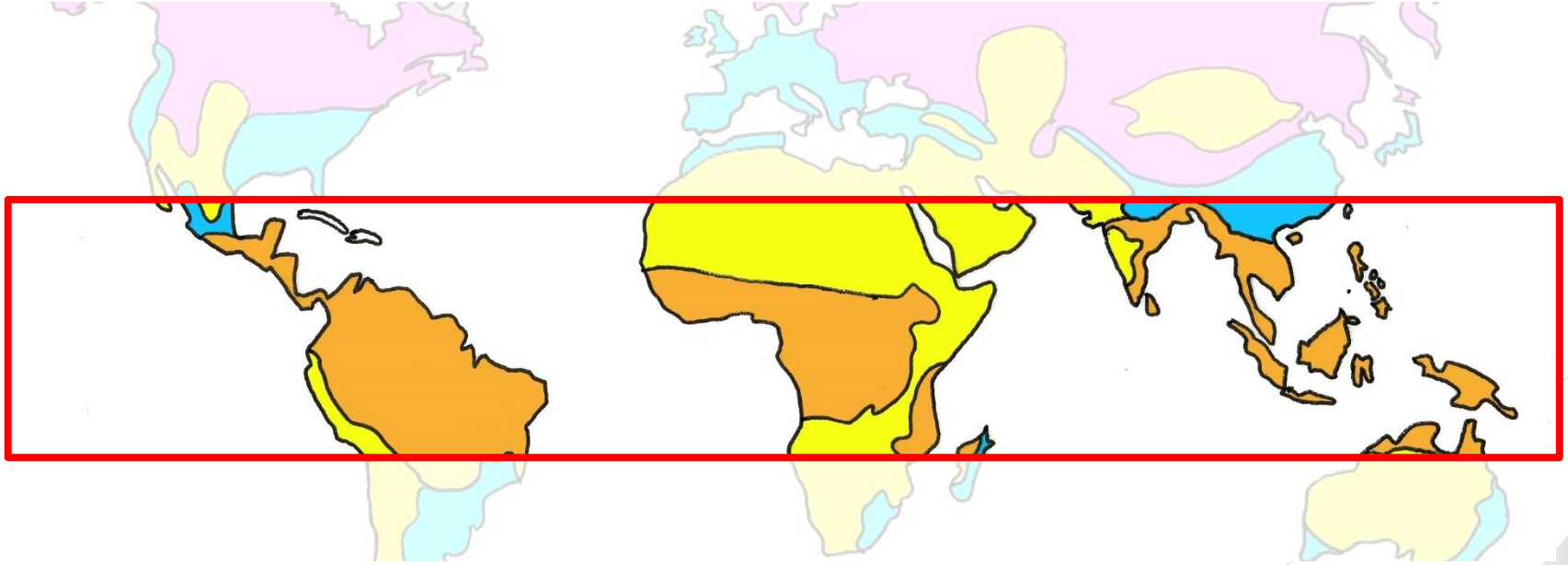
The site plan shall be used to calculate the site coverage of the UHI mitigation measures such as:

- Green and blue spaces for landscaping and roof
- Roofing materials or coatings or cool paints with high Solar Reflectance Index (SRI) > 40
- Unshaded hardscape areas with SRI > 39, inclusive of unshaded carparks, internal roads, plazas and pedestrian walkways
- Use of permeable paving strategies such as gravel or open paving systems
- Other performance based strategies that demonstrate URH effect mitigation

Areas with renewable energy (photovoltaic panels) shall be excluded.

1.03 – Tropicallity

1.03	Tropicality	10
1.03a	Tropical Façade Performance	4
1.03b	Internal Organisation	2
1.03c	Ventilation Performance	4

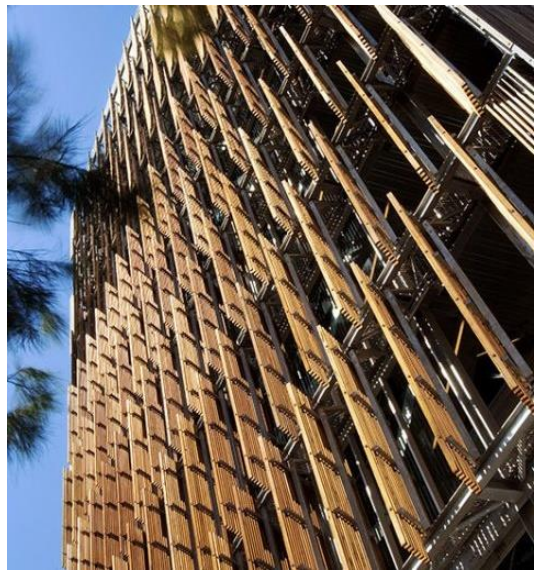


1.03a – Façade

Checklist based (elemental performance of façade based on notional façade for each building type) WWR, U values, Air tightness/or permeability, SC values, effective sun shading,

OR

Performance based – from simulation and a building physics report that details the façade performance (e.g. for highly engineered facades with high window to wall ratios)



1.03a – Façade - Checklist

Commercial Facade.

	Baseline	Points for Improvement
Overall weighted Envelope U-Value	1.6 $Wm^{-2}K^{-1}$	0.5 points U value of 1.6$Wm^{-2}K^{-1}$ Additional 0.5pts for every 0.2 reduction. *Cap at 2 points*
WWR (Excludes façade openings/voids)	0.4 (Overall) *East and West facades not to exceed 0.3%*	WWR 0.4 -1pt WWR 0.35 – 1.5pts WWR 0.3 – 2pts
Glass Shading Coefficient (SC1)	0.4	SC 0.4 = 0.5pt SC 0.35 = 1pt SC 0.3 = 1.5pt SC 0.2.5 = 2pt
Effective Sun Shading (North and South)	-	≥ 10% effectiveness 1pt
Effective Sun Shading East and West)	-	≥30% effectiveness 1pt
Roof U-Value	0.8 W $m^{-2}K^{-1}$	1pt for meeting 0.8 W $m^{-2}K^{-1}$
Sky light / Roof window U-Value	2.2 W $m^{-2}K^{-1}$	0.5points for meeting U-Value
	Total Points (Cap at 4)	

Industrial Facade.

	Baseline	Points for Improvement
Overall weighted Envelope U-Value	2.4 $Wm^{-2}K^{-1}$	0.5 points for every 0.4 W $m^{-2}K^{-1}$ reduction in U-Value compared to the baseline *Cap at 2 points*
WWR (Excludes Façade openings / voids)	0.2	WWR 0.2 -0.5pt WWR 0.15 – 1pt WWR 0.12 – 2pts
Glass Shading Coefficient (SC1)	0.6	SC 0.5 = 1pt SC 0.45 = 1.5pt SC 0.4 = 2 pt
Effective Sun Shading (North and South)	-	≥10% effectiveness 1pt
Effective Sun Shading East and West)	-	≥30% effectiveness 1pt
Roof U-Value	1.0 W $m^{-2}K^{-1}$	0.5points for a reduction of 0.1 *Cap at 2 points*
Sky light / Roof window U-Value	4.0 W $m^{-2}K^{-1}$	U-Value of 4 W $m^{-2}K^{-1}$ = 0.5pt U-Value of 2 W $m^{-2}K^{-1}$ = 1pt
	Total Points (Cap at 4)	

1.03a – Façade - Checklist

U-values to be calculated as per code on Envelope Thermal Performance for Buildings

The weighted U-value is the areas weighted U-Value of all the façade components including windows

	(b)	(k)	(R=b/k)
	thickness	k-value	Resistance
Outside Air			0.044
Aluminium cladding	0.003	211	1.42E-05
Polyurethane foam (insulation)	0.05	0.024	2.083333333
Concrete	0.25	1.442	0.173370319
gypsum plaster board	0.02	0.17	0.117647059
inside air			0.12
		R Total	2.54
		U Value	0.39

Glass Type	**U-Value**	**SC**
9mm Single Glazed	5.7	0.8
Basic Double Glazing	2.6	0.65
high performance Double Glazing	1.8	0.65
Low E High performance Double Glazing	1.8	0.35

Example total façade area = 2,000m2, WWR =0.4, based on the U values above -
Weighted U-Value = W1 x W1Area + F1 x F1 Area / Total façade Area

$$= \frac{(0.39 Wm^{-2}K^{-1} \times 1200) + (2.6\ Wm^{-2}K^{-1} \times 800)}{2000}$$

$$= 1.274 Wm^{-2}K^{-1}$$

1.03a – Façade - Checklist

	Baseline	Design	Points
Overall weighted Envelope U-Value	1.6 $Wm^{-2}K^{-1}$	1.29 $Wm^{-2}K^{-1}$	*1.25*
WWR (Excludes façade openings/voids)	0.4 (Overall) *East and West facades not to exceed 0.3%*	Overall = 0.3 East = 0.25 West 0.28	2
Glass Shading Coefficient (SC1)	0.4	0.65	0
Effective Sun Shading (North and South)	-	-	0
Effective Sun Shading East and West)	-	-	0
Roof U-Value	0.8 W $m^{-2}K^{-1}$	1 W $m^{-2}K^{-1}$	0
Sky light / Roof window U-Value	2.2 W $m^{-2}K^{-1}$	NA	NA
	Total Points (Cap at 4)		*3.25*

1.03a – Façade - Simulation

Notional Façade (baseline) for Simulation.

	Commercial & Institutional Buildings	Industrial
Weighted Window U-Value	2.8	5.4
Weighted Wall U-Value	0.7	1.5
Overall Envelope U-Value	1.6	2.4
WWR (each façade)	0.4	0.20
Total Effective Shading Coefficient (SC1 x SC2)	0.4	0.6
Maximal Air Leakage (AC Spaces only)	$5m^3/h/m^2$@ 50Pa	$10m^3/h/m^2$@ 50Pa
Roof U-Value	0.8	1.1
Sky light / Roof window U-Value	2.2	4.3
RTTV (where there are sky lights *for AC areas*)	50	50

Heat Gain Reduction (%)	Points
Meeting Notional Facade	1
5%	2
10%	3
15%	4

Simulation is ONLY required for the following:

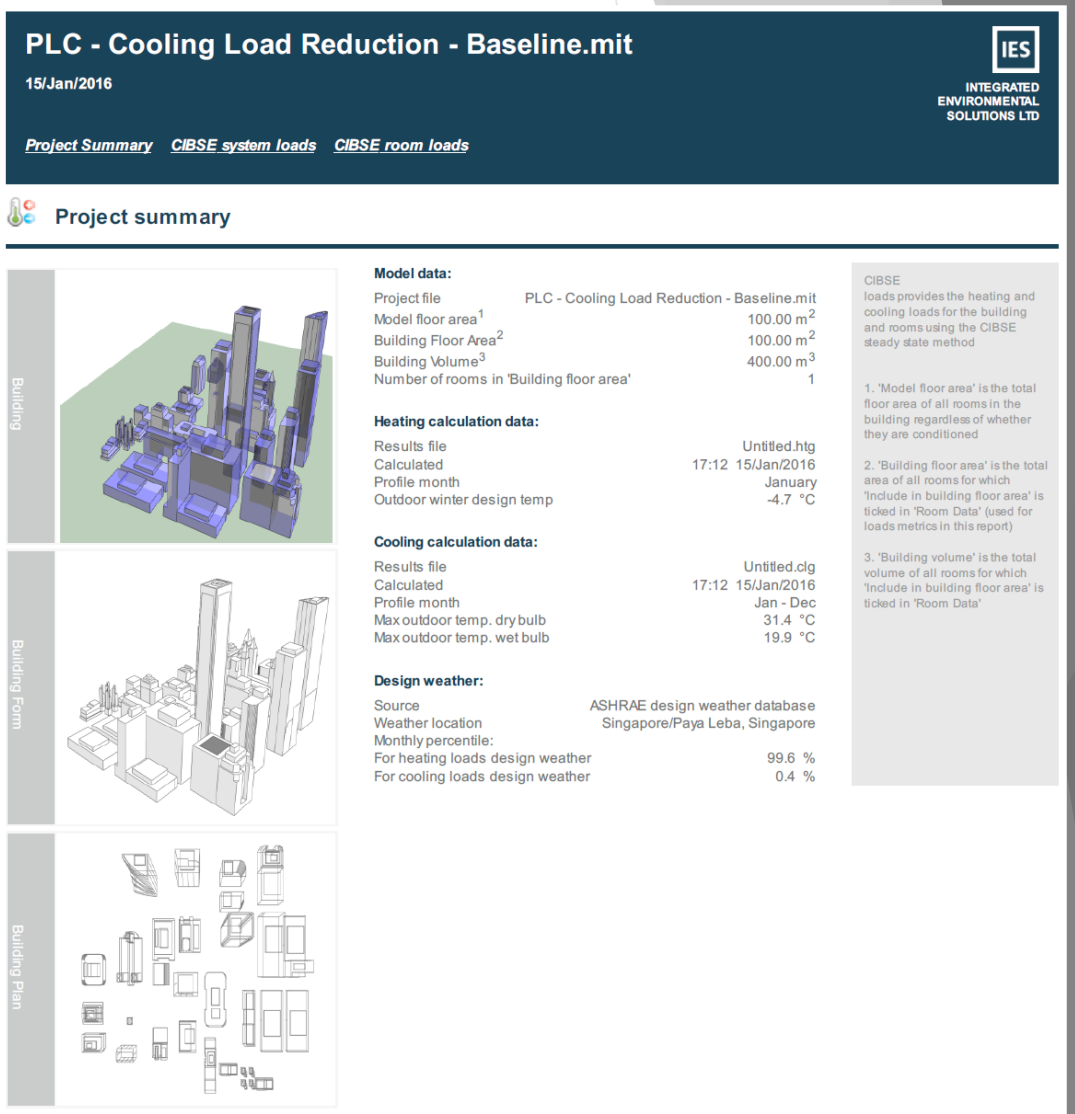
1) commercial buildings with a WWR greater than 0.5, and
2) Industrial buildings with a WWR greater than 0.25

1.03a – Façade - Simulation

Simulation Method:

1) Simulations should be conducted based on a single thermal block for the hours of daylight **only** (7am-7pm) for all building typologies. Context can be included (interlock shading) but must be consistent between the notional and design model. Context is OPTIONAL
2) Simulations can use 3D based modelling such as IES or data input method such as E20 based models

Heat Gain Reduction (%)	Points
Meeting Notional Facade	1
5%	2
10%	3
15%	4



PLC - Cooling Load Reduction - Baseline.mit

15/Jan/2016

INTEGRATED ENVIRONMENTAL SOLUTIONS LTD

Project Summary | CIBSE system loads | CIBSE room loads

Project summary

Building

Building Form

Building Plan

Model data:

Project file	PLC - Cooling Load Reduction - Baseline.mit
Model floor area[1]	100.00 m²
Building Floor Area[2]	100.00 m²
Building Volume[3]	400.00 m³
Number of rooms in 'Building floor area'	1

Heating calculation data:

Results file	Untitled.htg
Calculated	17:12 15/Jan/2016
Profile month	January
Outdoor winter design temp	-4.7 °C

Cooling calculation data:

Results file	Untitled.clg
Calculated	17:12 15/Jan/2016
Profile month	Jan - Dec
Max outdoor temp. dry bulb	31.4 °C
Max outdoor temp. wet bulb	19.9 °C

Design weather:

Source	ASHRAE design weather database
Weather location	Singapore/Paya Leba, Singapore
Monthly percentile:	
For heating loads design weather	99.6 %
For cooling loads design weather	0.4 %

CIBSE loads provides the heating and cooling loads for the building and rooms using the CIBSE steady state method

1. 'Model floor area' is the total floor area of all rooms in the building regardless of whether they are conditioned

2. 'Building floor area' is the total area of all rooms for which 'Include in building floor area' is ticked in 'Room Data' (used for loads metrics in this report)

3. 'Building volume' is the total volume of all rooms for which 'Include in building floor area' is ticked in 'Room Data'

1.03b – Internal Organisation

Common Area	AC	NV	MV
Toilets	0	10	15
Staircases	0	1	5
Corridors	4	2	6
Lift Lobbies	10	1	0
Atriums	0	1	0
Others (e.g. Pantry spaces)	0	10	0
Total Number	14	25	26
Weightage	0	1	0.5
Sum	0	25	13

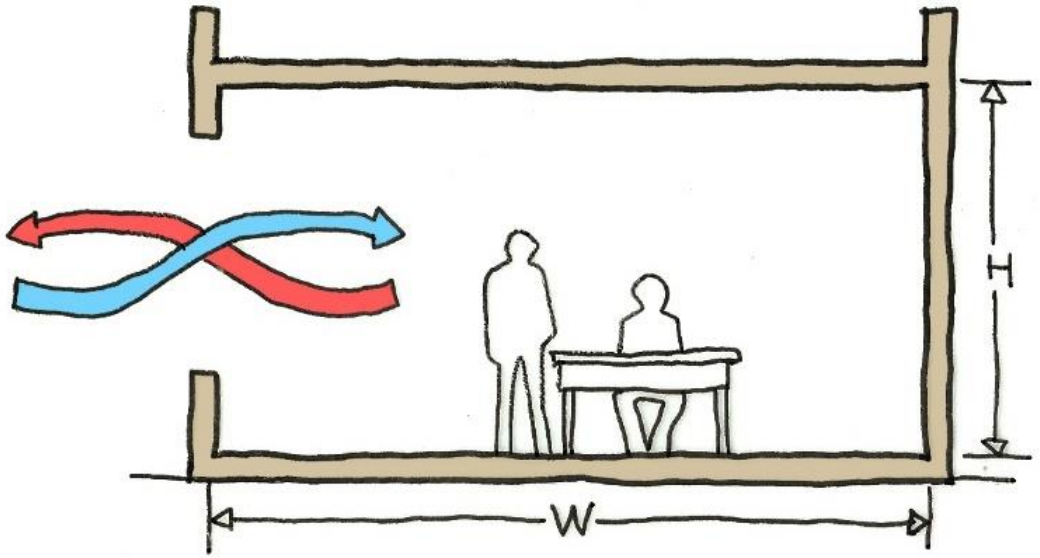
Total number of common areas = 65

Points = (25+13)/65 = 0.58

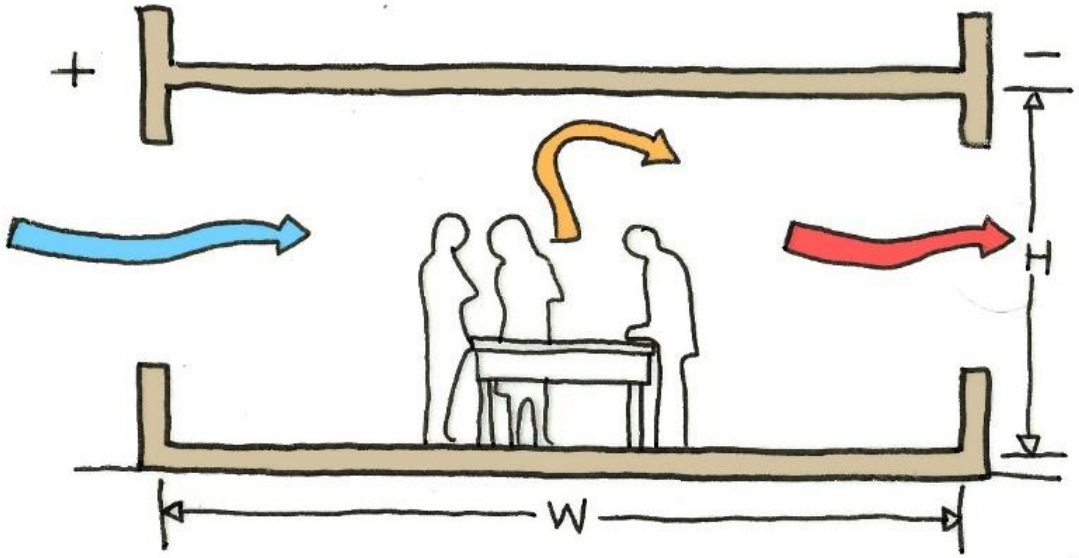
1.03c – Ventilation Performance

Criteria	Points
Ventilation performance checklist	3 points
Full Computational Fluid Dynamics (CFD) Simulation	4 points

1.03c – Ventilation Performance



Single sided ventilation – width of room (w) maximum 2.5 x height (h), limit to 6m. .



Cross ventilation (openings on opposite or 2 sides) maximum room width (w) = 5 x height (h), limit to 14m maximum

Design Rules - for good design for natural ventilation of spaces. Simple scoring methodology to encourage good ventilation design for NV spaces

1.03c – Ventilation Performance

Parameter	Description	Points
Openings towards Prevailing Wind directions (including Atria)	0.1 point for every 10% of units or rooms with openings facing towards the prevailing winds (North & South for Singapore)	1
Depth of Room vs Opening **Effective opening >5% floor area (Building Code)*	<u>Single sided ventilation</u>: the limiting depth(W) for effective ventilation is twice the floor-to-ceiling height (H) [W≤2H] (up to 6m) <u>Cross Ventilation</u>: the limiting depth(W) for effective ventilation is five times the floor-to-ceiling height (H) [W≤5H] (up to 15m) <u>Combination with stack effect atria</u>: 15m limiting depth of space from façade to atria. *Note:* *Atria to have an effective opening >10% floor area. Atria can be 1.5x the depth of room (above), or 2 x where the use of fixed fans or mixed mode systems are employed.*	1 Point *Where ≥50% of applicable spaces meet* 2 Points *Where ≥70% of applicable spaces meet*
		Total 3 Points

1.03c – Ventilation Performance

Points	Wind Speed Result	Thermal Comfort	Air Quality
3	Moderate (0.2m/s)	-	-
4 (Gold^{PLUS})	Good (0.4m/s)	-1.0 <PMV<+1.0	Air Change Rate ≥4 Air Exchange Efficiency of ≥ 1
(Platinum)	Very Good (0.6m/s)	-0.8 <PMV<+0.8	Air Change Rate ≥10 Air Exchange Efficiency of ≥ 1.2

Pre-requisite for Gold Plus and Platinum projects with ≥ 2,000m^2 of naturally ventilated functional spaces (excluding all transient spaces and M&E spaces with the exception of building atria)





1.03c – Ventilation Performance

Wind Speed

CFD Simulation:

- Moderate 0.2m/s
- Good 0.4m/s
- Very Good 0.6m/s

70% of naturally ventilated occupied space

Gold Plus ≥ 0.4m/s
Platinum ≥ 0.6m/s

1. Thermal Comfort

Thermal Comfort Simulation:

- Gold Plus: -1.0 <PMV<+1.0
- Platinum -0.8 <PMV<+0.8

The project team may use hybrid systems – fixed fans, return air from AC or elements of radiant cooling

For Option 1 - "moderate" natural ventilation performance.

OR

2. Air Quality

Air Quality Simulation:

- Gold^{PLUS} Air Change Rate ≥4
Air Exchange Efficiency of ≥ 1

Platinum Air Change Rate ≥10
Air Exchange Efficiency of ≥ 1.2

Air change – can use hybrid ventilation strategies.
Must achieve moderate under 1

For Option 2 . Only applicable for Industrial, warehouses & sports facilities



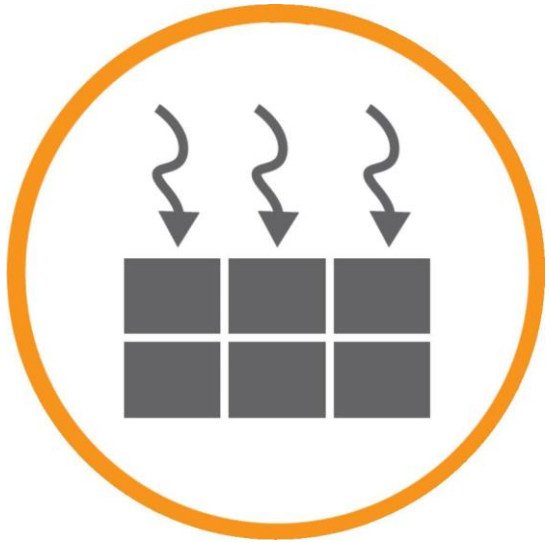
2.Building Energy Performance



Energy Efficiency
(7 points)



Energy Effectiveness
(15 points)

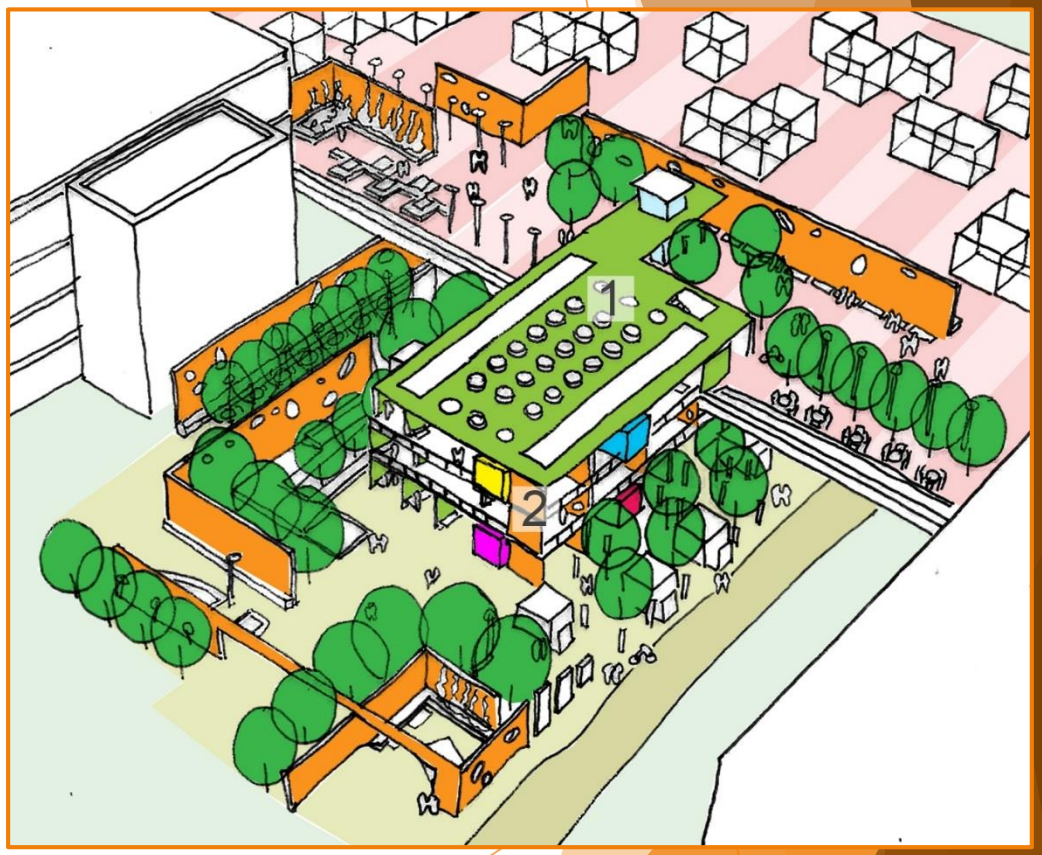


Renewable Energy
(8 points)

2. Building Energy Performance

Excel Based calculator is used to auto generate the points for the majority of this section. The excel calculator was developed in house by BCA and has been peer reviewed

- Easy to check (Consultants + Assessors)
- Easy to use (Consultants)
- Provides consistency (pre-programmed)
- Whole of Building Energy Consumption
- Encourages **reduction** of AC areas
- Based on normalised kWh/yr
- Can be used for verification/operations



BUILDING DETAILS

Building Details	Input	Comments	Supporting Evidence
Building Name	OFFICE / RETAIL MIX		
Address line 1	IGBC		
address line 2			
Postcode	NA		
Country	Singapore		
Primary Usage	Mixed Use GFA or Total GFA		
Operating Hours per week (hrs)	*62.39*		
Building GFA (exclude carpark)	*47,831*		
Building NLA			
Car Park Area	13,612		
Car Park Operating Hours per week	168	Lighting & fan Schedule	

Auto Generation of notional operational schedule (fixed) based on GFA breakdown

	Operating hours/week	Areas (GFA) - excludes carparks	Remarks
Office Buildings	*55*	35,649	
Retail Malls	*84*	12,182	
Hotels	*168*	0	
Schools & Institutions	60	0	
Industrial Buildings	168	0	
Other Building Types	0	0	Please Specify: _____
Mixed Use GFA	*62.39*	*47,831*	Operating hours & area will be autogenerated with area inputs of the above components of the mixed development
Total GFA			

COMMON AREAS - INPUT DATA

Common Areas	Area (m^2)	Mode of Ventilation
Toilets	1,176	MV
Staircases	1,023	
Corridors	3,541	
Retail Corridors (Interior)	0	
Lift Lobbies	0	AC
Atriums	602	AC
Retail Atriums	0	AC
Carparks	13,612	NV
M & E Spaces	2,259	MV

[Select from drop-down list]
NV
MV
AC

GFA area check:	*47831*	m2
(excludes carpark)	*Okay, please proceed.*	

GFA Check based on summary and inputs for common areas and functional areas

AIR CONDITIONED FUNCTIONAL AREAS - INPUT DATA

Functional Areas	Functional Use	Details*	Area (m^2)
Foodcourt	Retail		3,581
Open Plan offie and Executive Office	Office		35,649
[Empty]			0
[Empty]			0
[Empty]			0
[Empty]			0
[Empty]			0
[Empty]			0
[Empty]	[Empty]		0

Office
Retail
Hotel
Industrial
Education
Healthcare
Sports
Other

Fixed inputs using Drop Down Menu's that link to auto calculations

COMMON AREAS - INPUT DATA

Common Areas	Area (m^2)	Mode of Ventilation
Toilets	1,176	MV
Staircases	1,023	
Corridors	3,541	
Retail Corridors (Interior)	0	
Lift Lobbies	0	AC
Atriums	602	AC
Retail Atriums	0	AC
Carparks	13,612	NV
M & E Spaces	2,259	MV

[Select from drop-down list]
NV
MV
AC

Drop Down List for Common Area Ventilation (NV, MV, AC) – if AC selected – auto calculates Cooling Load and Annual Energy Consumption Based on Proposed AC DSE – Load based on SS, CIBSE & ASHRAE

AIR CONDITIONED FUNCTIONAL AREAS - INPUT DATA

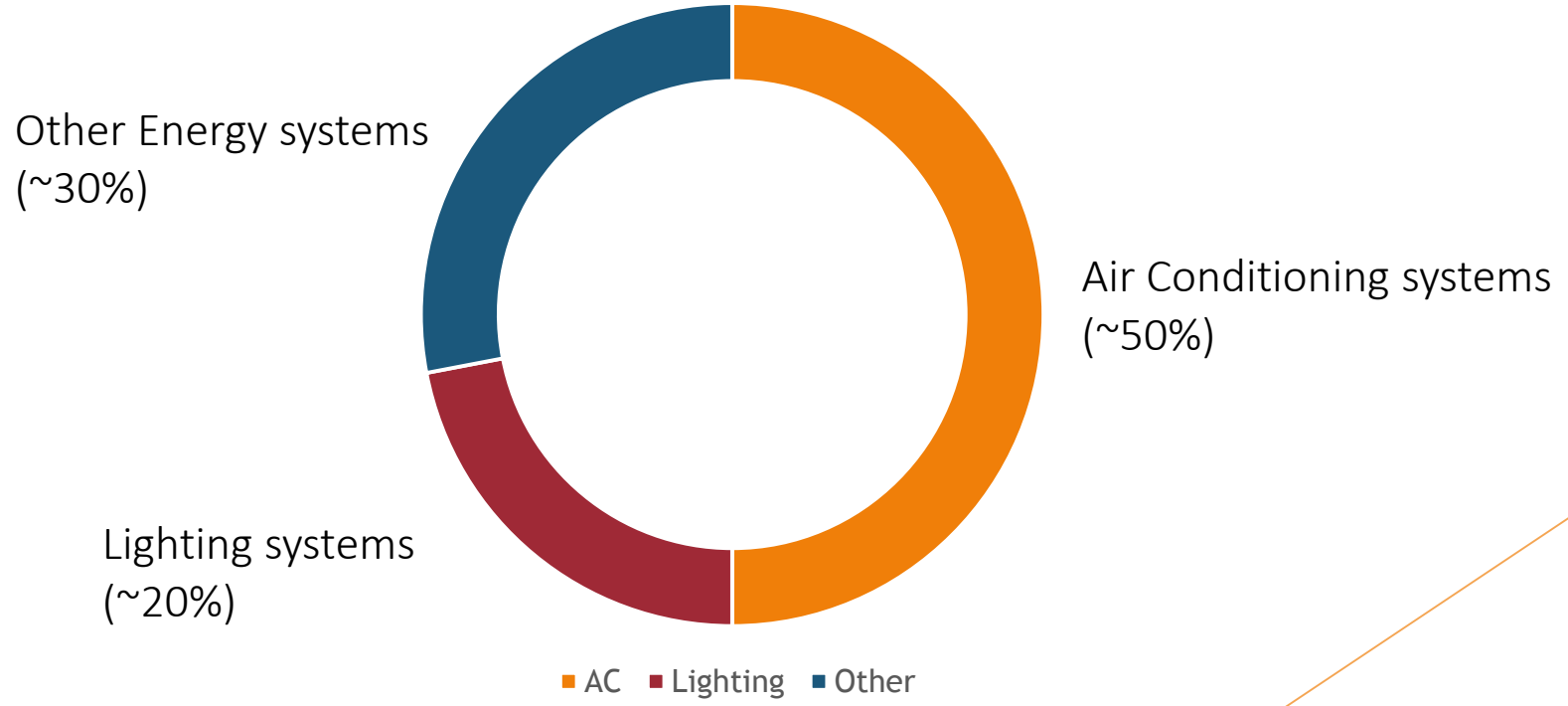
Functional Areas	Functional Use	Details*	Area (m^2)
Foodcourt	Retail		3,581
Open Plan offie and Executive Office	Office		35,649
[Empty]			0
[Empty]			0
[Empty]			
[Empty]			
[Empty]			
[Empty]			
[Empty]	[Empty]		

Office
Retail
Hotel
Industrial
Education
Healthcare
Sports
Other

Functional AC Area input – Auto generates RTh for calculator (Office, Hotel, Retail, Industrial etc.) Based on Verified EB data. Works for Mixed use Developments as well.
AC Efficiency figure based on calculated DSE as v4.1

2.01 Energy Efficiency

2.01	Energy Efficiency	7
2.01a	Air Conditioning Total System Efficiency	4
2.01b	Lighting Efficiency	3



2.01a AC Total System Efficiency

	Building Cooling Load (RT)	
	<500 RT	≥500RT
	Total Design System Efficiency (kW/RT)	
Baseline	1.08	0.98
1 point for every 6% improvement from baseline		

Total system efficiency of **all** the air conditioning systems and equipment normally in operation in the building, inclusive of chillers, unitary systems, associated pumps, cooling towers **and air distribution systems**.

Non-air-conditioned building projects shall score full points under this indicator.

Full points for <500RT = 0.82kW/RT
Full points for ≥500RT = 0.74 kW/RT

AC INFORMATION

Design Day Peak Load (RT)	AC System Type	Referecne Total System Efficency (Including Air Side)
3,174	Water Cooled Chilled Water	0.98

Water Cooled Chilled Water
Air Cooled Chilled Water
VRV/VRF
Split System
Combination of Systems
Other

Building Cooling Load	<500RT	≥ 500 RT
Certified	1.08	0.98
Gold Plus	0.95	0.90
Platinum	0.93	0.90

AC Total System Efficiency Baseline – Auto generated & used to calculate points and savings

Target System efficiencies (info)

TOTAL SYSTEM EFFICIENCY

System	Total RT	AC DSE (kW/RT)	Air Distribution (kW/RT)	TOTAL (kW/RT)	
Water Cooled Chilled Water Plant	***2,944,991***	*0.563*	**0.205**	0.768	syetem 1
Air Cooled Chilled Water Plant	*0*	*0.000*	0.000	0.000	System 2
Unitary System	*0*	*0.000*	0.000	0.000	system 3
TOTAL	***2,944,991***	***0.56***	***0.21***	***0.77***	

will auto populate from below data

Office Buildings	9 a.m. to 6 p.m.
Reta	
Indu	
Other	

Aggregate Total System Efficiency of the entire building calculated base on the DSE calculations of all the AC systems in the building (RT weighted) and the air distribution systems.

WATER COOLED CHILLED-WATER PLANT

Hours	Average Cooling Load (RT)	Chillers Power Input (kW)	CHW Pumps Power (kW)	CW Pumps Power (kW)	CT Power (kW)	Total Power Input (kW)	Chiller Configuration
00:00:00						*0*	
01:00:00						*0*	

Space for DSE Calculation details based on average operational load (simulated) for water cooled chilled water systems. Unitary systems are based upon the total weighted efficiency

Baseline	Building Cooling Load	
	≥ 500 RT	< 500 RT
Minimum Design System Efficiency (DSE) for Central Chilled Water Plant	0.70 kW/RT	0.80 kW/RT

Space for DSE Calculation details based on average operational load (simulated) for water cooled chilled water systems. Unitary systems are based upon the total weighted efficiency

Hours	Average Cooling Load (RT)	Chillers Power Input (kW)	CHW Pumps Power (kW)	CW Pumps Power (kW)	CT Power (kW)	Total Power Input (kW)	Chiller Configuration
12:00:00 AM						0	
1:00:00 AM						0	
2:00:00 AM						0	
3:00:00 AM						0	
4:00:00 AM						0	
5:00:00 AM						0	
6:00:00 AM						0	
7:00:00 AM						0	
8:00:00 AM						0	
9:00:00 AM	1190	620	43.74	60.96	21.39	746.09	2 x 700RT
10:00:00 AM	1260	658	51.92	72.36	25.43	807.71	2 x 700RT
11:00:00 AM	1260	658	51.92	72.36	25.43	807.71	2 x 700RT
12:00:00 PM	1260	658	51.92	72.36	25.43	807.71	2 x 700RT
1:00:00 PM	1260	658	51.92	72.36	25.43	807.71	2 x 700RT
2:00:00 PM	1260	658	51.92	72.36	25.43	807.71	2 x 700RT
3:00:00 PM	1260	658	51.92	72.36	25.43	807.71	2 x 700RT
4:00:00 PM	1190	620	43.74	60.96	21.39	746.09	2 x 700RT
5:00:00 PM	1190	620	43.74	60.96	21.39	746.09	2 x 700RT
6:00:00 PM	1190	620	43.74	60.96	21.39	746.09	2 x 700RT
7:00:00 PM						0	
8:00:00 PM						0	
9:00:00 PM						0	
10:00:00 PM						0	
11:00:00 PM						0	
TOTAL	12320					7830.62	

DSE (kW/RT)	0.64

WATER COOLED AIR DISTRIBUTION SYSTEM SUMMARY

AHU/PAU/FCU

Type	Total Air Flow Rate (CMH)	Total Motor Input Power (W)	Total Fan Efficiency (W/CMH)
PAHU			#DIV/0!
PFCU			#DIV/0!
AHU	1116000	334800	0.3
FCU			#DIV/0!
Others			#DIV/0!
Total	1116000	334800	0.3

TOTAL AIR FLOW RATE (CMH)	1116000	
TOTAL FAN POWER (kWh)	3348	
TOTAL AIR SIDE EFFICIENCY (KW/RT)	0.27	Base on RTh

Air Distribution system summary – calculated in a separate tab in the calculator

UNITARY / SPLIT CONDITIONERS SUMMARY

Hours	Average Cooling Load (RT)	Total Weighted COP	Total Condensing Units Power Input (kW)
12:00:00 AM			0
1:00:00 AM			0
2:00:00 AM			0
3:00:00 AM			0
4:00:00 AM			0
5:00:00 AM			0
6:00:00 AM			0
7:00:00 AM			0
8:00:00 AM			0
9:00:00 AM	200	4.9	143.5510204
10:00:00 AM	350	4.82	255.3838174
11:00:00 AM	350	4.82	255.3838174
12:00:00 PM	350	4.82	255.3838174
1:00:00 PM	350	4.82	255.3838174
2:00:00 PM	350	4.82	255.3838174
3:00:00 PM	350	4.82	255.3838174
4:00:00 PM	350	4.82	255.3838174
5:00:00 PM	350	4.82	255.3838174
6:00:00 PM	350	4.82	255.3838174
7:00:00 PM	150	4.71	112.0063694
8:00:00 PM	150	4.71	112.0063694
9:00:00 PM	150	4.71	112.0063694
10:00:00 PM	150	4.71	112.0063694
11:00:00 PM			0
TOTAL	3950		2890.030855

DSE (kW/RT)	0.73

Unitary systems will be based on each system's weighted COP (0.4 x COP@100% + 0.6 x COP@50%). The total weighted COP is a product of all the condensing units in the project, and their simulated opperational load. (excluding standby units)

VRV Example: Mixed Use building:
Office: VRV total installed capacity = 285RT
Retail: VRV total installed capacity = 215RT

1) Weighted Cooling load Office = 200RT
2) Weighted Cooling load Retail = 150RT
3) Calculated weighted COP for Office units =4.9
4) Calculated weighted COP for Retail units =4.71

Enter this into the spreadsheet based on the prescribed operational hours which will calculate the VRV Design System Efficiency

In this example it is 0.73kW/RT

2.01b Lighting Efficiency

The savings of the building's lighting power density in comparison with the lighting power budget in SS 530: 2014.

1 point shall be scored for every 15% savings over code.

Description	Areas (m^2)	Light Fitting Type	Power Consumption per fitting (W)			Ballast Loss (W)	Number of Fittings	Total Power Consumption per fitting
	(A)	(B)	(C)			(D)	(E)	[(C + D) x (E)]
Office 1	1500	T5	2	x	28	3	245	14455
Office 2	1250	T5	2	x	28	3	210	12390
Meeting Room	75	T8	1	x	36	5	15	615
		CFL Down Light	2	x	26	0	8	416
Atrium	850	T8	2	x	36	5	87	6699
		High Bay DownLight	1	x	150	0	10	1500
Stairs	300	T5	2	x	28	3	20	1180
Corridor 1	150	T5	2	x	28	3	15	885
Corridor 2	205	T5	2	x	28	3	15	885
		Halogen	1	x	70	0	9	630
Car parks	7500	T5	2	x	28	3	436	25724

BUILDING LIGHTING POWER BUDGET

Description	Areas (m^2)	Design Data		SS 530 Requirements	
		Total Power Consumption (by area) (W)	Design Lighting Power Budget (W/m^2)	Reference Lighting Power Budget (W/m^2)	Reference Total Power Consumption (by area) (W)
Office, Work and Study					
Offices	35649	257,386	*7.22*	*12*	*427788*
Meeting Room	0	0	*0.00*	*12*	*0*
Copy/Print Rooms	0	0	*0.00*	*12*	*0*
Concourse	0	0	*0.00*	*10*	*0*
Pantry/Prayer Room	0	0	*0.00*	*10*	*0*
Auditorium	602	5,418	*9.00*	*10*	*6020*
Concert Hall	0	0	*0.00*	*10*	*0*
			0.00		*0*
TOTAL	*47831*	*347,944*	*7.27*	*11.18*	*534893*
Annual Consumption (kWh/yr)		*1,128,754*			*1735230.38*
% IMPROVEMENT OVER REFERENCE		***35%***			

2.3 points

2.02 Energy Effectiveness

2.02	Energy Effectiveness	15
2.02a	Building Energy	11
2.02b	Car Park Energy	2
2.02c	Receptacle Energy	2



2.02 Energy Effectiveness

1. Energy Effectiveness for points:

- Demonstrated savings vs a simplified reference model (calculation based)
- Streamlined vs 4.1. – Single spreadsheet calculator
- Recognises efficiency and energy reduction strategies
- Notional baselines to incorporate AC total system efficiencies, non AC common areas etc.
- Separates building savings, car park savings and receptacle savings
- Can accept some of the energy modelling results such as AC efficiency values

2. Energy Modelling for % Savings vs Code:

- More robust reference model – more time simulating the proposed model
- Purely used to give % savings AGAINST CODE COMPLIANT BUILDING
- Includes receptacle load
- EXCLUDES car park energy
- Move towards EEI and EUI comparison
- Renewables can be recognised in energy savings subject to conditions

2.02 Energy Effectiveness

(a) Building Energy:

- 1 point for every 3% energy saving
- 11 points = 33% savings
- Advanced Green Effort points (Enhanced performance)
  - 1 point for ≥40% savings
  - 2 points for ≥50% savings

(b) Carpark Energy:

- 0.5 point for achieving 30% energy saving
- 0.5 points for every 10% subsequent energy saving (maximum @ 60%)

(c) Receptacle Energy:

- 1 point for achieving 30% reduction
- 1.5 points for achieving 35% reduction
- 2 points for achieving 40% reduction

Energy Use	Reference Building Electricity (kWh/Yr)	Proposed Building Electricity (kWh/yr)	% Savings	% of Proposed Consumption
Air Conditioning System	2,886,091.35	2,260,928.62	21.7%	55.4%
Lighting	1,735,230.38	1,128,753.88	35.0%	27.6%
Mechanical Ventilation	819,652.00	509,031.00	37.9%	12.5%
Vertical Transportation	34,911.00	31,420.00	10.0%	0.8%
Hot Water Generation	-	-	0.0%	0.0%
Energy efficienct fittings	-	-	0.0%	0.0%
[insert rows where applicable]			0.0%	0.0%
Service Equipment	18,506.00	18,506.00	0.0%	0.5%
Common area cooling	-	134,154.07	-100.0%	3.3%
Common area cooling (Applicable only for Retail Int Corridors and Retail Atrium)	-	-	0.0%	0.0%
BASE BUILDING	***5494390.72***	***4082793.57***		

Notes:
The Air Conditioning system i
proposed ACMV system. Wh
cooling load based on the fu
operational hours from the E

(a) Building Energy

PROPOSED IMPROVEMENT OVER REFERENCE BUILDING (kWh/yr)	*1411597.15*
% IMPROVEMENT OVER REFERENCE BUILDING	*26%*
POINTS SCORED FOR 2.02(a)	

2.02(b) - CARPARK ENERGY

Energy Use	Reference Car Park Electricity (kWh/yr)	Proposed Car Park Electricity (kWh/yr)	% Savings
Lighting	*596,227*	*196,756*	*67.0%*
Mechanical Ventilation	*1,169,279*	*356,732*	*69.5%*
Air Conditioning	-	-	
Receptacle			*0.0%*
TOTAL	***1,765,506***	***553,488***	

PROPOSED IMPROVEMENT (kWh/yr)	*1,212,018*
% IMPROVEMENT	*69%*
POINTS SCORED FOR 2.01(b)	

0.5pts 20%, 1pt 30%, 1.5pts 40%, 2pts 50%

(b) Carpark Energy

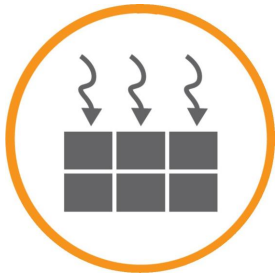
2.02(c) - RECEPTACLE ENERGY

FUNCTIONAL SPACE USE	AREA	REFERENCE POWER BUDGET (W/m2)	TOTAL REFERENCE POWER (W)	PROPOSED POWER BUDGET (W/m2)	TOTAL PROPOSED POWER (W)	**NOTES** *details of proposed savings must be noted here, and suplemented with the use of table below*
OFFICE	35,649	*16*	*570384*	**16**	*570384*	**none**
RETAIL	3,581	*50*	*179050*	**50**	*179050*	**none**
COMPUTER ROOM			*0*		*0*	

(c) Receptacle Energy

Energy Use	Reference Building Electricity (kWh/Yr)	Proposed Building Electricity (kWh/yr)	% Savings	% of Proposed Consumption
Air Conditioning System	*2,886,091.35*	*2,260,928.62*	*21.7%*	*55.4%*
Lighting	*1,735,230.38*	*1,128,753.88*	*35.0%*	*27.6%*
Mechanical Ventilation	*819,652.00*	*509,031.00*	*37.9%*	*12.5%*
Vertical Transportation	*34,911.00*	*31,420.00*	*10.0%*	*0.8%*
Hot Water Generation	-	-	*0.0%*	*0.0%*
Energy efficienct fittings	-	-	*0.0%*	*0.0%*
[insert rows where applicable]			*0.0%*	*0.0%*
Service Equipment	*18,506.00*	*18,506.00*	*0.0%*	*0.5%*
Common area cooling	-	*134,154.07*	*-100.0%*	*3.3%*
Common area cooling (Applicable only for Retail Int Corridors and Retail Atrium)	-	-	*0.0%*	*0.0%*
BASE BUILDING	***5494390.72***	***4082793.57***		

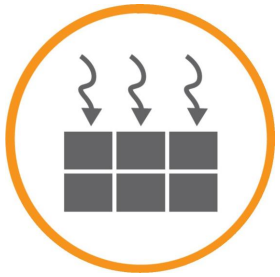
PROPOSED IMPROVEMENT OVER REFERENCE BUILDING (kWh/yr)	*1411597.15*
% IMPROVEMENT OVER REFERENCE BUILDING	*26%*
POINTS SCORED FOR 2.02(a)	



2.03 Renewable Energy

2.03	Renewable Energy	8
2.03a	Feasibility Study	0.5
2.03b	Solar Ready Roof	1.5
2.03c	Replacement Energy	6

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



2.03 Renewable Energy

(a) Feasibility Study:

- Pre-requisite for Gold and above
- Format of feasibility study given in Green Mark 2015 document
- Covers Technical and Financial aspects
- Includes recommendations for roof optimisation
- To be conducted at the earlier design phase of the project

(b) Solar Ready Roof:

- Structural readiness
- Roof layout and organisation
- Reduction of potential solar shading in PV areas (e.g. moving tall items away from the east and west)
- Electrical readiness – space for systems and circuit breakers
- Use other than solar – readiness of the roof for other uses such as greenery etc

2.03 Renewable Energy

Points shall be awarded based on the following:

Expected Energy Efficiency Index (EEI) [kWh/m2/yr]	% Replacement of Electricity (based on building electricity consumption) by Renewable Energy	
	%	Capped at 6 Points
≥ 120	1 point for every 0.5%	3%
80 ≤ EEI < 120	1 point for every 1%	6%
50 ≤ EEI < 80	1 point for every 1.5%	9%
< 50	1 point for every 2.5%	15%

For projects that exceed the replacement %, additional points can be scored under Additional Green Efforts (Enhanced Performance)

Expected Energy Efficiency Index (EEI) [kWh/m2/yr]	% Replacement of Electricity (based on building electricity consumption) by Renewable Energy		
	%	1 point for % additional replacement	Capped at 5 Bonus Points
≥ 120	3%	Every 0.5%	5.5%
80 ≤ EEI < 120	6%	Every 1%	11%
50 ≤ EEI < 80	9%	Every 1.5%	16.5%
< 50	15%	Every 2.5%	27.5%

2.03 Renewable Energy

For projects that are Low to Zero Energy - additional points can be scored under Additional Green Efforts (Enhanced Performance)

% Annual Energy Replacement	Bonus Points
60%	1
70%	2
80%	3
90%	4
100% (Net Zero)	5

2.03 Renewable Energy

2.03(c) - PROVISION OF PHOTOVOLTAICS

DESCRIPTION	AREA OF PV ARRAY	kWp INSTALLED	ANNUAL YIELD	NOTES
Upper roof Block A			*0*	
Roof Block B			*0*	
			0	
Total		*0*	*0*	

Annual Replacement Rate	***0.0%***	
EEI	***please check input building of GFA in cell H6 to H11***	kWh/m2/yr
Points Scored	**#N/A**	

EEI (Lower Limit)	EEI (Upper Limit)	Points	Remark
0	49.99	0.00	N.A.
50	79.99	0.00	N.A.
80	119.99	0.00	N.A.
120	NA	0.00	This is the score for 2.03(c)

2.03(c) - PROVISION OF PHOTOVOLTAICS (Advanced Green Efforts for Additional Replacement energy)

EEI (Lower Limit)	EEI (Upper Limit)	Points	Remark
0	49.99	0.00	N.A.
50	79.99	0.00	N.A.
80	119.99	0.00	N.A.
120	NA	0.00	This is the Advancecd Green Efforts score for 2.03(c) - Additional Replacement Energy

2.03(c) - PROVISION OF PHOTOVOLTAICS (Advanced Green Efforts for Low to Zero Energy Building)

% Annual Energy Replacement	Bonus Points	Remark
60%	1	N.A.
70%	2	N.A.
80%	3	N.A.
90%	4	N.A.
100%	5	N.A.

Q&A – THEN A QUICK TEA!!!



3.Resource Stewardship



Water
(8 points)



Materials
(18 points)



Waste
(4 points)

3.01 Water

3.01	Water	8
3.01a	Water Efficient Systems	3
3.01b	Water Monitoring and Leak Detection	2
3.01c	Alternative Sources of Water	3

3.01 Water

3.01a WATER EFFICIENT SYSTEMS:

- **Landscape Irrigation**
  - Water efficient irrigation or drought tolerant plants
- **Water consumption of cooling towers**
  - Achieving >7 CoC
  - Reduction of cooling tower drift (<0.002% of re-circulated flow)
  - Reduction of heat rejection through the cooling towers eg heat pumps
- **Advanced Green Effort** (Enhanced Performance)
  - 100% WELs excellent fittings
  - Water system audit during operation

3.01b WATER MONITORING & LEAK DETECTION:

- Sub meters linked to BMS for common major water use (1 point)
- Smart water system
  - Water portal & dashboard for the base building and for tenants (1 point)

3.01c USE OF ALTERNATIVE WATER:

- AHU Condensate (0.5 point)
- NEWater (0.5 point)
- Rainwater harvesting (2m^3 per 1000m^2 GFA, minimum size 7m^3, cap at 100m^3) (1 point)
- On-site recycled water (1 point)



3.02 Materials

3.02	Materials	18
3.02a	Sustainable Construction	8
3.02b	Embodied Energy and Life Cycle	2
3.02c	Sustainable Products	8

3.02a Sustainable Construction

Reduction of Concrete Usage (4 points)

- CUI +
- Adoption of Sustainable Building Systems (Engineered Timber, Steel Frame, PPVC)

Alternative Aggregates (3 points):

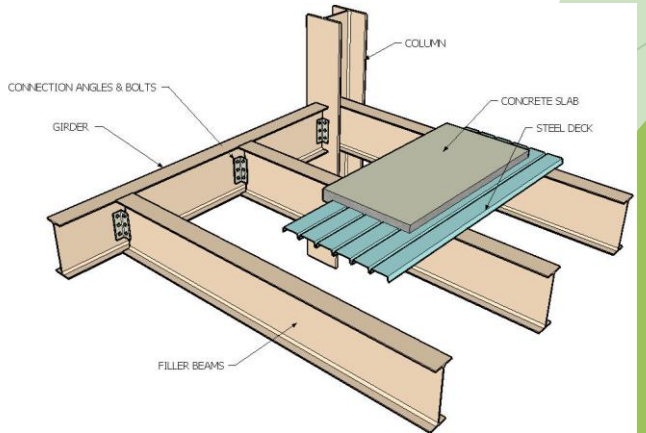
- 20% OPC Replacement
- % Mix for RCA and WCS

Resource Recovery (1 point):

- Conservation of existing buildings or structures
- Following an enhanced demolition protocol (>35% recovery rate of concrete)







3.02a Sustainable Construction

Project's CUI	Points
≤ 0.60	0.5
≤ 0.50	1
≤ 0.45	1.5
≤ 0.40	2
≤ 0.35	3

OPC Replacement Rate	Points
10%	0.5
20%	1

	Replacement Rate	RCA	WCS
%Replacement by mass of fine/coarse aggregate	2.5%	0.5	
	5%	1	
	7.5%	1.5	
	10%	2	
	Cap	2pts	

CUI + Sustainable Building System= 4 points (cap)

- CUI Calculation = Y points
- Adoption of Alternative Construction = CUI (Y) x Extent of Use

Next slide has working for the adoption rate of sustainable alternatives

e.g. 2 Concrete mix = 10% of RCA, 5% WCS for all floors and beams. Columns no replacement mix

Total concrete volume used = 100,000m3
Floors and beams = 70,000m3
RCA Mix = 10% x (70,000/100,000) = 7% (1pt)
WCS Mix = 5% x (70,000/100,000) = 3.5% (0.5pt)

Points Scored = 1.5

3.02a Sustainable Construction

Building Element	Replacement Metrics	% Replacement (A)	≥10% Replacement = 1, <10% Replacement = 0 (B)	Points
Slabs (incl roof)	Per m^2	11	1	= B/4
Columns	Number	25	1	=2/4 x 100%
Beams	Number	0	0	=50%
Walls	Per linear m (m run)	0	0	

<u>Example:</u>
CUI calculated = 0.39 = 2 points.

Project adopts the use of pre-stressed concrete floors, Structural steel columns. The pre-stressed slab area = 11% of all the slab area . The steel columns account for 25% 0f all the columns in the project.

SC friendly points = 2 (from CUI) x 0.5 (50%) = 1point

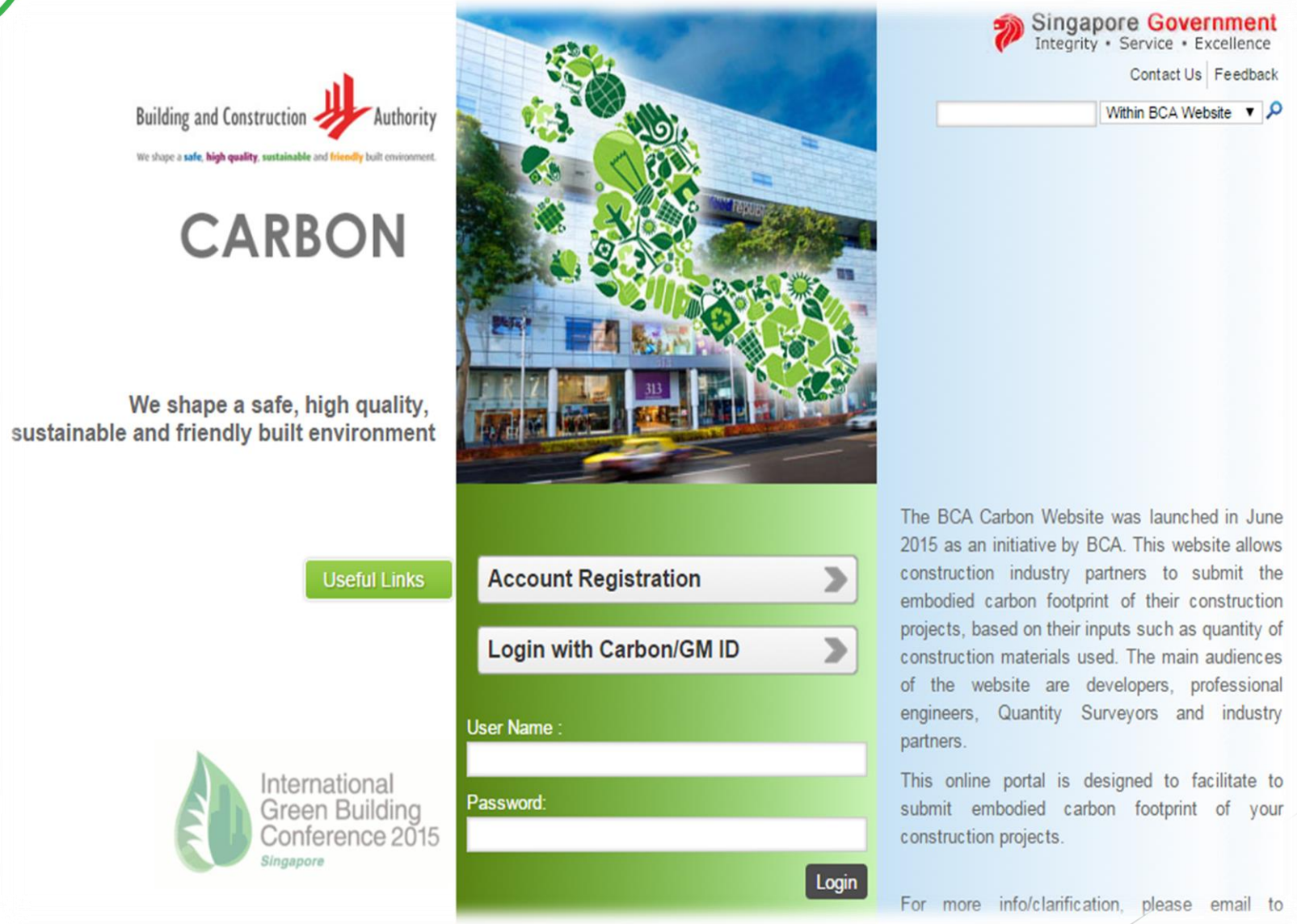
Total points based on CUI and SC elements = 2+1 = 3 points.

3.02b Embodied Energy

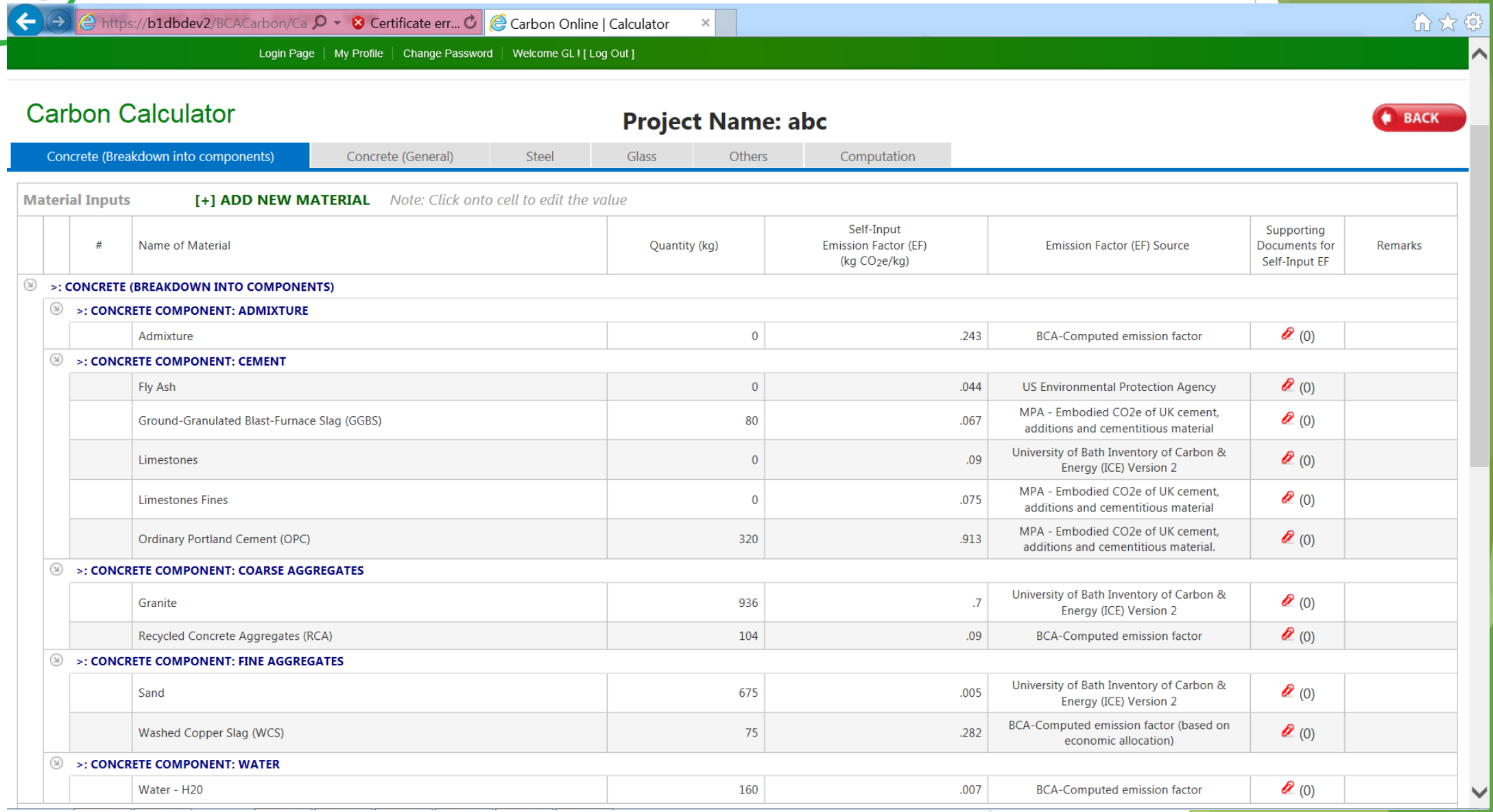
Criteria	Points
Use of BCA Online Embodied Carbon Calculator	2
Provide Own Emission Factors with Source Justification (Advanced Green Efforts)	*1*
Compute the Carbon Footprint of the Entire Development (Advanced Green Efforts)	*2*

Description	Points
Declaration of Concrete, Glass and Steel	1
Declaration of additional materials	0.25 points per material (cap at 1 point)

3.02b Embodied Energy



3.02b Embodied Energy



#	Name of Material	Quantity (kg)	Self-Input Emission Factor (EF) (kg CO_2e/kg)	Emission Factor (EF) Source	Supporting Documents for Self-Input EF	Remarks
>: CONCRETE (BREAKDOWN INTO COMPONENTS)						
>: CONCRETE COMPONENT: ADMIXTURE						
	Admixture	0	.243	BCA-Computed emission factor	(0)	
>: CONCRETE COMPONENT: CEMENT						
	Fly Ash	0	.044	US Environmental Protection Agency	(0)	
	Ground-Granulated Blast-Furnace Slag (GGBS)	80	.067	MPA - Embodied CO2e of UK cement, additions and cementitious material	(0)	
	Limestones	0	.09	University of Bath Inventory of Carbon & Energy (ICE) Version 2	(0)	
	Limestones Fines	0	.075	MPA - Embodied CO2e of UK cement, additions and cementitious material	(0)	
	Ordinary Portland Cement (OPC)	320	.913	MPA - Embodied CO2e of UK cement, additions and cementitious material.	(0)	
>: CONCRETE COMPONENT: COARSE AGGREGATES						
	Granite	936	.7	University of Bath Inventory of Carbon & Energy (ICE) Version 2	(0)	
	Recycled Concrete Aggregates (RCA)	104	.09	BCA-Computed emission factor	(0)	
>: CONCRETE COMPONENT: FINE AGGREGATES						
	Sand	675	.005	University of Bath Inventory of Carbon & Energy (ICE) Version 2	(0)	
	Washed Copper Slag (WCS)	75	.282	BCA-Computed emission factor (based on economic allocation)	(0)	
>: CONCRETE COMPONENT: WATER						
	Water - H20	160	.007	BCA-Computed emission factor	(0)	

3.02c Sustainable Products

System	Basic Flooring (excluding structural floor)	Basic Ceiling (excluding structural floor above)	Basic Roofing	External Wall	Internal Wall	Basic Door
Level 1	Base System (base material, waterproofing, etc)					
Points Available	>60% of applicable areas – 2 pts/ system					
Level 2	Finishes					
Points Available	>60% of applicable areas –1 pt/ system					

- If products are not used, it will be deemed to comply.
- Includes what tenants install at operation stage
- For each system, Level 1 must be scored before the Level 2 can be scored.
- For singular products outside of functional group (i.e. hardscape, building services), 0.25 pt is accorded for every item used (cap at 2 pts). Each product must meet at least 90% of its applicable use.

SINGAPORE GREEN BUILDING PRODUCT SGBC

GreenLabel SINGAPORE

3.02c Sustainable Products

EXAMPLE - FLOORING

	Description	Points
Level 1 (Base system >60% of all:)	Typical products: Levelling base, floor screed, waterproofing	2
Level 2 (Finishes >60% of all:)	Typical products: • Raised floor systems (Insulation, underlay, carpets/ carpet tiles) • Floor finishes including underlays, carpets, vinyl's, tiles, laminate flooring, timber flooring,	1

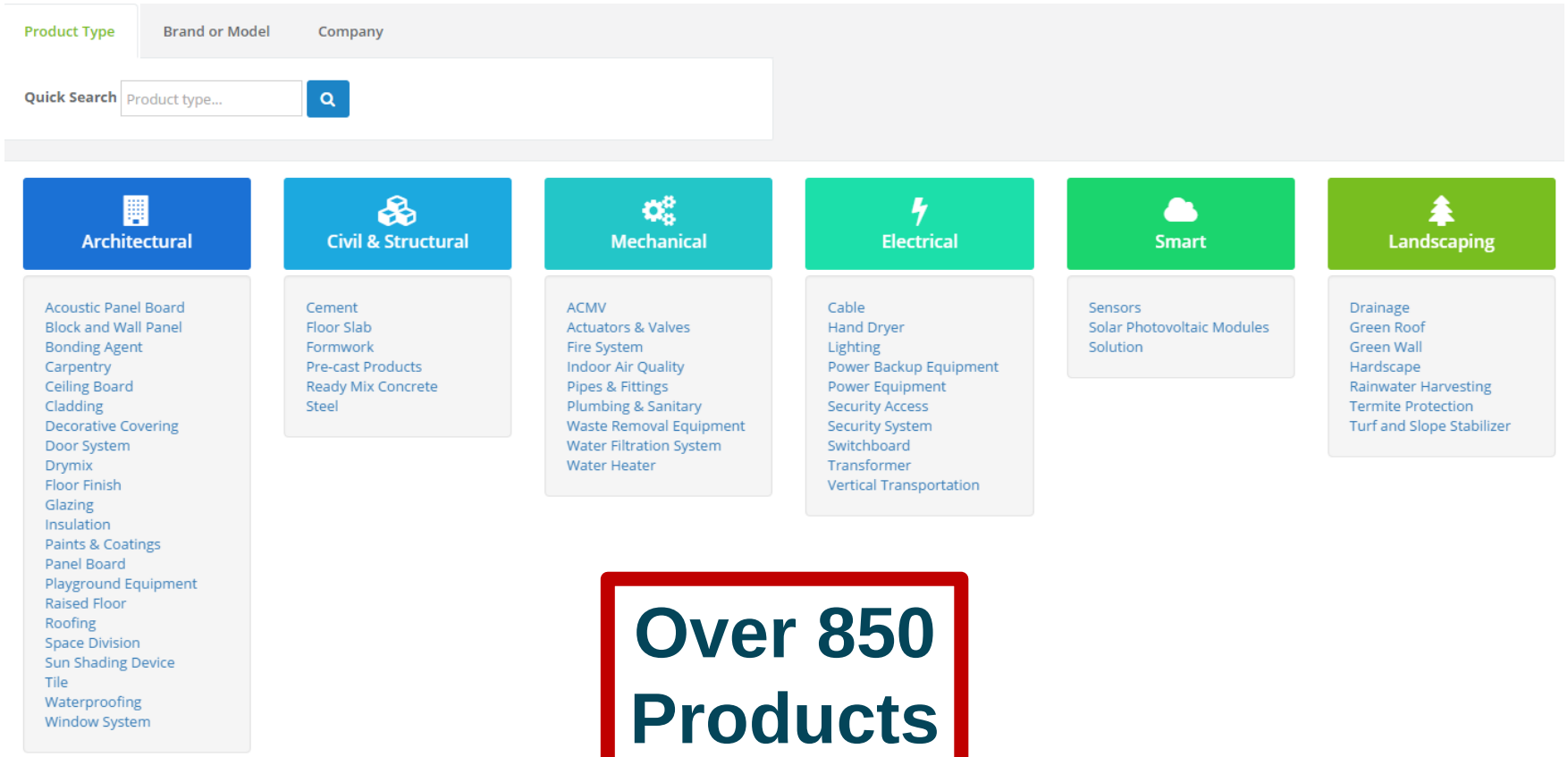
3.02c Sustainable Products



Good	✓			
Very Good	✓	✓		
Excellent	✓	✓	✓	
Leader	✓	✓	✓	✓

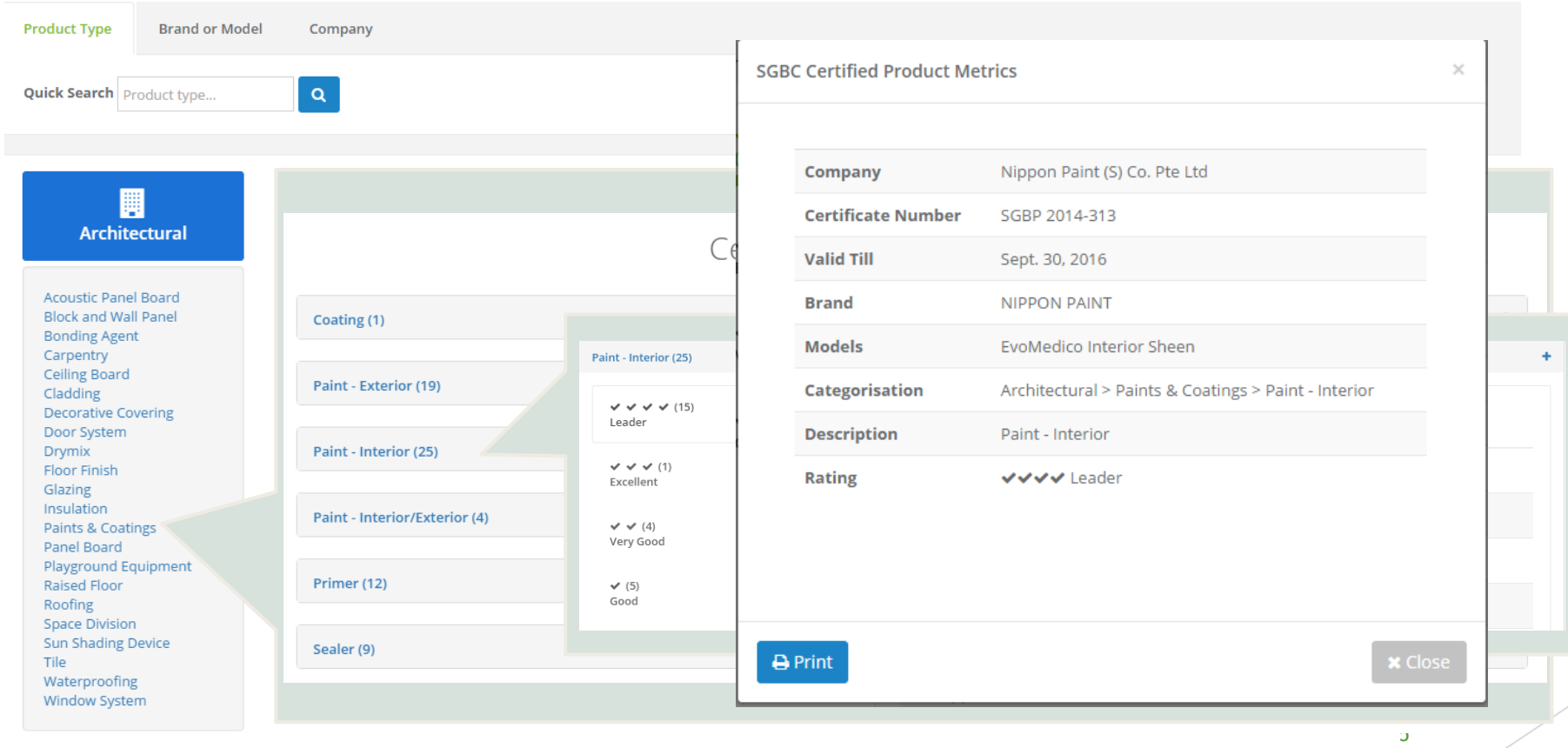
Use of 2 Ticks or higher products (Additional Green Efforts)
(part of functional system or hard/softscape or building services) – 2 points cap

3.02c Sustainable Products - SGBP



Over 850 Products
Available

3.02c Sustainable Products - SGBP



3.03 Waste

3.03	Waste	4
3.03a	Environmental Construction Management Programmes	1
3.03b	Operational Waste Management	2
3.03c	Provision of Recycling System for Horticultural or Wood Waste	1

Please see the criteria for the Environmental Construction Management Programmes guidance.

Operational waste – Recycle facilities (1pt). For food waste recycling (1pt)



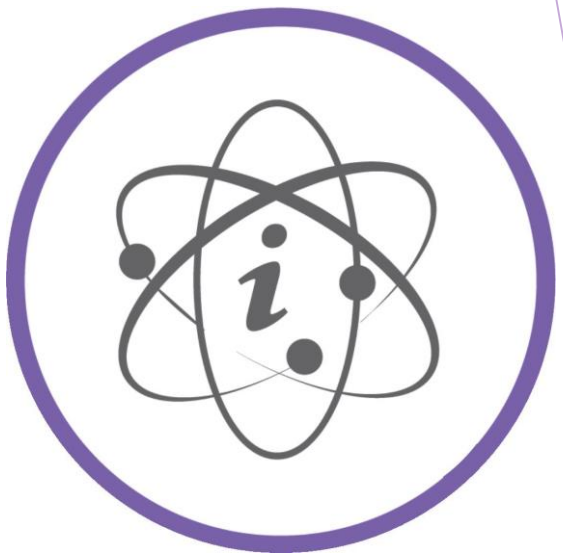
4.Smart and Healthy Building



Indoor Air Quality
(10 points)



Spatial Quality
(10 points)



Smart Operations
(10 points)

4.01 Indoor Air Quality

4.01	Indoor Air Quality	10
4.01a	Occupant Comfort	2
4.01b	Outdoor Air	3
4.01c	Contaminants	5

4.01a Occupant Comfort

4.01a (i) IAQ AUDIT:

- Conducted within one year after occupancy, - benchmarks within SS554: 2015 Clause 6 or NEA's Guidelines for Good Indoor Air Quality in Office Premises
- 1 point for conducting detailed audit using "reference method"

4.01a (ii) POST OCCUPANCY EVALUATION:

- POE guide within the Green Mark 2015 document
- 10% sample size (cap at 100 people)

4.01a Occupant Comfort

4.01a (i) IAQ AUDIT:

IAQ parameters	NEA's IAQ guidelines for office premises (1996)	SS554: 2009
Temperature	22.5 – 25.5 °C (dry bulb temperature)	24-26 °C (Operative temperature)
Relative Humidity	≤ 70%	≤ 65% for new ≤ 70% for EB
Air Movement	≤ 0.25 m/s	0.1 - 0.3 m/s
Carbon Dioxide	1000 ppm	700 + outdoor ppm
Carbon Monoxide	9 ppm	9 ppm
Formaldehyde	0.1 ppm	0.1 ppm
TVOC	3 ppm	3 ppm
Ozone	0.05 ppm	0.1 ppm (table 2)
Respirable Suspended Particles (PM4)	150 µg/m3	50 µg/m3
Particulate Matter (PM2.5)	NA	35 µg/m3 (table 2)
Total Bacteria Count	500 cfu/m3	500 cfu/m3
Total Mould Count	500 cfu/m3	500 cfu/m3

4.01a Occupant Comfort

4.01a (iii) IAQ DISPLAY:

- Display temperature and RH at each floor AND each tenanted area

4.01a (iv) INDOOR AIR QUALITY TRENDING (Advanced Green Effort – Enhanced performance):

- Permanent monitoring and logging of temperature, RH and common indoor air pollutants such as formaldehyde











4.01 Indoor Air Quality

4.01b OUTDOOR AIR:

- Measurement of outdoor air volume either at pre-cool units only (0.5 point) or at all AHU and FCU's (1 point)
- Use of CO_2 sensors or equivalent to match fresh air with the space demand (0.5 points)
- Use of MERV 14 at all times (either PAU's – 0.5pt, or all AHU's 1pt)
- Use of a dedicated outdoor air system (PAU) fro the effective treatment of outdoor air.

4.01c CONTAMINANTS:

- Local Exhausts and purging systems
- Use of UVGI system
- Low VOC emitting products for the interior surfaces (% area coverage), doors, and >60% of the system furniture
- PBT Free Lighting





4.02 Spatial Quality

4.02	Spatial Quality	10
4.02a	Lighting	6
4.02b	Acoustics	2
4.02c	Wellbeing	2

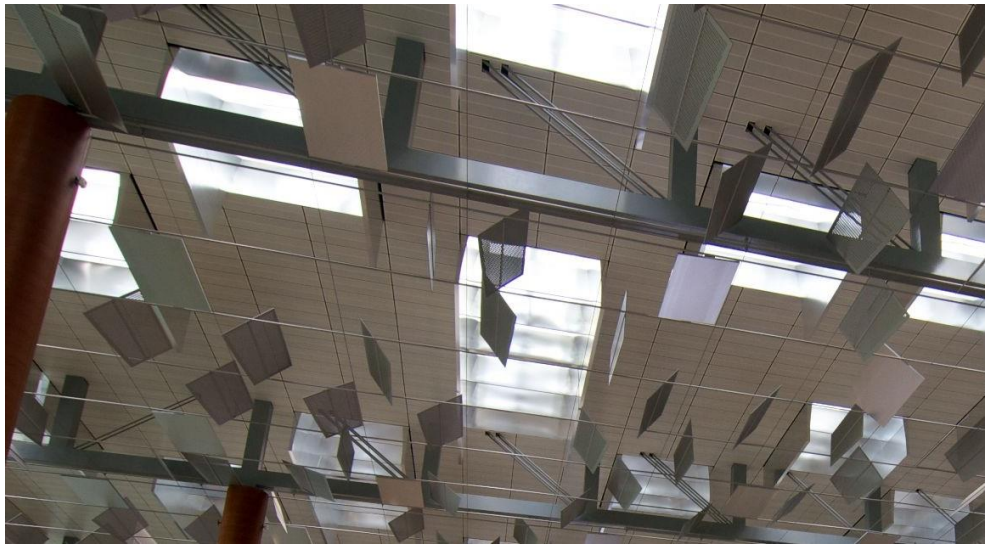
4.02a Lighting

Design for Daylight:

- Calculation based (based on design parameter tables for ease)
- Daylight Autonomy modelling

Design for Daylight controls:

- System based (blinds and screens, light shelves, clerestories and glazing treatments)
- Predictive Glare Model





Daylight modelling:

- Based on Daylight Autonomy (DA)

Predictive Glare Model:

- Useful Daylight Index (UDI) >3000lux for 10% occupied hours extending more than 1.25m away from the facade

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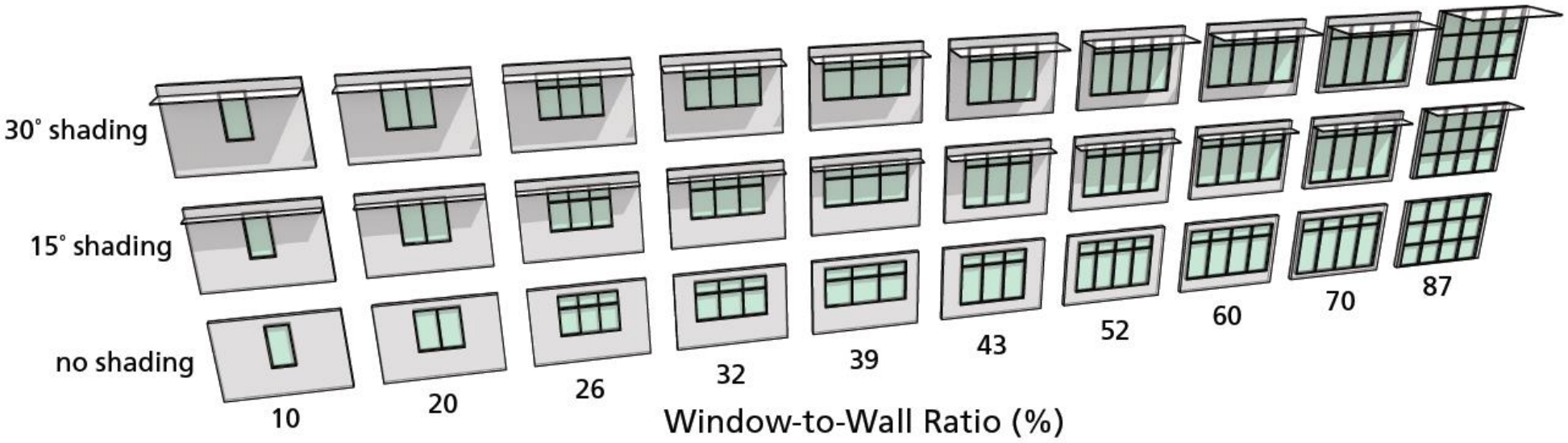
Day Lighting Based on Tables

The following parameters were tested:

- Urban Context (Sky View Factor) : Unobstructed, 22.5° angle to sky, 45° degree angle to sky
- Orientation : N, NE, E, SE, S, SW, W, NW
- Window-to-wall Ratio Percentage (WWR) : 10, 20, 26, 32, 39, 43, 52, 60, 70, 87
- Overhang Shading Angle : None, 15° sky obstructed, 30° sky obstructed
- Visible Window Transmittance Percentage (Tvis) : 25, 35, 45, 55, 65, 75



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4.02a Lighting

Table Based:

Points	% of the Applicable Area that Demonstrates Access to Effective Daylight
0.5	≥35%
1	≥40%
1.5	≥45%
2	≥55%
2.5	≥65%
3	≥75%

Simulation Based:

Functional Space	Description	Points
Office & Institutional spaces	Moderate: $DA_{500lux/50\%}$ ≥40% of the applicable areas	1
	Good $DA_{500lux/50\%}$ ≥55% of the applicable areas	2
	Very Good $DA_{500lux/50\%}$ ≥75% of the applicable areas	3
Hotels and residential style occupancy	Moderate $DA_{200lux/50\%}$ ≥40% of the applicable areas	1
	Good $DA_{200lux/50\%}$ ≥55% of the applicable areas	2
	Very Good $DA_{200lux/50\%}$ ≥75% of the applicable areas	3
Other Space Types	Moderate $DA_{300lux/50\%}$ ≥40% of the applicable areas	1
	Good $DA_{300lux/50\%}$ ≥55% of the applicable areas	2
	Very Good $DA_{300lux/50\%}$ ≥75% of the applicable areas	3



4.02b Acoustics

	Description
Sound Transmission Class (STC)	Between General Office spaces: STC: 40-50
	Hotel Rooms, Classrooms, Lecture Theatres, Meeting Rooms, Conference Rooms* STC: 50-60 * and spaces where confidential speech are required
	Between Mechanical/ Equipment spaces and occupied spaces: STC: 50-60



4.02b Acoustics

Functional Space	Recommended Reverberation Time (T60 seconds averaged between 500, 1000 and 2000Hz)	
Office	Open Plan Office	≤ 1
	Conference / Meeting Rooms	≤ 0.8 (0.4 for rooms with tele or video conference)
Institutional (Schools, Civic buildings)	Classrooms	0.6 - 1.0
	Seminar / tutorial rooms	0.6 - 0.8
	Libraries	<1.0
	Reading rooms	0.6 - 0.8
	Music Rooms	0.5 - 0.7
	Music Studios	0.7 - 0.8
	Multi-Purpose Halls	<1.5
	Gymnasiums	<1.5
Hotel	Meeting Room	<0.8
	Large Banquet Room/Hall	<1.2
Atria/ Commercial Lobby	Retail, office, institutional, or hotel atria or main lobby spaces.	(reduce as far as practicable for noise control)

4.02c Wellbeing

Biophillic Design:

- Re kindling the human-nature relationship through accessible sky terraces, rooftop gardens and internal courtyards with at least one outdoor refreshment area
- Greenery within the common spaces of a building (10% by area) and tenant areas (1% NLA)

Universal Design Mark:

- A building that is accessible for all

Provision of communal private spaces:

- A broad spectrum of spaces for relaxing, resting or collaborating. At least 1 space of 7.5m^2 per 2,000m^2 NLA



4.03 Smart Operations

4.03	Smart Building Operations	10
4.03a	Energy Monitoring	3
4.03b	Demand Control	3
4.03c	Integration and Analytics	3
4.03d	System Handover and Documentation	1

- From “Designing Right” to “Operating Right”
- Persistence of High-performance
  - Design and Delivery Integration
  - Continuous Monitoring
- Smartness → High-Performance, Operational Excellence
  - Integration in Breath & Depth
  - Open Standard and Future Ready

4.03 Smart Operations

1. Taxonomy
   - Level I – Monitoring

     Chiller system, Sub-metering, Open Standard, Energy Portal+Dashboard
   - Level II – Demand Control

     Lift/escalator with VVVF + Sleep mode

     Motion/occupancy sensors for transient and occupied areas

     Outdoor air regulation
   - Level III – Integration & Analytics

     Fault detection and diagnosis, BIM integration, etc.
2. System Verification & Handover
3. Third-party Post-Occupancy Performance Verification
4. Energy Performance Contracting (EPC)

4.03 Smart Operations

Energy Monitoring:

Energy Portal and Dashboard

- *For the building*
- *For tenants*

BAS Controllers with open protocol

Future proof the building network and to facilitate the exchange of data with other systems thru non proprietary protocols.

Demand Control:

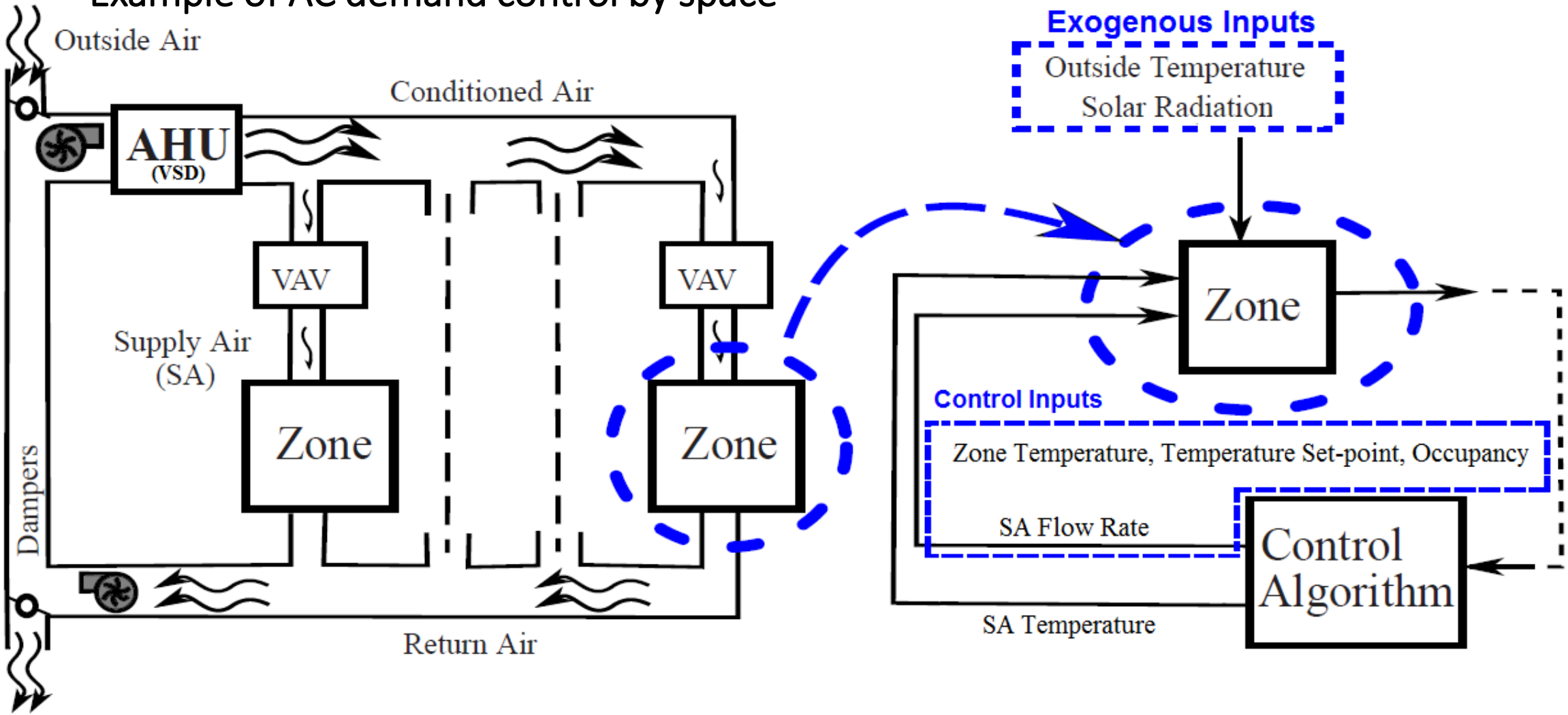
- ACMV and Lighting controls that are occupancy based – reducing energy consumption whilst maintaining good IEQ

Integration and Analytics:

- Fault detection and diagnostic systems
- Adaptive control algorithms, eg ACMV set points based on weather conditions addressing perceptive comfort
- Mobile applications for building adjustments based on real-time occupant feedback
- Occupancy monitoring systems in real-time linked to building automation

4.03 Smart Operations

Example of AC demand control by space



4.03 Smart Operations

4.03d SYSTEM HANDOVER & DOCUMENTATION

- Mechanical, electrical and control systems to be tested and verified to be operating within their desired parameters & handover of full manuals, documentation, software etc
- On-site testing and verification will be required
- Pre-requisite for Gold^{PLUS} and Platinum
- To facilitate the building to be operated as per its design intent

4.03 Smart Operations

4.03d SYSTEM HANDOVER & DOCUMENTATION

Provision of verification requirements and schedules for:

- All control actions to meet functional requirements
- Integration test including air and hydronic systems balancing
- Specified graphics and sensor data displays such as temperature, sub-meters

Provision of documentation including:

- Written description of plant operation and wiring diagrams
- Control strategy or logic diagrams
- Point list, including hard and derived points
- Description of user adjustable points

4.03 Smart Operations

Advanced Green Effort:

Engage Independent Competent Professionals, i.e. Energy Auditors, PE (Mechanical or Electrical)

- To verify operating performance of major energy-consuming systems against design intent. Applicable systems are:

  - Light controls
  - Hot water system
  - Heat recovery system
  - Mechanical ventilation
  - Renewable energy systems

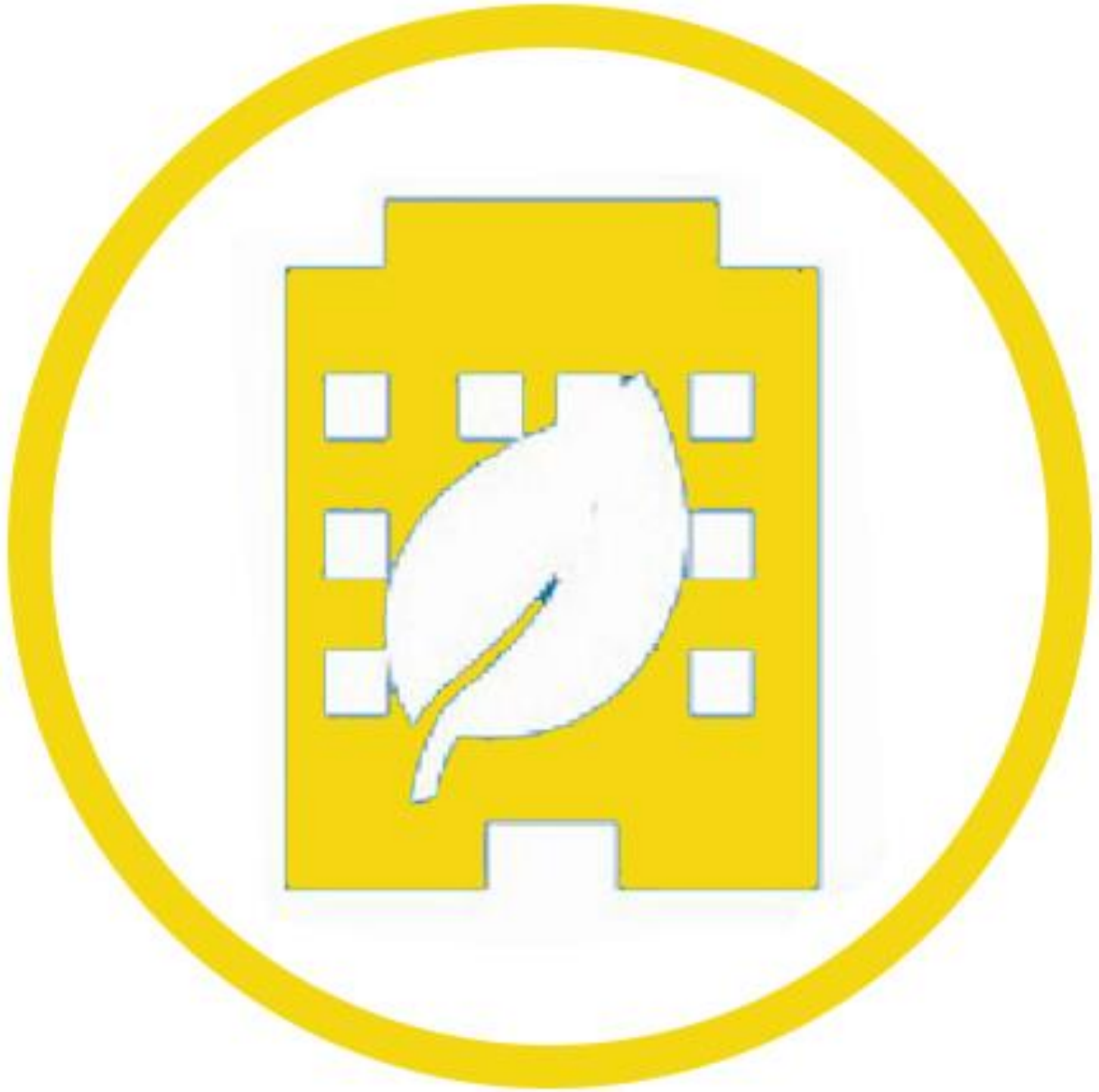
- Documented in a verification and recommendation report and operations manual,

- Within one year from the building's statutory completion

4.03 Smart Operations

Advanced Green Effort:

- Engage an external energy performance contracting firm (EPC or ESCO)
- To implement and deliver energy efficiency, renewable energy or energy recovery project
- With an energy performance contract wherein the EPC firm remuneration is based on demonstrated energy savings.



4. Enhanced Performance



Points shall be awarded based on the advanced green efforts indicators that are highlighted within the Green Mark 2015 criteria.

OR

Projects can demonstrate substantial performance to a specific sustainability indicator or outcome addressed within Green Mark. This will be reviewed on a case by case basis

Cap at 15 points

5.Advanced Green Effort



Cost Effective Design
(2 points)



Complementary Certification
(1 points)



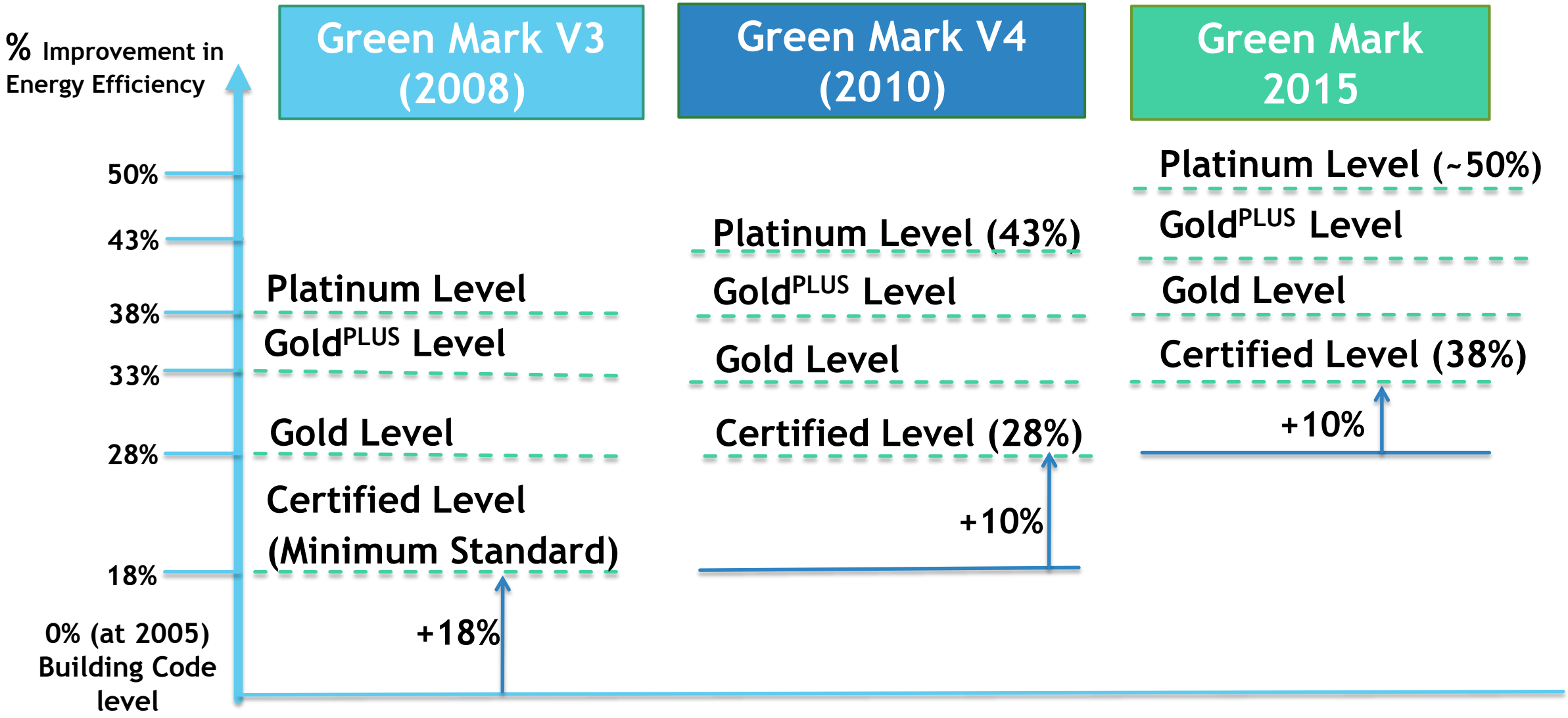
Social Benefit
(2 points)

Green Mark 2015

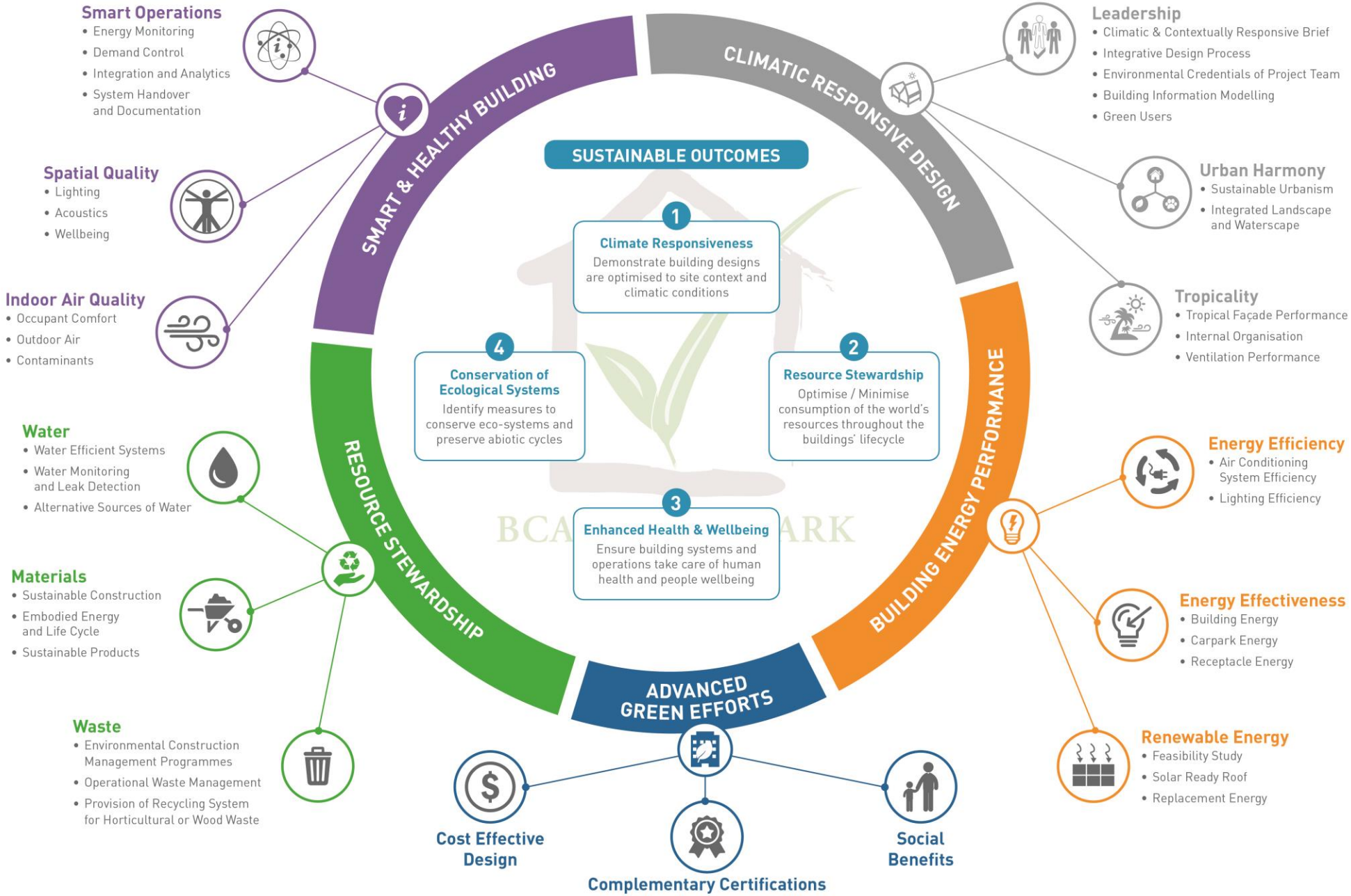
- 5 Scored Sections
- 16 Green Mark Criteria
- 79 Sustainability Indicators
- 120 Points + Advanced Green Efforts

Green Mark Score	Green Mark Rating
70 and above	Green Mark Platinum
60 to < 70	Green Mark Gold^{PLUS}
50 to < 60	Green Mark Gold
Green Mark Certified is equivalent to the BCA Regulation for Environmental Sustainability	

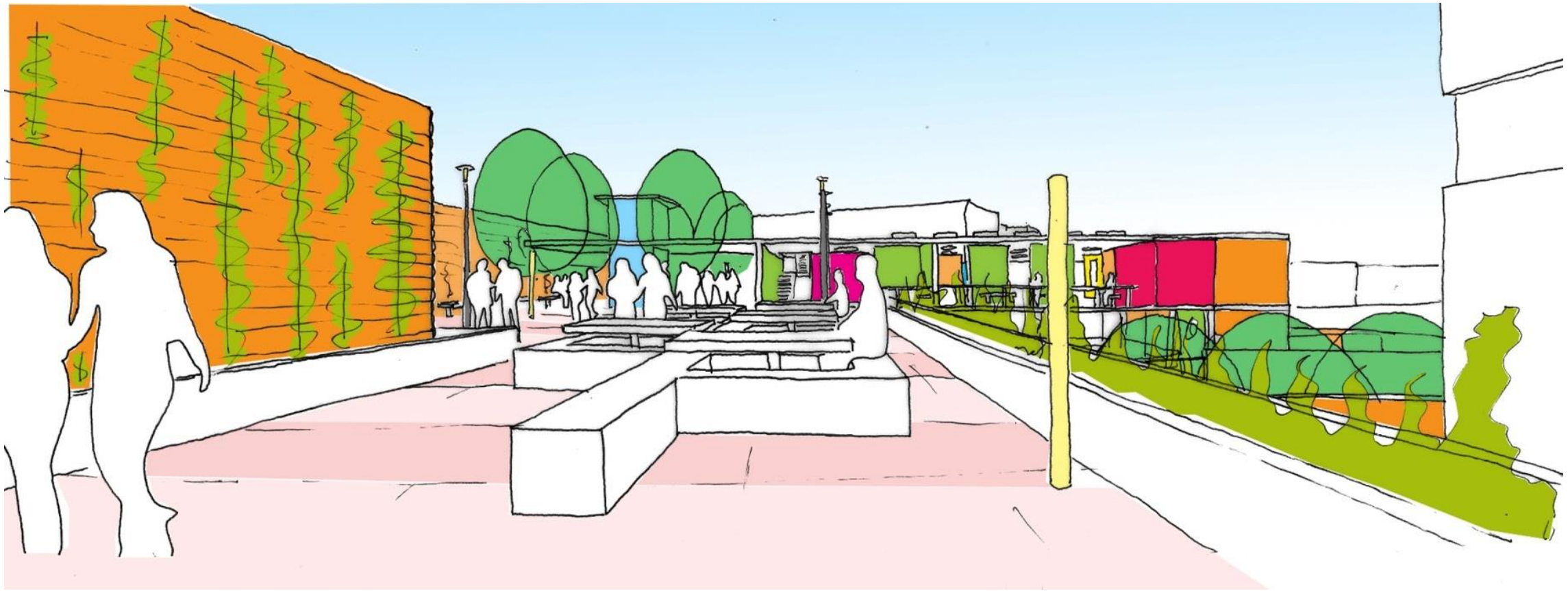
Marked Transformation of Industry



GM 2015 CRITERIA AND INDICATORS



Q&A



Thank You

Benjamin Henry Towell M.Arch; MSc; MRICS; C.Env; GMP; BREEAM AP

Senior Manager, BCA Green Mark (New Development).

Email: Benjamin_Towell@bca.gov.sg