Alpha
Consulting Engineers Pte Ltd

2 ALEXANDRA ROAD, #03-03 DELTA HOUSE, SINGAPORE 159919
TEL: (65) 6276 2228 FAX: (65) 6276 9929 E-MAIL: ace@alpha.com.sg
COMPANY REGISTRATION NO. 199407965N
WEBSITE: www.alpha.com.sg

Our Ref: OM-LA/021

10 September 2007

MEMORANDUM

To: Engineering Staff

From: Andrew Loh

BCA LEGISLATION ON ENVIRONMENTAL SUSTAINABILITY

Please find attached herewith the BCA Legislation on Environmental Sustainability for your information.

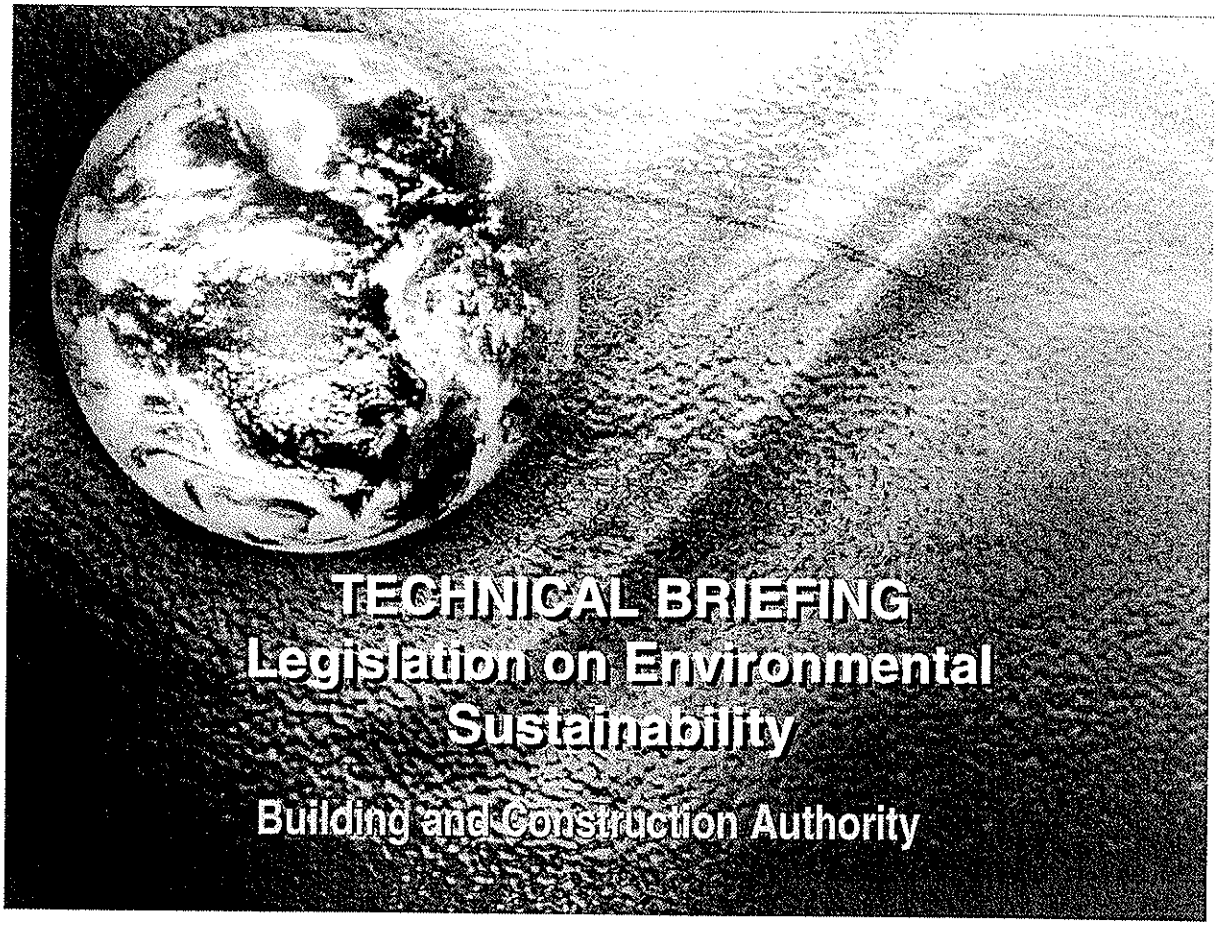
ANDREW LOH

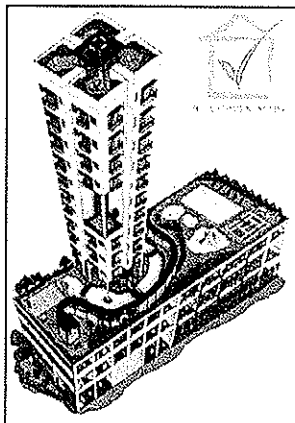
cc TLS/RT/CCG/LFY/GSH

enc

LCT/hi

BCA
ISO 9000
CERT. NO.: 324
SS ISO 9001 : 2000


TECHNICAL BRIEFING
Legislation on Environmental Sustainability
Building and Construction Authority



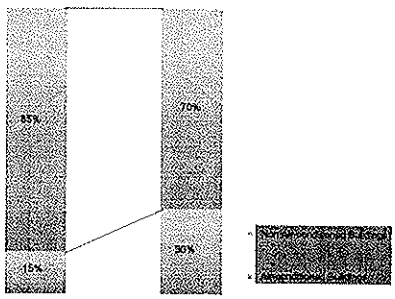
Proposed Legislative Framework on Environmental Sustainability

Presented by Grace Cheok-Chan
Technology Development Division
BCA

Agenda

1. Proposed Legislative Framework
2. Non-Residential Green Mark Criteria
3. Residential Envelope Transmittance Value (RETV)

Current Situation



Proposed Legislative Framework

Legislation Environmental Sustainability

Objective

- To establish a **minimum environmental sustainability standard** in the planning, design, construction and operation of building projects, to mitigate the environmental impacts of built structures

Proposed Legislative Framework

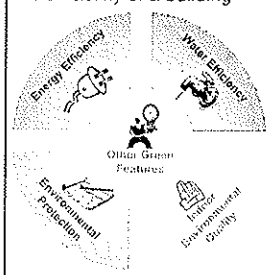
Legislation Environmental Sustainability

What is the minimum environmental sustainability standard ?

- A minimum energy standard that yields about 10 % -15% energy saving and
- Other green requirements which enhance water efficiency, environmental protection, indoor air quality etc

Legislation of Green Mark requirements

Green Mark can be an effective mean to appraise and set the optimum standard of environmental sustainability of a building



Set minimum requirements for environmental sustainability – Green Mark Certified Level

Green Mark Rating	Points
Platinum	85 and above
Gold^{PLUS}	80 to 84
Gold	70 to 79
Certified	50 to 69

Scope of Legislation

Legislation
Environmental
Sustainability

The legislation will cover

- All new developments and existing buildings undergoing major retrofitting works with GFA of 2000 square metres or more

Major Retrofitting Works

- Works involving overhauling of air-conditioning system, modification to building façade, changing of lighting and other building services

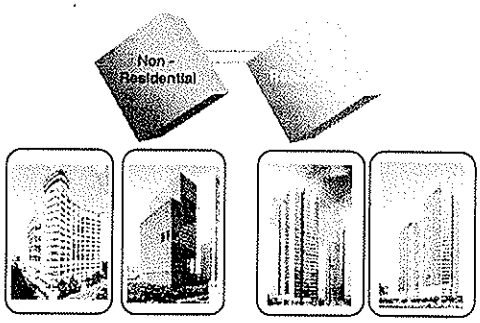
Scope of Legislation

Legislation
Environmental
Sustainability

Effective Time Frame

- Application for Planning Permission from **Jan 08** onwards

Fine-tuning of Green Mark Criteria



Criteria for Non-Residential Buildings

To achieve Green Mark Certified
50 points

Minimum requirements

Mandatory Requirements under Current BC Regulations
Building Envelope/ Roof / Air-Conditioning System/ Artificial Lighting/ Ventilation/ Luminance Level etc
ETTV of 50W/m2
Singapore Standard SS530:2006

Energy Related Requirements
Min 30 points

Elective Requirement for Energy Improvement (Combination of the following items to meet 30 points)

Part 1 - Energy Efficiency

Additional requirements

About 10-15% Energy Saving

- 1-1 Building Envelope — Air - Con
- 1-2 Air-Conditioning System — Air - Con
- 1-3 Building Envelope – Design Thermal Parameters — Non Air-Con
- 1-4 Natural Ventilation — Non Air-Con
- 1-5 Artificial Lighting — General
- 1-6 Ventilation at Common Areas and Carparks — General
- 1-7 Lift and Escalator — General
- 1-8 Provision of Clothes Drying Facilities — General

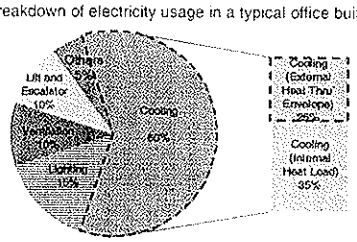
Other Green Requirements
Min 20 points

Elective Requirement from other areas Combination of the following items to meet 20 points)

Part 2 - Water Efficiency
Part 3 – Environmental Protection
Part 4 - Indoor Environmental Quality
Part 5 – Other Green Features

Linking Green Mark Points to Energy Efficiency

Breakdown of electricity usage in a typical office building



Improve Aircon system efficiency by 5%	Reduce 3% energy	Award 10 points
Improve Aircon system efficiency by 10%	Reduce 6% energy	Award 20 points

Criteria for Residential Buildings

To achieve Green Mark Certified
50 points

Minimum requirements

Mandatory Requirements under Current BC Regulations
Building Envelope/ Roof / Air-Conditioning System/ Artificial Lighting/ Ventilation/ Luminance Level etc

RETV of 25 W/m²

Energy Related Requirements
Min 30 points

Elective Requirement for Energy Improvement (Combination of the following items to meet 30 points)

Part 1 - Energy Efficiency

Additional requirements

About 10-15% Energy Saving

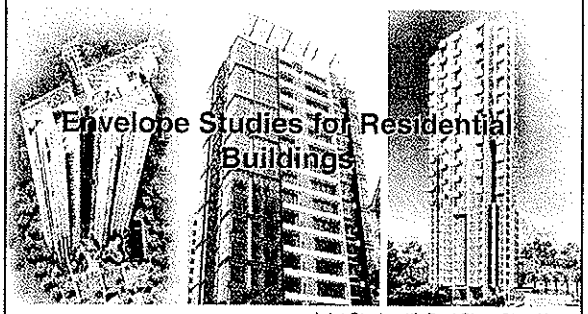
- 1-1 Building Envelope- RETV
- 1-2 Dwelling Units Indoor Comfort
- 1-3 Natural Ventilation for Common Areas and Carpark
- 1-4 Lighting
- 1-5 Lifts
- 1-6 Provision of Clothes Drying Facilities
- 1-7 [illegible]

Other Green Requirements
Min 20 points

Elective Requirement from other areas Combination of the following items to meet 20 points)

Part 2 - Water Efficiency
Part 3 – Environmental Protection
Part 4 - Indoor Environmental Quality
Part 5 – Other Green Features

RETV (Residential Envelope Transmittance value)



Envelope Studies for Residential Buildings

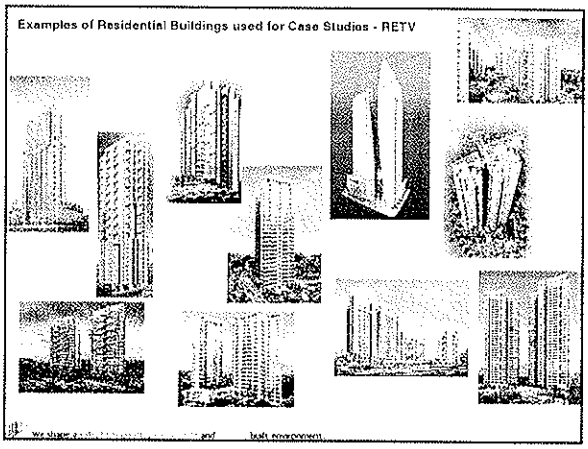
Joint Study with Prof Chou Siaw Kiang
Professor, Department of Mechanical Engineering, NUS

Findings

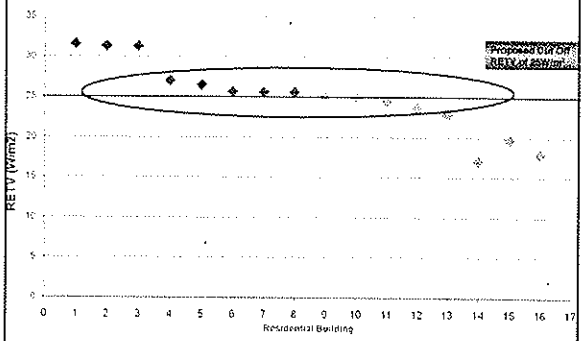
- Usage pattern is different from that of typical air-conditioned commercial building
- Modeling and simulation were carried out
- RETV (Residential Envelope Transmittance value)

$$RETV = \underbrace{3.4(1-WWR)U_w}_{\text{Heat conduction }_{wall}} + \underbrace{1.3(WWR)U_f}_{\text{Heat conduction }_{glass}} + \underbrace{58.6(WWR)(CF)(SC)}_{\text{Heat Retention }_{glass}}$$

Examples of Residential Buildings used for Case Studies - RETV



RETV Values for Residential Buildings



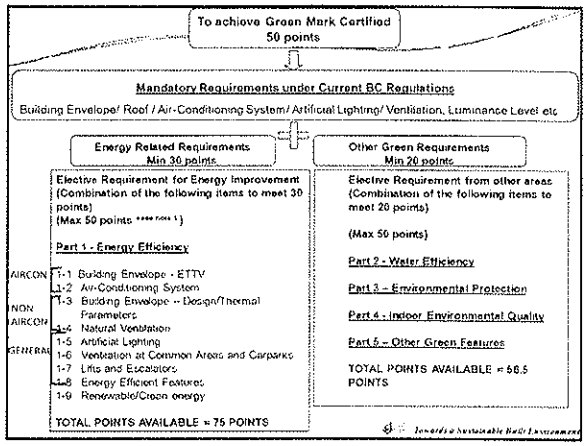
Compliance to Regulation

- Based on Qualified Person's Declaration
- Software tool to assist designers
- Random site checks prior or during TOP inspection to be carried out to ensure compliance

Third party assessment by BCA will be conducted to award Projects with Green Mark Gold Plus and above

BCA GREEN MARK CRITERIA
Non-Residential Building

30th August 2007
Technology Development Division, BCA
By Chia Yen Ling



1-1 Building Envelope (Aircon)

- AIM

  To enhance overall thermal performance of building envelope to minimize heat gained through external walls and windows of a building thus reducing the overall cooling load requirement.

- REQUIREMENTS

  Baseline : Maximum Permissible ETTV = 50 W/m²

  2 points for every reduction of 1 W/m² in ETTV from the baseline (*up to 15 points*)

1-2 Air-Conditioning System

- AIM

  To encourage the use of efficient air-conditioned equipment to minimize energy consumption.

- REQUIREMENTS

  Baseline : Minimum efficiency requirement of the air-conditioning system stated in SS530:2006 & CP 13:1999.

  (a) Air-conditioned Plant
  (b) Air Distribution System
  (c) Unitary Air-conditioners / Condensing Units
  (d) Sensor / Automatic Control Devices

  A maximum Green Mark points of 25 shall be awarded based on the combination of item (a) and (b) OR item (c).

1-2 Air-Conditioning System

- REQUIREMENTS

  Air-conditioned Plant

  Baseline : Minimum efficiency requirement of the air-conditioning system (chillers, chilled water pumps and condenser water pumps) stated in SS530:2006.

  Only applicable to all air-cooled & water cooled chiller plants.

  1.5 points for every percentage improvement in the air-conditioned plant efficiency above the baseline.

1-2 Air-Conditioning System

- REQUIREMENTS

  Air Distribution System

  Baseline : Minimum efficiency requirement of the air-conditioning system (fan coil units and air handling units) stated in CP13:1999.

  Only applicable to all air-side equipment for the air-cooled & water cooled chiller plants.

  0.5 points for every percentage improvement in the air distribution system design above the baseline.

1-2 Air-Conditioning System

- REQUIREMENTS

Unitary Air Conditioners / Condensing Units

Baseline : Minimum efficiency requirement of the air-conditioning system (fan coil units and air handling units) stated in SS530:2006.

1.5 points for every percentage improvement in the efficiency of unitary air-conditioners/ condensing units above the baseline.

1-2 Air-Conditioning System

- REQUIREMENTS

Sensor / Automatic Control Devices

To regulate outdoor air flow rate to maintain the concentration of carbon dioxide below 1000ppm.

A maximum of 2 points awarded based on the extensive use of sensors/automatic control devices in the development.

1-2 Air-Conditioning System

- HYPOTHETICAL EXAMPLE

Total Air-Conditioned areas (m^2)	25,000
Total Air-Conditioned areas (m^2) using chiller plant	90%
~~Total Air-Conditioned areas (m^2) using unitary air-conditioners~~	~~10%~~
Total designed Cooling Capacity (kW) of chiller plant	3517
~~Total designed Cooling Capacity (kW) of unitary air-conditioners~~	~~200~~

1-2 Air-Conditioning System

- HYPOTHETICAL EXAMPLE

Table 1: System Efficiency of Air-Conditioned Plant

	Air-Con Plant Equipment	From Suppliers' Specifications: Total input power (kW)	From Suppliers' Specifications: Total Cooling Capacity (kW)	Equipment Efficiency: Plant Efficiency	Specified by Design Code	UOM	Design Code
1	Chillers 1 & 2 (2 x 500RT)	562	3517	0.160	0.165	(kW/kW)	SS 530:2006
2	Chilled Water Pumps 1 & 2	100	3517	0.028	0.032	(kW/kW)	CP13:1999
3	Condenser Water Pumps 1 & 2	70	3517	0.020	0.025	(kW/kW)	CP13:1999
	Total	732	3517	0.208	0.223	(kW/kW)	

% Improvement in System Efficiency for Air-Conditioned Plant: 6.67%
Green Mark Points (1.6pt for every percent improvement in system efficiency): 10.67

1-2 Air-Conditioning System

- HYPOTHETICAL EXAMPLE

Table 2: Efficiency for Air Distribution Equipment

	Air-Con Plant Equipment	From Suppliers' Specifications: Total Motor Power (W)	From Suppliers' Specifications: Total Airflow Rate (CMH)	Equipment Efficiency: Ave (W/CMH)	Specified by Design Code	UOM	Design Code
1	AHUs 1 to 5 (VAV)	70000	100000	0.70	0.74	(W/CMH)	CP13:1999
2	Chilled water FCUs (CAV) 1 to 10	8000	20000	0.40	0.47	(W/CMH)	CP13:1999
	Total	78000	120000	0.65	0.695		

% Improvement in Efficiency for Air Distribution Equipment: 6.47%
Green Mark Points (0.5pt for every percent improvement in air distribution eff.): 3.24

A) Total GM Points awarded for Table 1 & 2: 13.24

1-3 Building Envelope

- AIM

To enhance overall thermal performance of building envelope to minimize heat gained though external walls and windows of a building which encourage natural ventilation.

- REQUIREMENTS

Applicable for Non Air-Conditioned Building with areas > 500 m^2.

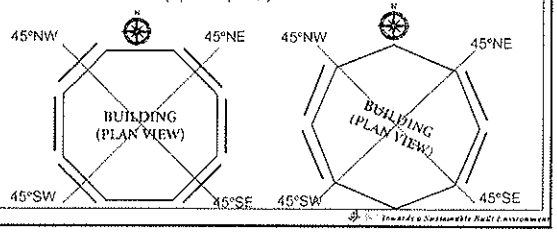
(a) Minimal direct east or west facing external wall/window through building design orientation.
(b) Sunshading provision for external windows
(c) U-value of east and west facing external walls and fixed glazing
(d) U-value of roof

1-3 Building Envelope

- REQUIREMENTS

(a) Minimal direct east or west facing external wall/window through building design orientation

0.1 point for every percentage reduction in the areas with east and west facing external walls/windows (Up to 10 points)



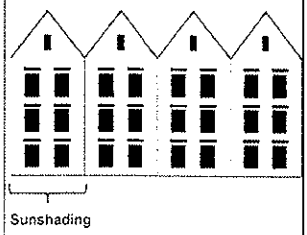
1-3 Building Envelope

- REQUIREMENTS

(b) Sunshading provision for external windows

0.1 point for every percentage increase in external windows with sunshading provision

Points awarded = 0.1 x (% of external windows with sunshading devices)
(Up to 10 points)



1-3 Building Envelope

- REQUIREMENTS

(c) Thermal Transmittance (U-value) of east and west facing external walls and fixed glazing

Baseline: U-value for wall stated below depending on the window/wall ratio (WWR):

Where WWR = 0
U-value brickwall and curtain wall is 2.62 W/m²K
U-value precast wall is 3.96 W/m²K

Where WWR < 0.5
Average U-value = 4.25 W/m²K

2 points for every 0.1W/m²K reduction
(Up to 5 points)

No point will be awarded for WWR > 0.5

1-3 Building Envelope

- REQUIREMENTS

(d) Thermal Transmittance (U-value) of roof

Baseline: U-value for roof stated below depending on the weight range of roof structure:

Weight Group	Weight range (kg/m²)	Maximum Thermal Transmittance (W/m²K)
Light	Under 50	0.6
Medium	50 to 230	[illegible]
Heavy	Over 230	1.5

2 points for every 0.1W/m²K reduction *(Up to 5 points)*

1-4 Natural Ventilation

- AIM

To encourage the design of natural ventilation in common areas and carpark to reduce the needs of mechanical ventilation.

- REQUIREMENTS

Applicable for Non Air-Conditioned Building with areas > 500 m².

(a) Proper design of building layout that utilizes prevailing wind conditions to achieve adequate cross ventilation. (4 points)
(b) Good ventilation in indoor units through sufficient openings. (4 points)
(c) Use of ventilation simulation software or wind tunnel testing to identify the most effective building design and layout to achieve good natural ventilation. (4 points)

1-5 Artificial Lighting

- AIM

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

- REQUIREMENTS

Baseline : Minimum efficiency requirement of the air-conditioning system stated in SS530:2006.

0.5 point for every percentage improvement above the baseline *(up to 5 points)*

Note : If tenant lightings are not provided, the points awarded will be capped at 2 points

1-5 Artificial Lighting

- HYPOTHETICAL EXAMPLE

Type of usage	Total Area (A)	Proposed Design W/m² (B)	Reference Design (SS530) W/m² (C)	Proposed Design Load (A x B)	Reference Design Load (A x C)
Office	20,000	12	15	240,000	300,000
Lobbies and corridors	2,000	7	10	14,000	20,000
Stairs	900	5	6	4,500	5,400
Car parks	800	3.5	5	2,800	4,000
Exterior lighting	1,000	5	5	4,500	7,500
			Total	265,800	336,900
				Σ (AxB)	Σ (AxC)

21.1% improvement above the baseline
Points awarded = 0.5 x (21.1%)
= 10.55 points
CAP at 5 points

1-6 Ventilation for Carparks

- AIM

To encourage the use of natural ventilation and to reduce the need of mechanical ventilation.

- REQUIREMENTS

Sensor or similar automatic control device are used to regulate the demand for mechanical ventilation at basement carpark or where carpark is designed with 100% natural ventilation to reduce energy consumption for ventilation.

1-7 Lifts and Escalators

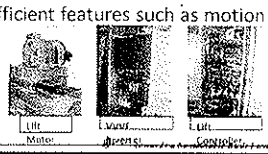
- AIM

To encourage the use of energy efficient lifts.

- REQUIREMENTS

(a) Lifts with energy efficient features such as AC variable voltage and variable frequency (VVVF) motor drive and sleep mode features.

(b) Escalators with energy efficient features such as motion sensors .



1-8 Energy Efficient Features

- AIM

To encourage other energy efficient green features not stated in the previous section which are innovative and have positive environmental impact

- REQUIREMENTS

Energy efficient green features which are innovative and have positive environmental impact:

2 points for high impact item

1 point for medium impact item

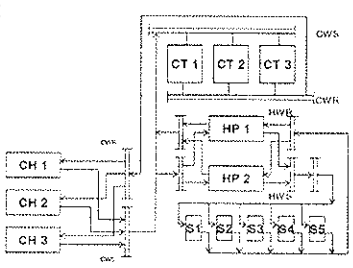
0.5 point for low impact item

(Up to 3 points)

1-8 Energy Efficient Features

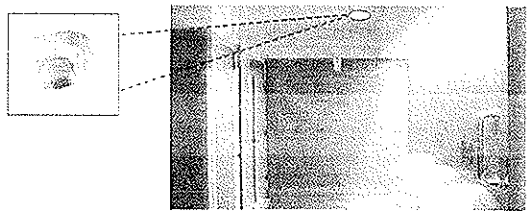
- EXAMPLE 1: Heat Recovery System

Recover waste heat from air-conditioning systems to produce hot water.



1-8 Energy Efficient Features

- EXAMPLE 2: Motion Sensors



1-9 Renewable/Clean Energy (Bonus points)

- AIM

  To recognize and encourage the use of renewable or clean energy in order to reduce the needs of fossil fuel energy use

- REQUIREMENTS

  (Bonus points)

  1 point for every 3KWp of solar energy

  1 point for every 1% replacement of electricity (exclude household's usage) by renewable/ clean energy

  (up to 20 points)

1-9 Renewable/Clean Energy (Bonus points)

- EXAMPLE 1:

  Solar Energy (Photovoltaics)

  Wind Energy

  Biomass

  (up to 20 points)

Energy Efficiency – Points Computation

Sub-Total A x Air-Conditioned Building Floor Area / Total Floor Area
+
Sub-Total B x Non Air-Conditioned Building Floor Area / Total Floor Area
+
Sub-Total C
–
Bonus points

Part 1 - Energy Efficiency

A
- 1-1 Building Envelope - ETTV
- 1-2 Air-Conditioning System
- 1-3 Building Envelope – Design/Thermal Parameters

B
- 1-4 Natural Ventilation
- 1-5 Artificial Lighting

C
- 1-6 Ventilation at Common Areas and Carparks
- 1-7 Lifts and Escalators
- 1-8 Energy Efficient Features

Bonus
- 1-9 Renewable/Clean energy

TOTAL POINTS AVAILABLE = 75 POINTS

Achieving minimum 30 points for Energy Efficiency

Item	Criteria	Points available	Actual points	Remarks
1	Energy Efficiency			
1-1	Building envelope	15	0	• ETTV 42 W/m²
1-2	Air-Conditioning System	27	14	• 6% energy efficiency improvement above baseline • Sensor/Automatic device to maintain CO_2 < 1000ppm
1-3	Building Envelope - Design/Thermal Parameters	30		NA (Assuming fully air-conditioned)
1-4	Natural ventilation	12		NA (Assuming fully air-conditioned)
1-5	Artificial Lighting	5	5	• T5 lighting & Compact Fluorescent Lamps • Using daylighting at staircase and lift lobbies
1-6	Ventilation at Carparks	3	3	• Sensors to regulate demand for mechanical ventilation/100% natural ventilation.
1-7	Lifts & Escalators	2	2	• VVVF lift with sleep mode • Escalators with slowdown mode
1-8	Energy efficient features	1		Assume none
1-9	Renewable/ clean energy	20	0	(Bonus points)
	Sub-total for Energy Efficiency	75	30	(Min 30 points is achieved)

2-1 Water Efficiency

- AIM

  To recognize and encourage the use of water efficient fittings to reduce the use of PUB water in buildings.

- REQUIREMENTS

  At least 90% of the total fitting type used

  (*Up to 5 points*)

2-1 Water Efficiency

- AIM

  To recognize and encourage the use of water efficient fittings to reduce the use of PUB water in buildings.

- REQUIREMENTS

  At least 90% of the total fitting type used

  (*Up to 5 points*)

	Rating based on WELS		
	Good ✓	Very Good ✓✓	Excellent ✓✓✓
Basin taps	0.5 points	1 point	2 points
Flushing cistern			
Showers			
Sink/bib taps			
All other water fittings			

2-2 Water Usage & Leak Detection

- AIM

  To ensure water systems are capable of being monitored and managed.

- REQUIREMENTS

  Sub-meters for major water usage such as irrigation, cooling tower.

  Sub-meters for tenants.

  Linking all sub-meters to BMS to provide a leak detection system.

2-3 Water Efficient Irrigation

- AIM

  To reduce the consumption of PUB water for landscape irrigation.

- REQUIREMENTS

  Provision of suitable systems that utilize rainwater or recycled water for site irrigation based on the percentage reduction in use of potable water (from PUB).

  % Reduction in potable water usage
  100% : 4 points
  75% : 3 points
  50% : 2 points
  25% : 1 points

  (Up to 4 points)

2-4 Water Consumption of CoolingTower

- AIM

  To reduce the consumption of PUB water for landscape irrigation.

- REQUIREMENTS

  Applicable for Buildings with Cooling Tower

  To reduce potable water use for cooling purpose by using water cooling tower system which can achieve 6 or better cycles of concentration or uses 90% non-potable water such as NEWater and recycled water .

3-1 Sustainable Construction

- AIM

  To recognize and encourage the adoption of building materials that use less natural resources and to increase the reusability of building materials to reduce waste.

- REQUIREMENTS

  (a) Encourage more efficient use of concrete. (4points)

  (b) Encourage reuse of existing buildings (2points)
  Applicable to structural elements (i.e. structural floor and roof decking) and building envelope (i.e. exterior façade and framing excluding window assemblies)

  (c) Use of environmental friendly or recycled material with 100 % usage. (4points)

3-2 Greenery Provision

- AIM

  To recognize and encourage greater use of greenery to reduce urban heat island and also to conserve existing natural wherever possible and to restore them to promote biodiversity.

- REQUIREMENTS

  Greenery provision (up to 4 points)

  Restoration of trees on site, conserving or relocating of existing trees on site (1 point)

  Use of compost recycled from horticulture waste (1 point)

3-2 Greenery Provision

Greenery provision (GnP) is calculated by considering the 3D volume covered by plants using the following green area index (GAI)

Grass	GAI=1	Palm trees	GAI=4
Shrubs	GAI=3	Trees	GAI=6

	Qty A	Canopy area B	Radius C	Green area index GAI	Green Area AxBxC²xGAI
Palms (Numbers)	x	3.14	1	4	a
Trees (Numbers)	x	3.14	3.5	6	b
Shrubs (Numbers)	x	1/3	NA	3	c
Landscape area + roof garden area + vertical greening (m^2)	x (m^2)	NA	NA	1	d
				Total green area	a + b + c + d

Greenery provision (GnP) = Total green area / site area

3-3 Environmental Management Practice

- AIM

  To recognize and encourage greater use of greenery to reduce urban heat island and also to conserve existing natural wherever possible and to restore them to promote biodiversity.

- REQUIREMENTS

(a) Implement effective construction and demolition waste management programme including monitoring and setting targets to minimise energy use, water use and construction waste. (2 points)

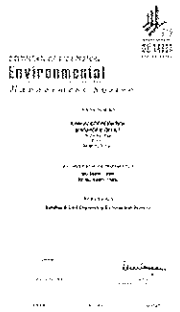
(b) Building quality assessed under CONQUAS (1 point)

3-3 Environmental Management Practice

- REQUIREMENTS

(c) Developer, main builder, consultants and architects that are ISO 14000 certified. (1 point)

(d) Project team comprises at least one Green Mark Advisor and/or one Green Mark Professional (up to 2 points)



3-3 Environmental Management Practice

- REQUIREMENTS

(e) Building users' guide on facilities within building, environmental friendly use and operation of building. (1point)

(f) Provision of facilities or recycling bins at each floor level for collection and storage of different recyclable waste such as paper, glass, plastic etc. (1point)

3-4 Public Transport Accessibility

- AIM

  To recognize development that provides a choice of transport modes for residents with the intention of reducing car usage

- REQUIREMENTS

Provisions for access to MRT/LRT or bus stops (1 point)

Provisions for adequate bicycles parking lots (1 point)

3-5 Refrigerants

- AIM

  To recognize development that provides a choice of transport modes for residents with the intention of reducing car usage

- REQUIREMENTS

Provision of automatic refrigerant pump down is made to the heat exchanger (or dedicated storage tanks) with isolation valves. (0.5 point)

Refrigerant leak detection system is specified/installed covering high-risk parts of the plant (evaporator or condenser coils can be omitted from this) (1 point)

Refrigerants with (ODP) of zero OR no refrigerants used. (1 point)

4-1 Thermal Comfort

- AIM

  To optimize thermal comfort level for occupants.

- REQUIREMENTS

Applicable if there are aggregate air-conditioned areas of more than 500 m^2

Indoor temp between 22.5 to 25.5 ° C
Relative Humidity < 70%

4-2 Noise Level

- AIM

  To noise levels are maintained at an appropriate level.

- REQUIREMENTS

Building services are designed to contribute no more than 5 dB to space noise levels. (1point)

General offices areas and private offices are designed for sound level between 45-55 dB LAeqT and 40-45 dB LAeqT respectively. (1point)

Building design to achieve ambient internal noise level as specified:

Urban areas:	55dB (6am-10pm) LeqA	
Suburban areas:	50dB (6am-10pm) LeqA	(1point)

4-3 Indoor Air Pollutants

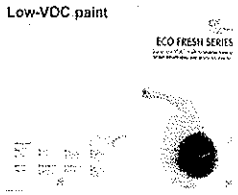
- AIM

  To recognize development that make effort to reduce sources of indoor pollutants.

- REQUIREMENTS

Use of low VOC paints certified under Green Labels over more than 90% of the total internal wall areas (1 point)

Use of composite wood product with low emission formaldehyde (1 point)



4-4 High Frequency Ballasts

- AIM

  To enhance the visual performance of the environment.

- REQUIREMENTS

High frequency ballasts installed in fluorescent luminaries.

At least 90% of Gross Floor Area (2 points)

5-1 Other Green Features

- AIM

  To encourage other green features not stated in the previous section which are innovative and have positive environmental impact.

- REQUIREMENTS

The adoption of other green features which are innovative and have positive environmental impact.

2 points for high impact item

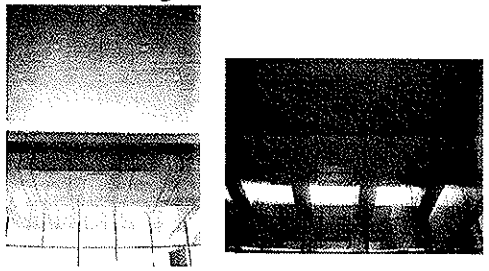
1 points for medium impact item

0.5 point for low impact item

(up to 5 points)

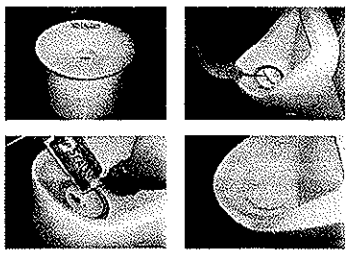
5-1 Other Green Features

- EXAMPLE 1: Light Shelves



5-1 Other Green Features

- EXAMPLE 2: Waterless Urinal



Achieving ~~minimum 20 points~~ for other green requirements

Item	Criteria	Points available	Actual points	Remarks
2	**Water Efficiency**			
2-1	Water efficient fitting	4	2.5	• Water fittings with WELS good rating
2-2	Water usage & leak detector	3	2	• Sub-metering to major water usage & tenants
2-3	Water efficient irrigation and landscaping	4	0	• Assume None
2-4	Water consumption of cooling tower	1	1	• For better cycles of concentration
3	**Environment Protection**			
3-1	Sustainable construction	10	0	• Assume None
3-2	Greenery Provision	6	2	• Greenery provision (1) • Compost recycled from horticulture waste (1)
3-3	Environmental Management Practice	3	2	• Tender specified monitoring of energy & water use and construction waste (1) • CONQUAS project (1) • Building user guide (1) • Provision of recycling bin at all floors (1)
3-4	Public Transport Accessibility	2	2	• Within 500m from bus stop/MRT (1) • Provision of bicycle parking lots (1)
3-5	Refrigerants	2.5	1	• Refrigerants with zero ODP

Achieving ~~minimum 20 points~~ for other green requirements

Item	Criteria	Points available	Actual points	Remarks
4	**Indoor Environmental Quality**			
4-1	Thermal Comfort	3	3	• Indoor temp between 22.5 to 25.5 °C • Relative Humidity < 70%
4-2	Noise level	1	1	• Tender specified design noise level
4-3	Indoor air pollutants	3	1	• Low VOC paint
4-4	High Frequency Ballasts	2	0	• Assume none
5	**Other Green Features**			
5-1	Other Green Features	1	0	
	Sub-total for other green requirements	50.5	20.5	(Min. 20 points is achieved)

Thank You

http://www.bca.gov.sg/GreenMark/green_mark_buildings.html

www.greenmark.sg

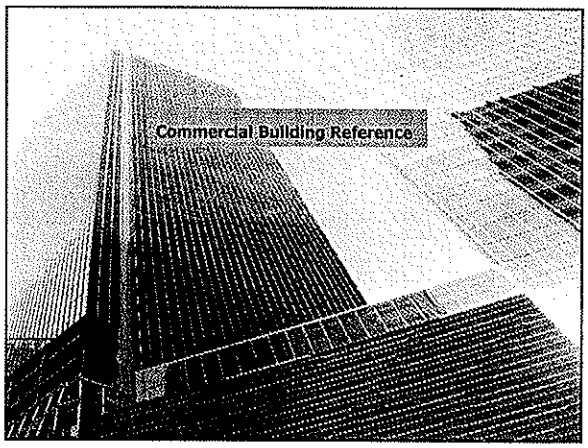
Residential ETTV Criterion for Buildings in Singapore

30 August 2007
at Building and Construction Authority

by
S.K. Chou, Dept of Mechanical Engineering, NUS

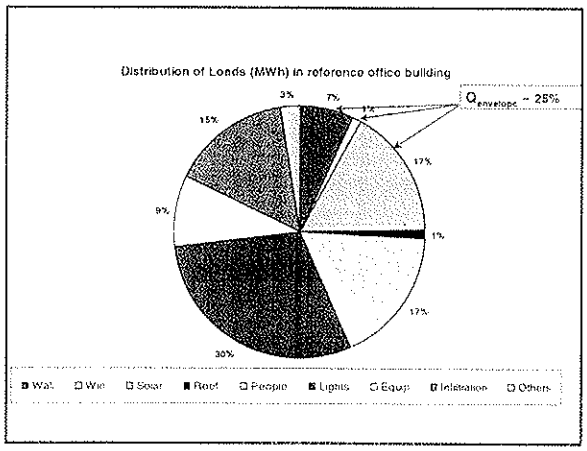
Presentation Outline

- Commercial building reference
- Residential air-con survey
- Building description and modelling
- Formulation of residential ETTV equation
- Relating Residential ETTV to cooling energy
- Residential ETTV cutoff value
- Approaches to reducing ETTV/RETV
- Tool for RETV calculation

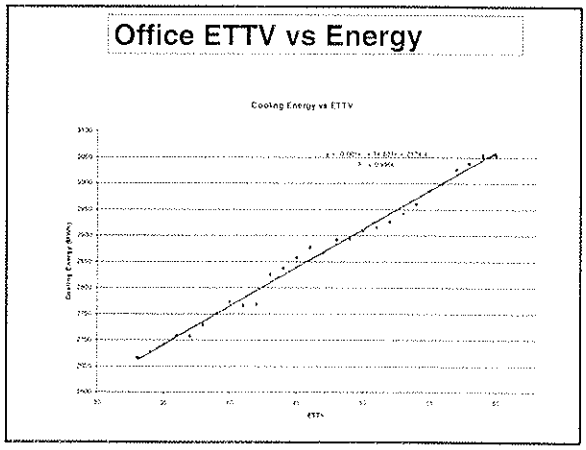


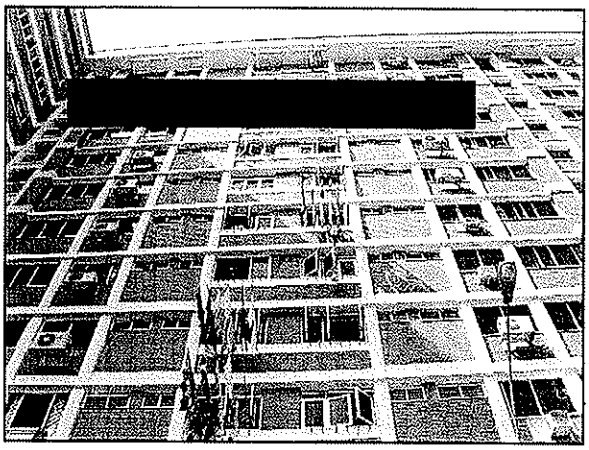
Parameters and Range

Uwall (W/m²K)	0.5 – 2.5
Uf(W/m²K)	0.2 – 4.21
SC	0.2 – 0.7
WWR	0.3 – 0.9
OA (cfm)	5 – 10
LIT (W/m²)	10 – 20
LTS	0.5 – 0.8
COP	3.5 – 5.5



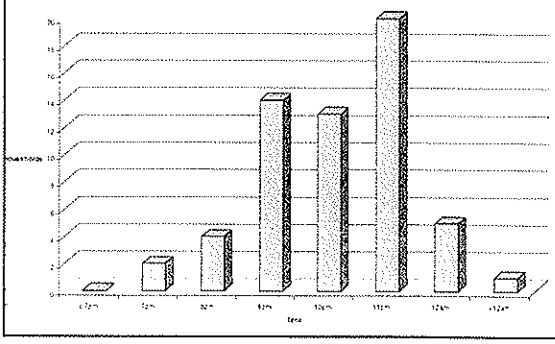
Office ETTV vs Energy



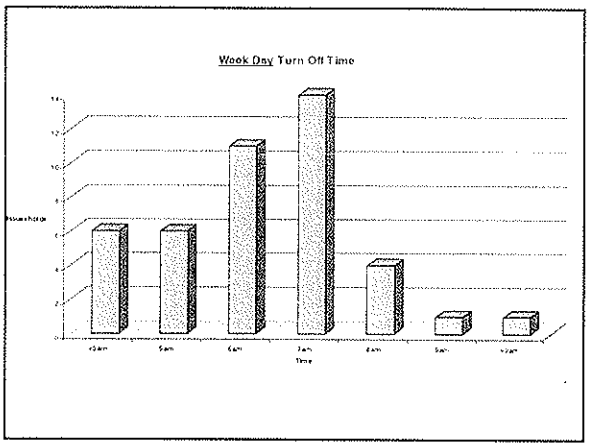


Air Conditioning Pattern Survey Results

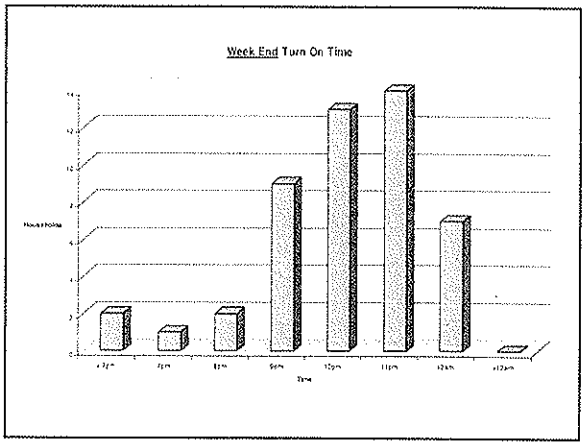
Week Day Turn On Time



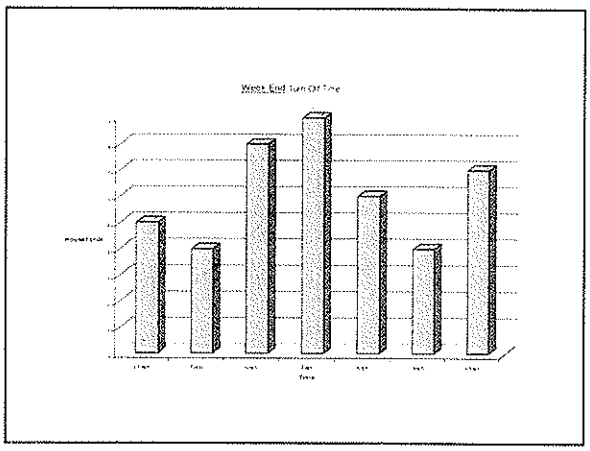
Week Day Turn Off Time



Week End Turn On Time



Week End Turn Off Time

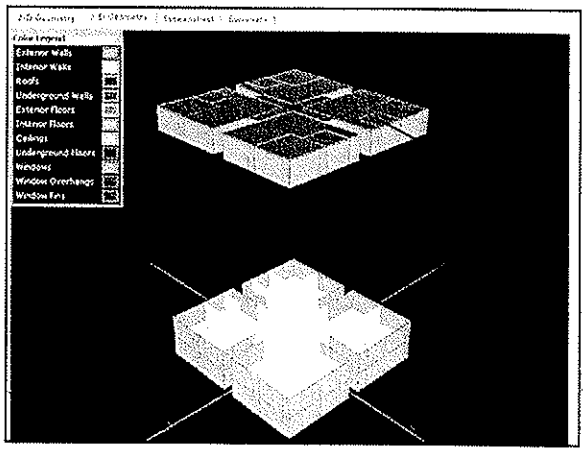


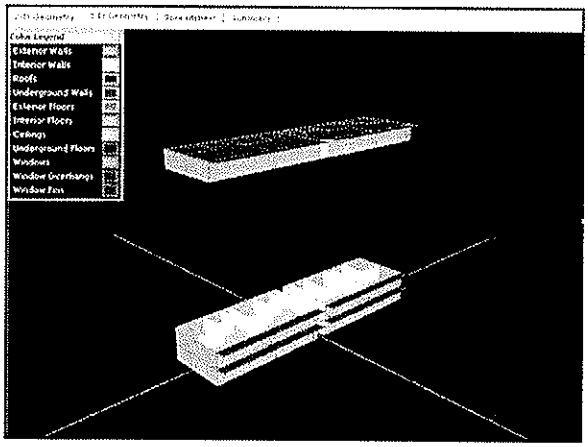
Survey Summary

- From the survey, it can be seen that most people turn on air conditioning between 9pm and 11pm for both weekdays and weekends
- Air conditioning is turned off mostly between 6am and 8am.
- This information is reflected in DOE2 coding

HDB Building Description

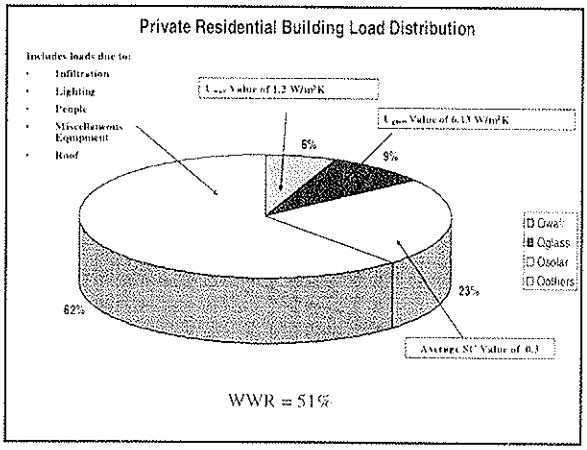
System type	Split unit, rated @ 22,000 BTU/hr for Bedroom 1 and 15,000 BTU/hr for Bedroom 2
Cooling setpoint	24 °C Weekdays (Operation) 22:00-07:00 Weekends (Operation) 22:00-08:00 Rest set point is 37 °C
COP	2.0 to 3.0
Number of occupants in an apartment	A family of 4
Air-conditioned area	Bedroom 1 and Bedroom 2
Building	12 storeys 4 x 144 m²
Windows	Opened when A/C is off to provide natural ventilation, closed when A/C is on

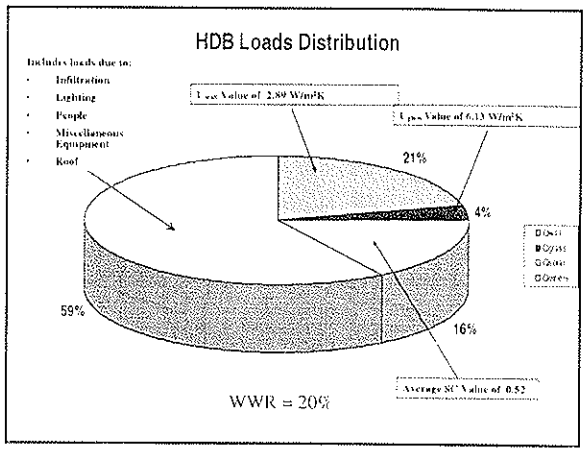




Envelope Parameters and Ranges

Parameters	Ranges
U_w (W/m² K)	1.2 – 4.5
U_f (W/m² K)	2.2 – 6.2
SC	0.2 – 0.9
WWR	0.20 – 0.51
Wall Absorptance	0.45





Formulation of equivalent residential ETTV equation - considerations

- Sensitivity and range
- Effect of building shape or aspect ratio and orientation
- Residential ETTV equation should relate to accurate estimation of cooling energy consumption like its commercial building counterpart

Residential ETTV equation coefficients

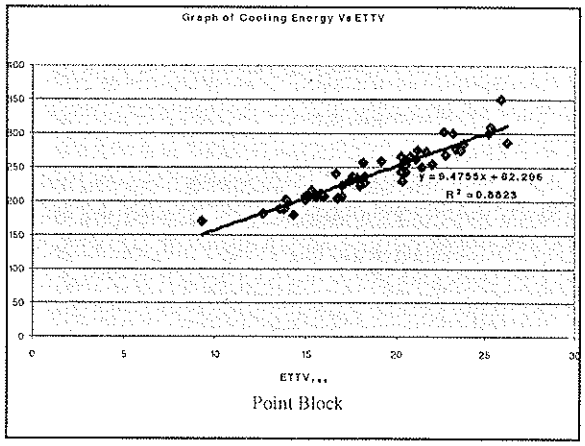
Sample of simulation data

	Qwall (MWh)	Qwin (MWh)	Qsol (MWh)	Td_{eq}(°C.)	Δt(°C.)	SF
1	266.072	135.490	408.379	3.01	1.10	55.10
2	421.664	58.168	406.307	3.11	1.36	55.92
3	332.222	95.550	567.662	3.24	1.24	55.80
4	337.497	78.530	352.353	3.31	1.22	56.83
5	216.398	144.099	660.434	3.38	1.10	55.33

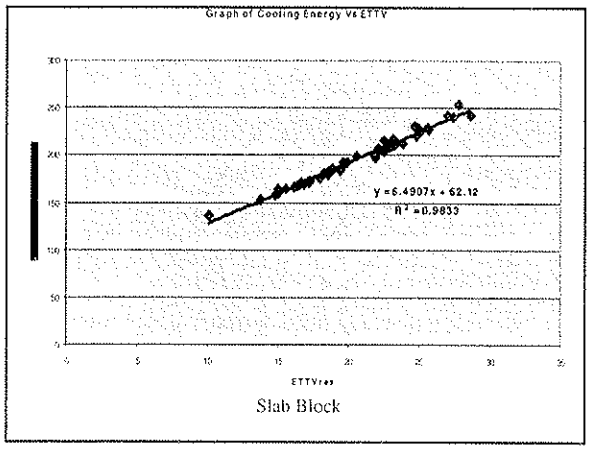
Building Type	Tdeq (°C)	Δt (°C)	SF
Point Block	3.31	1.21	56.12
Slab Block	3.56	1.32	61.05

The residential ETTV equation is thus:

$$ETTV_{res} = 3.4(1 - WWR)U_w + 1.3(WWR)U_f + 58.6(WWR)(CF)(SC)$$



Point Block



Slab Block

RETV (Residential Envelope Transmittance Value)

=

$ETTV_{res}$ (Residential ETTV)

Potential energy savings

About the mid point RETV range of 20 W/m^2,

- Slab block - A unit decrease in RETV results in 3.5% decrease in the annual cooling energy
- Point block - A unit decrease in RETV results in 4% decrease in the annual cooling energy

Approaches to reducing ETTV/RETV

1. Glass shading coefficient
2. Window-to-Wall ratio
3. Wall absorptance
4. Wall resistance
5. U fenestration
6. Wall cladding
7. External shading devices
8. Solar film

THANK YOU

ALTERNATIVE APPROACH IN COMPLIANCE TO RETV

By Alice Goh SDO(RID)

RETV CALCULATIONS

	Development	Block	Orientation	Window Thickness	Window U-Value	Window SC	WWR	RETV (W/m2)
Private	Pte Devt 1		NNW-SSE	6mm - 12.75mm	5.89-5.68	0.64-0.62	0.68	31.6
	Pte Devt 2		N-S	6mm - 9.75	6.25 - 5.7	0.75 - 0.67	0.77	31.33
	Pte Devt 3		N-S	6mm - 8mm	4.97-5.74	0.95 - 0.86	0.51	31.3
	Pte Devt 4		NW-SE	8mm-12.75mm	3.8 - 5.68	0.53	0.92	27.04
	Pte Devt 5		N-S	6mm - 8mm	5.7 - 5.83	0.69	0.52	26.51
	Pte Devt 6	Block 1	N-S	6mm	5.7	0.67	0.5	26.03
		Block 2	NW-SE	6mm	5.7	0.67	0.44	25.41
	Pte Devt 7		N-S	6mm	4.2	0.52	0.71	25.68
	Pte Devt 8		NE-SW	6mm - 12.75mm	6.25 - 6.02	0.67 - 0.63	0.48	25.65
	Pte Devt 9		N-S	10.8mm	5.6	0.72 - 0.71	0.47	25.07
	Pte Devt 10		NEE-SWW	8mm-12.75mm	6.06, 5.05, 4	0.66 - 0.55	0.44	24.89
	Pte Devt 11		NE-SW	24mm	1.7 - 2.8	0.49 - 0.59	0.73	24.55
	Pte Devt 12		NW-SE	8mm	6.06	0.66	0.43	23.69
	Pte Devt 13		NW-SE	6mm	5.89	0.62	0.44	22.88
	Pte Devt 14		N-S	8mm	5.83	0.6	0.32	17.08
Public	Public Devt 1		NNW-SSE	5mm - 12.76mm	5.93-5.68	0.75	0.38	23.58
	Public Devt 2	Blk 79C	N-S	5mm - 12.76mm	5.93-5.68	0.75	0.29	20.12
		Blk 79B	NNW-SSE	5mm - 12.76mm	5.93-5.68	0.75	0.25	19.32
	Public Devt 3		NNE-SSW	5mm - 12.76mm	5.93-5.68	0.75	0.29	19.7
	Public Devt 4	Block 1	N-S	5mm - 12.76mm	5.93-5.68	0.75	0.22	18.3
		Block 2	NE-SW	5mm - 12.76mm	5.93-5.68	0.75	0.17	17.6

'Deemed to satisfy' Provision

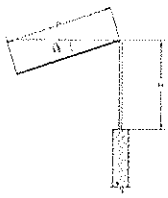
$WWR_{Bldg} < 0.3$ and $SC_{facade} < 0.7$

or

$WWR_{Bldg} < 0.4$ and $SC_{facade} < 0.5$

or

$WWR_{Bldg} < 0.5$ and $SC_{facade} < 0.43$



Note:

WWR : Window to wall ratio

SC : Shading coefficient of fenestration = SC_{Glass} X $SC_{shading\ device}$

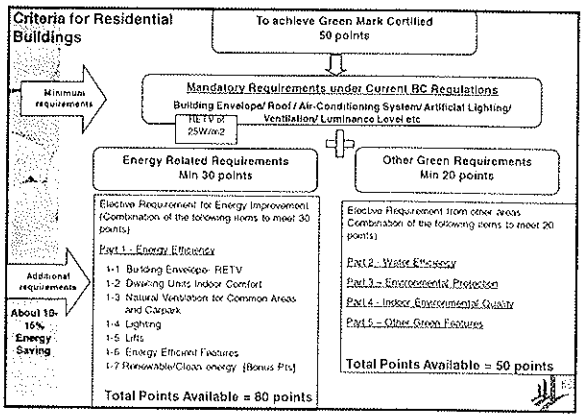
GREEN MARK CRITERIA FOR RESIDENTIAL BUILDINGS

BY

Ms Lee Sui Fung

Senior Executive Development Officer

Certification (BCA)



1-1 Building Envelope

AIM

To enhance overall thermal performance of building envelope through minimizing heat gained from external walls and windows of a building thus reducing overall cooling load requirements

REQUIREMENTS

Baseline: Maximum permissible RETV = 25 W/m²

3 points for every reduction of 1 W/m² in RETV from the baseline of 25 W/m²
(up to 15 points)

1-1 Building Envelope - Examples

Devt	Orientation	Window Thickness	Window U-Value	Window SC	WWR	RETV (W/m2)	GM scores
Pte Devt 1	NEE-SWW	6mm-12.75mm	6.06, 5.05, 4	0.66 - 0.55	0.44	24.89	0.33
Pte Devt 2	NE-SW	24mm (low-e double glazing)	1.7 - 2.8	0.49 - 0.59	0.73	24.55	1.35
Pte Devt 3	NW-SE, SW-NE	12.76mm-17.5mm	4 - 5.2	0.35-0.6	0.10 - 0.84	19.0	15

1-2 Dwelling Unit Indoor Comfort

AIM

To encourage the use of energy efficient air-conditioners or the design of dwelling unit with good natural ventilation

REQUIREMENTS

For dwelling units with provision of air-conditioners, the following points for selection of energy efficient air-conditioners under Singapore's Energy Efficiency Labelling Scheme

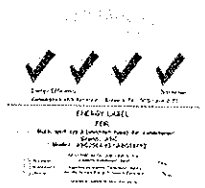
Extent of coverage: at least 90% of the dwelling units' air-conditioners

1-2 Dwelling Unit Indoor Comfort

REQUIREMENTS

Air-conditioners labelled with:

2 Ticks A/C - 2 points
3 Ticks A/C - 6 points
4 Ticks A/C - 10 points



Use of ventilation simulation to ensure good natural ventilation in design of building layout and dwelling units

1-3 Natural Ventilation for Common Areas and Carpark

AIM

To encourage the design of natrual ventilation in common areas and carpark to reduce the needs of mechanical ventilation

REQUIREMENTS

Cross ventilation in common areas such as lift lobby, corridors and staircases (2 points)

Carpark designed with 100% natural ventilation (8 points)

1-3 Natural Ventilation for Common Areas and Carparks

REQUIREMENTS

CO sensor are used to regulate the demand for mechanical ventilation (MV) at basement carpark

Points awarded based on the mode of mechanical ventilation provided

Fume extract – 6 points

MV with or without supply – 4 points



CO monitoring

1-4 Lighting

AIM

To recognize and encourage energy efficient lighting design and fixtures

REQUIREMENTS

Artificial lighting

Baseline = Maximum lighting power budget stated in SS 530

0.2 points for every percentage improvement above the baseline (up to 10 points)

1-4 Lighting

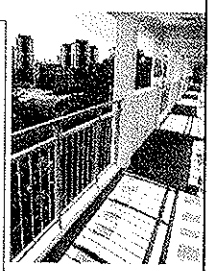
REQUIREMENTS

Day lighting for Common Areas

All lift lobbies (including private lift lobbies) and corridors are designed with 100% day lighting (1 point)

All staircases are designed with 100% day lighting (1 point)

Car park is designed with 100% day lighting (1 point)



1-4 Lighting - Examples

Artificial Lighting

•Using T8 and Compact Fluorescent Lamps for staircases, lobbies and carpark

• Using exterior lamps with high luminous efficacy

30.6% improvement above the baseline

Points awarded = 0.2 x (30.6%)

= 6.12 points

Type of usage	Total Area (A)	Proposed Design W/m² (B)	Reference Design (SS530) W/m² (C)	Proposed Design Load (A x B)	Reference Design Load (A x C)
Staircase	89	5	6	2.5kW	5.3kW
Corridors	1.5kS	3	10	10.2kW	15.4kW
Car parks	7kS	3.5	5	2.2kW	3.9kW
Interior lighting	1.2kS	5	5	5.2kW	6.2kW
			Total	20.1kW	33.2kW

1-4 Lighting - Examples

Artificial Lighting

•Using T5 Fluorescent Lamps for staircases, lobbies and carpark

• Using exterior lamps with high luminous efficacy and low wattage LED lightings

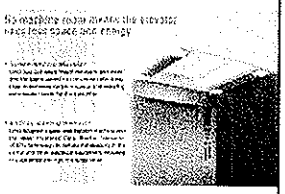
63.4% improvement above the baseline

Points awarded = 0.2 x (63.4%)

= 10 points

Type of usage	Total Area (A)	Proposed Design W/m² (B)	Reference Design (SS530) W/m² (C)	Proposed Design Load (A x B)	Reference Design Load (A x C)
Staircase	89S	3	6	2.5kW	5.3kW
Corridors	1.5kS	3.5	10	5.3kW	15.4kW
Car parks	7kS	3	5	1.3kW	3.9kW
Interior lighting	1.2kS	3.5	5	2.6kS	6.2kW
			Total	12.1kW	33.2kW

1-5 Lifts



AIM

To recognize and encourage energy efficient lifts

REQUIREMENTS

Use lifts with AC variable voltage and variable frequency (VVVF) motor drive or equivalent (2 points)

Lifts with energy efficient features such as sleep mode (2 points)

1-6 Energy Efficient Features

AIM

To encourage other energy efficient green features not stated in the previous section which are innovative and have positive environmental impact

REQUIREMENTS

The adoption of energy efficient green features which are innovative and have positive environmental impact.

2 points for high impact item

1 points for medium impact item

0.5 point for low impact item

(up to 4 points)

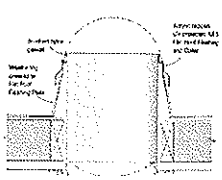
1-6 Energy Efficient Features - Examples

Paloma

Use of gas water heater in at least 75% of the dwelling units (1 point)

1-6 Energy Efficient Features - Examples

Use of at least 10 nos. of sun pipes for natural lighting (0.5 points)





1-7 Renewable/ Clean Energy (Bonus)

AIM

To recognize and encourage the use of renewable or clean energy in order to reduce the needs of fossil fuel energy use

REQUIREMENTS

(Bonus points)

1 point for every 3KWp of solar energy

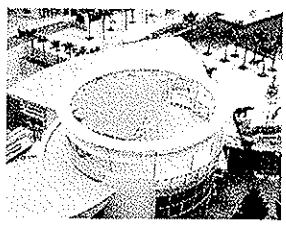
1 point for every 1% replacement of electricity (exclude household's usage) by renewable/ clean energy

(up to 20 points)

1-7 Renewable/ Clean Energy - Examples

5.15KWp solar array is installed on the roof of clubhouse

1.72 bonus points awarded



Examples on achieving min 30 points for energy related requirements

Item	Criteria	Points available	Actual points score	Remarks
1	Energy Efficiency			
1-1	Building envelope	15	0	•RETV 25m/w2
1-2	Dwelling unit indoor comfort	14	10	•4 ticks A/C
1-3	Natural ventilation for common areas and car parks	10	6	•car park with CO (4) •cross ventilation in common areas such as lift lobbies and staircase (2)
1-4	Lighting	13	10	•using PLC at lobbies and T5 lighting at car park (6) •Using daylighting at staircase and lift lobbies (2)
1-5	Lifts	4	4	•VVVF lift with sleep mode
1-6	Energy efficient features	4	0	
	Sub-total for Energy Efficiency	60	30	(Min 30 points and max 50 points)
1-7	*Renewable/ clean energy*	20	0	*(Bonus points)*

2-1 Water Efficient Fitting

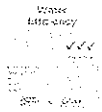
AIM

To recognize and encourage the use of water efficient fittings to reduce the use of PUB water in building

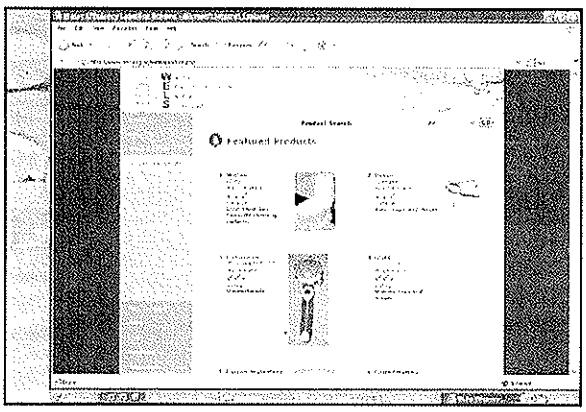
REQUIREMENTS

Points shall be awarded for selection of PUB's Water Efficiency Labelling Scheme (WELS)

(up to 8 points)



http://www.sec.org.sg/wels/



2-1 Water Efficient Fitting

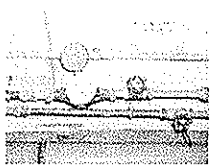
Extent of coverage:
At least 90% of the dwelling units' water fitting type used

	Rating based on WELS		
	Good ✓	Very Good ✓✓	Excellent ✓✓✓
Basin taps	0.5 points	1 point	2 points
Flushing cistern			
Showers			
Sink/bib taps			
All other water fittings			

2-2 Water Usage

AIM

To ensure water systems are capable of being monitored and managed.



Sub-meter to monitor water usage of all major water uses in the building such as irrigation, swimming pools and other water features

2-3 Water Efficient Irrigation and Landscaping

AIM

To reduce the consumption of PUB water for landscape irrigation.

REQUIREMENTS

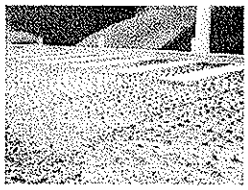
Reduce or eliminated the use of PUB water for site irrigation by the following

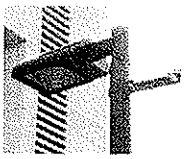
- Use of rainwater collection system (2 points)
- Use of efficient irrigation system (1 point)
- Use of water efficient plants (1 point)

2-3 Water Efficient Irrigation and Landscaping

Efficient Irrigation System

At least 50% of the landscape areas have a drip irrigation system with rain sensor to cut off the irrigation system during raining day





3-1 Sustainable Construction

AIM

To recognize and encourage the adoption of building materials that use less natural resources and to increase the reusability of building materials to reduce waste.

REQUIREMENTS

Encourage reuse of existing buildings – applicable to structural elements and building envelope (2 points)

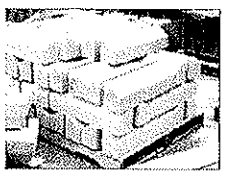
Use of environmental friendly or recycled material
- 1 point for high impact item
- 0.5 point for low impact item

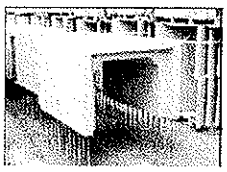
(up to 4 points)

3-1 Sustainable Construction - Example

Use of RC drains using recycled aggregate (0.5 points – low impact as only use in a small area of the development)

Use of internal partitions using recycled materials in every dwelling units (1 point)





3-2 Greenery

AIM

To recognize and encourage greater use of greenery to reduce urban heat island and also to conserve existing natural wherever possible and to restore them to promote biodiversity

REQUIREMENTS

Greenery provision (up to 4 points)

Restoration of trees on site, conserving or relocating of existing trees on site (1 point)

Use of compost recycled from horticulture waste (1 point)



3-2 Example on Greenery Provision

Greenery provision (GnP) is calculated by considering the 3D volume covered by plants using the following green area index (GAI)

Grass	GAI=1	Palm trees	GAI=4
Shrubs	GAI=3	Trees	GAI=6

	Qty A	Canopy area B	Radius C	Green area index GAI	Green Area AxBxC²xGAI
Palms (Nos)	20	3.14	1	4	251.2
Trees (Nos)	10	3.14	3.5	6	2307.9
Shrubs (Nos)	420	1/3	NA	3	420
landscape area + roof garden area + vertical greening (m²)	1850	NA	NA	1	1850
				Total green area	4829.1

Greenery provision (GnP) = Total green area / site area

3-3 Environmental Management Practice

AIM

To recognize and encourage the adoption of environmental friendly management practice during construction and also later the operation of the building

REQUIREMENTS

Implement effective construction and demolition waste management programme including monitoring and setting targets to minimize energy use, water use and construction waste (1 point)

Adoption of CONQUAS and Quality Mark (2 points)

3-3 Environmental Management Practice

REQUIREMENTS

Developer, main contractor, M&E consultant and architect that are ISO 14000 certified (1 point)

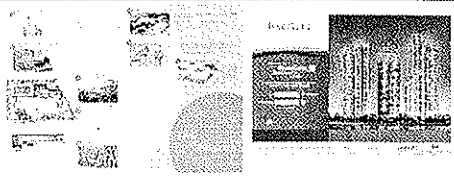
Project team comprises at least one Green Mark Advisor and/or one Green Mark Professional (2 points)

3-3 Environmental Management Practice

REQUIREMENTS

Building users' guide on environmental friendly facilities within building (1 point)

Provision of recycling bins or facilities for collection and storage of different recyclable waste such as paper, glass, plastics, etc (1 point)



3-4 Public Transport Accessibility

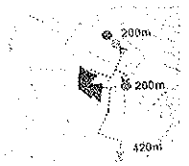
AIM

To recognize development that provides a choice of transport modes for residents with the intention of reducing car usage

REQUIREMENTS

Provisions for access to MRT/LRT or bus stops (1 point)

Provisions for adequate bicycles parking lots (1 point)



4-1 Noise Level

AIM

To recognize development that ensure dwelling units' noise levels are maintained at an appropriate level.

REQUIREMENTS

Building design sound level shall be as specified:

- *55 dB (6am – 10pm)* L_{Aeq}
- 45 *dB (10pm- 6am)* L_{Aeq}

4-2 Indoor Air Pollutants

AIM

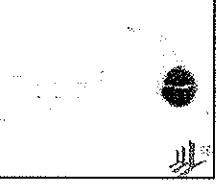
To recognize development that make effort to reduce sources of indoor pollutants.

REQUIREMENTS

Use of low VOC paints certified under Green Labels over more than 90% of the total internal wall areas (2 points)

Use of composite wood product with low emission formaldehyde (1 point)

Low-VOC paint



4-3 Waste Disposal

AIM

To recognize development that make effort to reduce occupant's exposure to indoor pollutants from refuse chute.

REQUIREMENTS

Refuse chute is located at open ventilation area such as service balcony or common corridor

4-4 Day lighting

AIM

To recognize development that provides good day lighting so that improve the quality of life in homes and reduce the need for artificial lighting during daytimes

REQUIREMENTS

Provision of window opening at living room, bedroom and kitchen to create a conducive environment



5 Other Green Features

AIM

To encourage other green features not stated in the previous section which are innovative and have positive environmental impact

REQUIREMENTS

The adoption of other green features which are innovative and have positive environmental impact.

2 points for high impact item

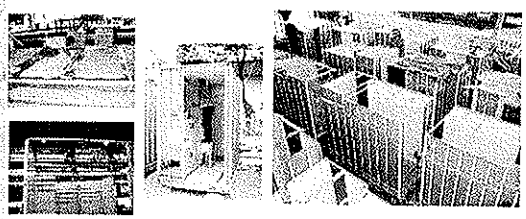
1 points for medium impact item

0.5 point for low impact item

(up to 5 points)

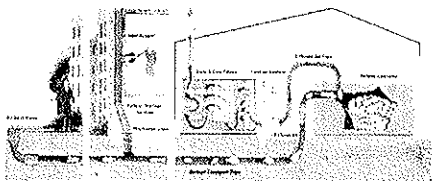
5 Other Green Features - Examples

Use of precast toilets for more than 75% of the toilets (2 points)



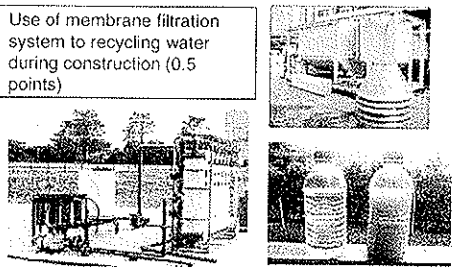
5 Other Green Features - Examples

Use of pneumatic waste collection system (1 point)



5 Other Green Features - Examples

Use of membrane filtration system to recycling water during construction (0.5 points)



Examples on achieving min 20 points for other green requirements

Item	Criteria	Points available	Actual points score	Remarks
2	Water Efficiency			
2-1	Water efficient fittings	6	2	•Water fittings with WELS good rating
2-2	Water usage	1	1	•Provision of sub-metering to major water usages such as irrigation and swimming pool
2-3	Water efficient irrigation and landscaping	4	1	•Selection of water efficient plant
3	Environmental Protection			
3-1	Sustainable construction	6	3	•Use of recycled materials for: mental doors, drywalls, partitions and wardrobe
3-2	Greenery	6	3	•Greenery provision (2) •Use of compost recycled from horticulture waste (1)
3-3	Environmental Management Practice	6	4	•Tender specified monitoring of energy & water use and construction waste (1) •CONQUAS project (1) •Building user guide (1) •Provision of recycling bin at 1st basement lobby (1)

Examples on achieving min 20 points for other green requirements

Item	Criteria	Points available	Actual points score	Remarks
3-4	Public Transport Accessibility	2	2	•Within 500m from bus stop or provision of shuttle bus [1] •Provision of bicycle parking lots [1]
4	Indoor Environmental Quality			
4-1	Noise level	1	1	•Indoor specified design noise level
4-2	Indoor air pollutants	3	1	•Use of composite wood product with low emission formaldehyde
4-3	Waste Disposal	1	1	•Locating refuse chute at service balcony
4-4	Daylighting	1	1	•Provision of window opening at living room, bedroom and kitchen
5	Other Green Features			
5-1	Other Green Features	5	0	
	Sub-total for other green requirements	**50**	**20**	

Green Mark Assessment Criteria for Residential Building (Version 3.0)

To achieve Green Mark Certified
50 points

Mandatory Requirements under Current BC Regulations

Building Envelope/ Roof / Air-Conditioning System/ Artificial Lighting/ Ventilation, Luminance Level etc

Energy Related Requirements
Min 30 points

Elective Requirement for Energy Improvement
(Combination of the following items to meet min 30 points)
(Max 50 points *see note 1**)**

Part 1 - Energy Efficiency

1-1 Building Envelope – RETV
1-2 Dwelling Unit Indoor Comfort
1-3 Natural Ventilation for Common Areas and Carpark
1-4 Lighting
1-5 Lifts
1-6 Energy Efficient Features
1-7 Renewable/Clean energy

Note :
(1) The cap of 50 points does not include Item 1-7 – Renewable/Clean Energy. Bonus points can be obtained for compliance with Item 1-7

Other Green Requirements
Min 20 points

Elective Requirement from other areas
(Combination of the following items to meet 20 points)
(Max 50 points)

Part 2 - Water Efficiency

2-1 Water Efficient Fittings
2-2 Water Usage
2-3 Water Efficient Irrigation and Landscaping

Part 3 – Environmental Protection

3-1 Sustainable Construction
3-2 Greenery Provision
3-3 Environmental Management Practice
3-4 Public Transport Accessibility

Part 4 - Indoor Environmental Quality

4-1 Noise Level
4-2 Indoor Air Pollutants
4-3 Waste Disposal
4-4 Daylighting

Part 5 – Other Green Features

- Pneumatic waste collection system
- Cool paints
- Infiltration trenches etc

Green Mark Assessment Criteria - Version 3.0 (Draft)
Mandatory Requirement

1 Building Envelope – RETV

The residential envelope thermal transmittance value (RETV) of the building, as determined in accordance with the formula set out in the "Guidelines on Residential Envelope Thermal Transmittance Value" issued by the Commissioner of Building Control, shall not exceed 25 W/m^2

2 Roof – U Value

In respect of roofs without skylight, the average thermal transmittance (U-value) for the gross area of the roof shall not exceed the limit prescribed in the following Table 2-1 for the corresponding weight group.

Table 2-1 – Maximum Thermal Transmittance for roof of non-air-conditioned building

Weight Group	Weight range (kg/m^2)	Maximum Thermal Transmittance (W/m^2K)
Light	Under 50	0.8
Medium	50 to 230	1.1
Heavy	Over 230	1.5

This requirement does not apply to building with aggregate floor area not exceeding 500 m^2, open sided sheds, covered walkways and linkways, store rooms and utility rooms or plants and equipment rooms.

Note : This requirement is under review, details will be confirmed later.

3 Air-Conditioning System

(a) Where the cooling capacity of any air-conditioning system exceeds 30 kW, the equipment shall comply with the relevant provisions of SS 530 – Code of Practice for energy efficiency standard for building services and equipment.

(b) Air-conditioning system shall be equipped with manual switches, timers or automatic controllers for shutting off part of the air-conditioning system during non-use of reduce heat load.

4 Air Tightness and Leakage

(a) All windows on the building envelope shall not exceed the air leakage rates specified in SS 212 – Specification for Aluminium Alloy Windows

(b) Where the door opening of any commercial unit is located along the perimeter of the building envelope or leading to an exterior open space, external corridor, passageway or pedestrian walkway, that unit shall –

(i) be completely separated from the other parts of the building; and
(ii) has its air-conditioning system separated from and independent of the central system.

5 Artificial Lighting

(a) The maximum lighting power budget in a building shall comply with SS 530 – Code of Practice for energy efficiency standard for building services and equipment.

(b) Lighting control for artificial lighting shall be provided in accordance with SS 530.

(c) In any hotel building, a control device shall be installed in every guestroom for the purpose of automatically switching off the lighting and reducing the air-conditioning when a guestroom is not occupied.

6 Ventilation

Ventilation shall be adequately provided in a building for its intended occupancy.

(a) Where natural ventilation is applicable, it shall be provided by means of one or more openable windows or other openings with an aggregate area of not less than -
   (i) 5% of the floor area of the room or space required to be ventilated and/ or
   (ii) 15% of the floor area of the aboveground car parking area required to be ventilated

(b) Where mechanical ventilation or air-conditioning systems are used, the ventilation rates of these systems shall comply with SS CP 13 Code of Practice for Mechanical Ventilation and Air-conditioning in Buildings.

7 Electrical Sub-Metering

Provision of sub-metering to monitor energy consumption of key building services and energy usage of end users or tenants.

8 Luminance Level

Building lighting is maintained at luminance level as stated in CP 38 for various types of occupancy.

Elective Requirements

Part 1 - Energy Efficiency (Min 30 points)	Green Mark points
1-1 Building Envelope Baseline : Maximum Permissible RETV = 25 W/m^2 Enhancing overall thermal performance of building envelope through minimising heat gained from external walls and windows of a building thus reducing overall cooling load requirement.	3 points for every reduction of 1 W/m^2 in RETV from the baseline Points awarded = 75 – 3(RETV); where RETV ≤ 25 W/m^2 (up to 15 points)
1-2 Dwelling Unit Indoor Comfort Enhancing dwelling unit indoor comfort either through the provision of better efficient air-conditioners or good natural ventilation design. (a)Design for using air-conditioners Use energy efficient air-conditioners labelled under the Singapore Energy Labelling Scheme. OR Design for using natural ventilation • Proper design of building layout that utilizes prevailing wind conditions to achieve adequate cross ventilation. • Good ventilation in indoor units through sufficient openings. (b) Use of ventilation simulation software or wind tunnel testing to identify the most effective building design and layout to achieve good natural ventilation.	Air-conditioners labelled with : Two Ticks – 2 points Three Ticks – 6 points Four Ticks – 10 points OR 5 points 5 points Point will only be awarded provided recommendations resulted from the ventilation simulation are implemented 4 points
1-3 Natural Ventilation for Common Areas and Carparks (a) Cross ventilation in common areas such as lift lobby, corridor and staircases. (b) Carparks designed with 100% natural ventilation (c) CO sensor are used to regulate the demand for mechanical ventilation (MV) at basement carparks	2.0 points 8.0 points Points awarded based on the mode of mechanical ventilation provided Fume extract – 6 points OR MV with or without supply - 4 points

Part 1 - Energy Efficiency (Min 30 points)	Green Mark points
1-4 Lighting (a) Artificial lighting Baseline = Maximum lighting power budget stated in SS530 Use of better efficient lighting to minimize energy consumption from lighting usage while maintaining proper lighting level. (b) Daylighting for Common Areas Design which maximises the use of daylighting at the following common areas • Lift lobbies and corridors • Staircases • Car park	0.2 points for every percentage improvement above the baseline Points awarded = 0.2 x (% improvement) (up to 10 points) 1 point 1 point 1 point
1-5 Lifts Lifts with energy efficient features such as AC variable voltage and variable frequency(VVVF) motor drive and sleep mode features	4 points
1-6 Energy Efficient Features Energy efficient green features which are innovative and have positive environmental impact: Examples: • Heat recovery system • Use of motion sensors at staircase half landing	2 points for high impact item 1 point for medium impact item 0.5 point for low impact item (Up to [illegible] points)
Sub-Total (A)	

Part 1 - Energy Efficiency (Min 30 points)	Green Mark points
<u>1-7 Renewable/Clean energy</u> Use of solar energy Use of other renewable/clean energy	*(Bonus points)* 1 point for every 3 kWp of solar energy 1 point for every 1% replacement of electricity (exclude household's usage) by renewable / clean energy (Up to 20 points)
Part 1 – Energy Efficiency **SUB-TOTAL :**	Sub-Total(A) + Bonus points

<table>
<tr><th colspan="4">Part 2 – Water Efficiency</th><th>Green Mark points</th></tr>
<tr><td><u>2-1 Water Efficient Fitting</u>
(a) Basin Taps
(b) Flushing Cistern
(c) Showers
(d) Sink/bib taps
(e) All other water fittings</td><td colspan="3">Rating based on Water Efficiency Labelling Scheme (WELS)
Good: 0.5 points
V Good: 1 points
Excellent: 2 points</td><td>Extent of coverage :
At least 90% of the total fitting type used
(Up to 8 points)</td></tr>
<tr><td colspan="4"><u>2-2 Water Usage</u>
Provision of sub-metering to monitor the major water usage such as irrigation, swimming pools etc</td><td>1 point</td></tr>
<tr><td colspan="4"><u>2-3 Water Efficient Irrigation and Landscaping</u>
Provision of suitable systems that utilise rainwater or recycled water for site irrigation.
• Rainwater collection system designed with storage tank capacity to hold all the water from 30 mm rainfall event taking into consideration the roof area
• Efficient irrigation system
• Water efficient plant</td><td>Points awarded based on the rainwater collection system size
≥ 50% of roof area - 1 point
≥ 75% of roof area - 2 points
1 point
1 point</td></tr>
<tr><td colspan="4">Part 2 – Water Efficiency SUB-TOTAL :</td><td></td></tr>
</table>

Part 3 – Environmental Protection	Green Mark points
3-1 Sustainable Construction (a) Encourage less use of natural resources in building construction	*Details to be confirmed later* (Up to 4 points)
(b) Encourage reuse of existing buildings Applicable to structural elements (i.e. structural floor and roof decking) and building envelope (i.e. exterior façade and framing excluding window assemblies)	Extent of coverage : Maintain at least 75% of the existing structural elements or building envelope (by area) (Up to 2 points)
(c) Use of environmental friendly or recycled material with 100 % usage.	1 point for high impact item 0.5 point for low impact item (Up to 4 points)
3-2 Greenery Provision (a) Green Area (GA) is calculated by considering the 3D volume covered by plants using the following green area index (GAI): Grass GAI = 1 ; Shrubs GAI = 3; Palm Trees GAI = 4 ; Trees GAI = 6	GA = 2 to < 3 – 1 point GA = 3 to < 3.5 – 2 points GA = 3.5 to < 4.0 – 3 points GA > 4.0 – 4 points *Note : The GA requirement is under review. Details to be confirmed later*
(b) Restoration of trees on site, conserving or relocating of existing trees on site	1 point
(c) Use of compost recycled from horticulture waste	1 point

Part 3 – Environmental Protection	Green Mark points
3-3 Environmental Management Practice	
(a) Implement effective construction and demolition waste management programme including monitoring and setting targets to minimise energy use, water use and construction waste	1 point
(b) Building quality assessed under the Construction Quality Assessment System (CONQUAS) and Quality Mark Scheme	1 point each (up to 2 points)
(c) Developer, main builder, consultants and architects that are ISO 14000 certified	1 point
(d) Project team comprises at least one Green Mark Advisor and/or one Green Mark Professional	1 point each (Up to 2 points)
(e) Building users' guide on facilities within building, environmental friendly use and operation of building	1 point
(f) Provision of facilities or recycling bins for collection and storage of different recyclable waste such as paper, glass, plastic etc	1 point
3-4 Public Transport Accessibility	
Provisions for access to MRT/LRT or bus stops	1 point
Provisions for adequate bicycles parking lots	1 point
Part 3 – Environmental Protection SUB-TOTAL :	

Part 4 – Indoor Environmental Quality	Green Mark points
4-1 Noise Level Building design to achieve ambient internal noise level as specified : 55 dB (6am-10pm) LeqA 45 dB(10pm-6 am) LeqA	1 point
4-2 Indoor Air Pollutants (a) Use of low VOC paints or alternative surface coating over more than 90% of the total internal wall areas. (b) Use of composite wood product with low emission formaldehyde OR no composite wood product used.	2 points 1 point
4-3 Waste Disposal Refuse chute is located at open ventilation area such as service balcony.	1 point
4-4 Daylighting Use of daylighting to create a conducive environment for dwelling units.	1 point
Part 4 – Indoor Environmental Quality SUB-TOTAL :	

Part 5 – Other Green Features	Green Mark points
Other green features adopted in the project which are innovative and have positive environmental impact. Examples : ▪ Pneumatic waste collection system ▪ Dual Chute System ▪ Cool paints ▪ Self cleaning façade system ▪ Infiltration trenches ▪ Integrated storm water retention/treatment into landscaping ▪ etc	2 points for high impact item 1 point for medium impact item 0.5 point for low impact item (Up to 5 points)
Part 5 – Other Green Features SUB-TOTAL :	

Green Mark Assessment Criteria for Non-Residential Building (Version 3.0)

To achieve Green Mark Certified
50 points

Mandatory Requirements under Current BC Regulations

Building Envelope/ Roof / Air-Conditioning System/ Artificial Lighting/ Ventilation, Luminance Level etc

Energy Related Requirements
Min 30 points

Other Green Requirements
Min 20 points

Elective Requirement for Energy Improvement

(Combination of the following items to meet 30 points)
(Max 50 points *see note 1 **)**

Part 1 - Energy Efficiency

Air-con
- 1-1 Building Envelope - ETTV
- 1-2 Air-Conditioning System

Non Air-con
- 1-3 Building Envelope – Design/Thermal Parameters
- 1-4 Natural Ventilation

General
- 1-5 Artificial Lighting
- 1-6 Ventilation at Common Areas and Carparks
- 1-7 Lifts and Escalators
- 1-8 Energy Efficient Features
- 1-9 Renewable/Clean energy

Note :

(1) The cap of 50 points does not include Item 1-9 – Renewable/Clean Energy. Bonus points can be obtained for compliance with Item 1-9

Elective Requirement from other areas

(Combination of the following items to meet 20 points)
(Max 50 points)

Part 2 - Water Efficiency

- 2-1 Water Efficient Fittings
- 2-2 Water Usage and Leak Detection
- 2-3 Water Efficient Irrigation and Landscaping
- 2-4 Water Consumption of Cooling Tower

Part 3 – Environmental Protection

- 3-1 Sustainable Construction
- 3-2 Greenery Provision
- 3-3 Environmental Management Practice
- 3-4 Public Transport Accessibility
- 3-5 Refrigerants

Part 4 - Indoor Environmental Quality

- 4-1 Thermal Comfort
- 4-2 Noise Level
- 4-3 Indoor Air Pollutants
- 4-4 High Frequency Ballasts

Part 5 – Other Green Features

- Pneumatic waste collection system
- Thermal energy storage cooling
- Rainwater harvesting etc

Green Mark Assessment Criteria Version 3.0 (Draft)
Mandatory Requirement

1 Building Envelope – ETTV

The envelope thermal transfer value (ETTV) of the building, as determined in accordance with the formula set out in the "Guidelines on Envelope Thermal Transfer Value for Buildings" issued by the Commissioner of Building Control, shall not exceed 50 W/m^2

2 Roof – RTTV

In respect of roofs with skylight, the roof thermal transfer value(RTTV) as determined in accordance with the formula set out in the "Guideline on Envelope Thermal Transfer Value for Buildings" issued by the Commissioner of Building Control, shall not exceed 50 W/m^2.

3 Roof – U Value

In respect of roofs without skylight, the average thermal transmittance (U-value) for the gross area of the roof shall not exceed the limit prescribed in the following Table 3-1 and Table 3-2 for the corresponding weight group.

Table 3-1 – Maximum Thermal Transmittance for roof of air-conditioned building

Weight Group	Weight range (kg/m^2)	Maximum Thermal Transmittance (W/m^2K)
Light	Under 50	0.5
Medium	50 to 230	0.8
Heavy	Over 230	1.2

Table 3-2 – Maximum Thermal Transmittance for roof of non-air-conditioned building

Weight Group	Weight range (kg/m^2)	Maximum Thermal Transmittance (W/m^2K)
Light	Under 50	0.8
Medium	50 to 230	1.1
Heavy	Over 230	1.5

This requirement does not apply to building with aggregate floor area not exceeding 500 m^2, open sided sheds, covered walkways and linkways, store rooms and utility rooms or plants and equipment rooms.

4 Air-Conditioning System

(a) Where the cooling capacity of any air-conditioning system exceeds 30 kW, the equipment shall comply with the relevant provisions of SS 530 – Code of Practice for energy efficiency standard for building services and equipment.

(b) Air-conditioning system shall be equipped with manual switches, timers or automatic controllers for shutting off part of the air-conditioning system during non-use of reduce heat load.

5 Air Tightness and Leakage

(a) All windows on the building envelope shall not exceed the air leakage rates specified in SS 212 – Specification for Aluminium Alloy Windows

(b) Where the door opening of any commercial unit is located along the perimeter of the building envelope or leading to an exterior open space, external corridor, passageway or pedestrian walkway, that unit shall –

(i) be completely separated from the other parts of the building; and
(ii) has its air-conditioning system separated from and independent of the central system.

6 Artificial Lighting

(a) The maximum lighting power budget in a building shall comply with SS 530 – Code of Practice for energy efficiency standard for building services and equipment.

(b) Lighting control for artificial lighting shall be provided in accordance with SS 530.

(c) In any hotel building, a control device shall be installed in every guestroom for the purpose of automatically switching off the lighting and reducing the air-conditioning when a guestroom is not occupied.

7 Ventilation

Ventilation shall be adequately provided in a building for its intended occupancy.

(a) Where natural ventilation is applicable, it shall be provided by means of one or more openable windows or other openings with an aggregate area of not less than -
   (i) 5% of the floor area of the room or space required to be ventilated and/ or
   (ii) 15% of the floor area of the aboveground car parking area required to be ventilated

(b) Where mechanical ventilation or air-conditioning systems are used, the ventilation rates of these systems shall comply with SS CP 13 Code of Practice for Mechanical Ventilation and Air-conditioning in Buildings.

8 Electrical Sub-Metering

Provision of sub-metering to monitor energy consumption of key building services and energy usage of end users or tenants.

9 Luminance Level

Building lighting is maintained at luminance level as stated in CP 38 for various types of occupancy.

Note :

(1) QP will be required to declare the air-conditioned building areas and the non-conditioned building areas in their submission.

(2) For Part 1 - Energy Efficiency, the points will be apportioned based on the percentage of air-conditioned and non air-conditioned building areas excluding carpark areas.

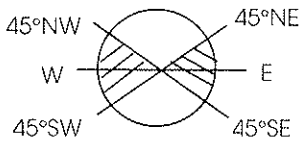
(3) Item 1-1 and Item 1-2 are applicable for air -conditioned building areas where the aggregate air-conditioned areas > 500 m^2.

(4) Item 1-3 and Item 1-4 are applicable for non air -conditioned building areas where the aggregate non air-conditioned areas > 500 m^2.

(5) Item 1-5 to Item 1-8 are common items applicable to all building areas,

Elective Requirements

Part 1 - Energy Efficiency (Min 30 points)	Green Mark Points
Applicable for Air-Conditioned Building Areas (with Aggregate Air-Conditioned Areas > 500 m^2)	
1-1 Building Envelope - ETTV Baseline : Maximum Permissible ETTV = 50 W/m^2 Enhancing overall thermal performance of building envelope to minimise heat gained through external walls and windows of a building thus reducing the overall cooling load requirement.	2 points for every reduction of 1 W/m^2 in ETTV from the baseline Points awarded = 100 – 2(ETTV); where ETTV ≤ 50 W/m^2 (up to 15 points)
1-2 Air-Conditioning System Baseline : Minimum efficiency requirement of the air-conditioning system stated in SS530:2006 & CP 13:1999. Use of better efficient air-conditioned equipment to minimise energy consumption. Efficiency of the systems to be considered are as follows - (a) Air-Conditioned Plant : • Chiller • Chilled-water pump • Condenser water pump (b) Air Distribution System : • Air Handling Units (AHUs) • Fan Coil Units (FCUs) (c) Unitary Air Conditioners/Condensing Units : • Single-Spilt Unit • Multi-Spilt Unit • VRV System Where there is a combination of different air - conditioning system used (for example centralized air-con system for the main building together with unitary air-conditioned system in some areas), the computation for the points awarded will only be based on the air-conditioning systems with a larger capacity. Sensor or similar automatic control device is used to regulate outdoor air flow rate to maintain the concentration of carbon dioxide below 1000ppm.	(a) Air-Conditioned Plant 1.5 points for every percentage improvement in the air-conditioned plant efficiency above the baseline. Points awarded = 1.5 x (% improvement) (b) Air Distribution System 0.5 points for every percentage improvement in the air distribution system efficiency above the baseline. Points awarded = 0.5 x (% improvement) (c) Unitary Air-Conditioners/Condensing Units 1.5 points for every percentage improvement in the efficiency of unitary air-conditioners/ condensing units above the baseline. Points awarded = 1.5 x (% improvement) Overall points awarded based on the combination of item (a) and (b) OR item (c) (Up to 25 points) 2 points
Sub-Total (A)	

Part 1 – Energy Efficiency (Min 30 points)	Green Mark Points
Applicable for Non Air-Conditioned Building Areas (with Aggregate Non Air-Conditioned Areas > 500 m^2)	
1-3 Building Envelope – Design/ Thermal Parameters Enhancing overall thermal performance of building envelope to minimise heat gained though external walls and windows of a building which encourage natural ventilation.	
(a) Minimal direct east or west facing external wall/window (see note) through building design orientation. *Note : External walls/ windows that are located within the range of 45° NE and 45° SE or 45° NW and 45° SW as shown below are defined as east/west facing external walls/windows. Core walls for lifts or staircases and toilets that are east or west facing are exempted in computation.*  	0.1 point for every percentage reduction in the areas with east and west facing external walls/windows Points awarded = 10 – 0.1 x (% of east/west facing external walls /window area) (Up to 10 points)
(b) Sunshading provision for external windows.	0.1 point for every percentage increase in external windows with sunshading provision Points awarded = 0.1 x (% of external windows with sunshading devices) (Up to 10 points)
(c) Better Thermal Transmittance (U-value) of east and west facing external walls and fixed glazing. Baseline: Depending on the window/ wall ratio(WWR) and U value of the respective wall type of 100mm thick as follows: (i) Where WWR = 0 U-value brickwall/curtain wall is 2.62 W/m^2K U-value precast wall is 3.96 W/m^2K (ii) Where WWR < 0.5 Average U-value = 4.25 W/m^2K	2 points for every 0.1W/m^2K reduction (Up to 5 points) No point will be awarded for WWR > 0.5
(d) Better Thermal Transmittance (U-value) of roof. Baseline: U-value for roof stated below depending on the weight range of roof structure: Weight Group / Weight range (kg/m^2) / Maximum Thermal Transmittance (W/m^2K) Light / Under 50 / 0.8 Medium / 50 to 230 / 1.1 Heavy / Over 230 / 1.5	2 points for every 0.1W/m^2K reduction (Up to 5 points)

Part 1 – Energy Efficiency (Min 30 points)	Green Mark Points
Applicable for Non Air-Conditioned Building Areas (With Aggregate Non Air-Conditioned Areas > 500 m^2) – Cont'd	
<u>1-4 Natural Ventilation (exclude carparks)</u> (a) Proper design of building layout that utilizes prevailing wind conditions to achieve adequate cross ventilation. (b) Good ventilation in indoor units through sufficient openings. (c) Use of ventilation simulation software or wind tunnel testing to identify the most effective building design and layout to achieve good natural ventilation.	 4 points 4 points Point will only be awarded provided that the appropriate recommendations from ventilation simulations are implemented 4 points
Sub-Total (B)	

Part 1 - Energy Efficiency (Min 30 points)	Green Mark Points
General	
1-5 Artificial Lighting Baseline = Maximum lighting power budget stated in SS530 Use of better efficient lighting to minimise energy consumption from lighting usage while maintaining proper lighting level.	0.5 point for every percentage improvement above the baseline Points awarded = 0.5 x (% improvement) (up to 5 points) Note : If tenant lightings are not provided, the points awarded will be capped at 2 points
1-6 Ventilation for Carparks Sensor or similar automatic control device are used to regulate the demand for mechanical ventilation at basement carpark or where carpark is designed with 100% natural ventilation to reduce energy consumption for ventilation.	3 points
1-7 Lifts and Escalators (a) Lifts with energy efficient features such as AC variable voltage and variable frequency (VVVF) motor drive and sleep mode features. (b) Escalators with energy efficient features such as motion sensors.	1 point 1 point
1-8 Energy Efficient Features Energy efficient green features which are innovative and have positive environmental impact: Examples: • Heat recovery system • Use of motion sensors at staircase half landing	2 points for high impact item 1 point for medium impact item 0.5 point for low impact item (Up to 3 points)
Note : For buildings without Item 1-6 and/or Item 1-7, the total Green Mark Points for Sub-Total (C) under Part 1 will be prorated accordingly.	
Sub-Total (C)	

Part 1 - Energy Efficiency (Min 30 points)	Green Mark Points
1-9 Renewable/Clean energy Use of solar energy Use of other renewable/clean energy	*(Bonus Points)* 1 point for every 3 kWp of solar energy 1 point for every 1% replacement of electricity (exclude household's usage) by renewable / clean energy (Up to 20 points)
Part 1 – Energy Efficiency **SUB-TOTAL :**	Sub-Total(A) X Air-Conditioned Building Floor Area / Total Floor Area + Sub-Total(B) X Non Air-Conditioned Building Floor Area / Total Floor Area + Sub-Total(C) + Bonus points

<table>
<tr><th>Part 2 – Water Efficiency</th><th>Green Mark points</th></tr>
<tr><td><u>2-1 Water Efficient Fitting</u>
(a) Basin Taps
(b) Flushing Cistern
(c) Showers
(d) Sink/bib taps
(e) All other water fittings

Rating based on Water Efficiency Labelling Scheme (WELS)
Good: 0.25 points
V Good: 0.5 points
Excellent: 1.0 points</td><td>Extent of coverage :

At least 90% of the total fitting type used

(Up to 5 points)</td></tr>
<tr><td><u>2-2 Water Usage and Leak Detection</u>

(a) Sub-meters for major water usage such as irrigation, cooling tower.

(b) Sub-meters for tenants.

(c) Linking all sub-meters to BMS to provide a leak detection system.</td><td>1 point for each item

(Up to 3 points)</td></tr>
<tr><td><u>2-3 Water Efficient Irrigation and Landscaping</u>

<u>Applicable for Buildings with Landscaping</u>
Provision of suitable systems that utilise rainwater or recycled water for site irrigation based on the percentage reduction in use of potable water (from PUB).</td><td><u>% Reduction in potable water usage</u>
100% : 4 points
75% : 3 points
50% : 2 points
25% : 1 points

(Up to 4 points)</td></tr>
<tr><td><u>2-4 Water Consumption of Cooling Tower</u>

<u>Applicable for Buildings with Cooling Tower</u>
To reduce potable water use for cooling purpose by using water cooling tower system which can achieve 6 or better cycles of concentration and/or uses 90% non-potable water such as NEWater and recycled water .</td><td>1 point for each item

(Up to 2 points)</td></tr>
<tr><td>Note : For buildings without item 2-3 and/or 2-4, the total Green Mark Points for Part 2 will be prorated accordingly.</td><td></td></tr>
<tr><td>Part 2 – Water Efficiency SUB-TOTAL :</td><td></td></tr>
</table>

Part 3 – Environmental Protection	Green Mark points
3-1 Sustainable Construction	
(a) Encourage more efficient use of concrete.	*Details to be confirmed later* (Up to 4 points)
(b) Encourage reuse of existing buildings Applicable to structural elements (i.e. structural floor and roof decking) and building envelope (i.e. exterior façade and framing excluding window assemblies)	Extent of coverage : Maintain at least 75% of the existing structural elements or building envelope (by area) (Up to 2 points)
(c) Use of environmental friendly or recycled material with 100 % usage.	1 point for high impact item 0.5 point for low impact item (Up to 4 points)
3-2 Greenery Provision	
(a) Green Area (GA) is calculated by considering the 3D volume covered by plants using the following Green Area Index (GAI) : Grass GAI = 1 ; Shrubs GAI = 3; Palms Trees GAI = 4; Trees GAI = 6	GA = 2 to < 3 – 1 point GA = 3 to < 3.5 – 2 points GA = 3.5 to < 4.0 – 3 points GA > 4.0 – 4 points *Note : The GA requirement is under review. Details to be confirmed later*
(b) Restoration of trees on site, conserving or relocating of existing trees on site.	1 point
(c) Use of compost recycled from horticulture waste.	1 point
3-3 Environmental Management Practice	
(a) Implement effective construction and demolition waste management programme including monitoring and setting targets to minimise energy use, water use and construction waste.	2 points
(b) Building quality assessed under the Construction Quality Assessment System (CONQUAS)	1 point
(c) Developer, main builder, consultants and architects that are ISO 14000 certified.	1 point
(d) Project team comprises at least one Green Mark Advisor and/or one Green Mark Professional	1 point each (Up to 2 points)
(e) Building users' guide on facilities within building, environmental friendly use and operation of building.	1 point

Part 3 – Environmental Protection (Cont'd)	Green Mark points
3-3 Environmental Management Practice (cont'd) (f) Provision of facilities or recycling bins at each floor level for collection and storage of different recyclable waste such as paper, glass, plastic etc.	1 point
3-4 Public Transport Accessibility (a) Provisions for access to MRT/LRT or bus stops. (b) Provisions for adequate bicycles parking lots.	1 point 1 point
3-5 Refrigerants (a) Provision of automatic refrigerant pump down is made to the heat exchanger (or dedicated storage tanks) with isolation valves. (b) Refrigerant leak detection system is specified/installed covering high-risk parts of the plant (evaporator or condenser coils can be omitted from this) (c) Refrigerants with (ODP) of zero OR no refrigerants used.	0.5 point 1.0 point 1.0 point
Note : For buildings without item 3-5, the total Green Mark Points for Part 3 will be prorated accordingly.	
Part 3 – Environmental Protection **SUB-TOTAL :**	

Part 4 – Indoor Environmental Quality	Green Mark points
4-1 Thermal Comfort *Applicable if there are aggregate air-conditioned areas of more than 500 m^2* HVAC system is designed to allow for cooling load variations due to fluctuations in ambient air temperature to ensure consistent indoor conditions for thermal comfort. Indoor temp between 22.5 to 25.5 ° C Relative Humidity < 70%	2 points
4-2 Noise Level (a) Building services are designed to contribute no more than 5 dB to space noise levels. (b) General offices areas and private offices are designed for sound level between *45-55 dB* L_{AeqT} and *40-45 dB* L_{AeqT} respectively. (c) Building design to achieve ambient internal noise level as specified : • Urban areas 55dB (6am-10pm) LeqA • Suburban areas 50dB (6am-10pm) LeqA	1 point 1 point 1 point
4-3 Indoor Air Pollutants (a) Use of low VOC paints or alternative surface coating over more than 90% of the total internal wall areas. (b) Use of composite wood product with low emission formaldehyde OR no composite wood product used.	1 point 1 point
4-4 High Frequency Ballasts High frequency ballasts installed in fluorescent luminaries.	Extent of Coverage : At least 90% of Gross Floor Area (GFA) 2 points
Note : For buildings without item 4-1, the total Green Mark Points for Part 4 will be prorated accordingly.	
Part 4 – Indoor Environmental Quality **SUB-TOTAL :**	

Part 5 – Other Green Features	Green Mark points
Other green features adopted in the project which are innovative and have positive environmental impact. Examples : ▪ Pneumatic waste collection system ▪ Dual Chute system ▪ Cool paints ▪ Self cleaning façade system ▪ Infiltration trenches ▪ Integrated storm water retention/treatment into landscaping ▪ etc	2 points for high impact item 1 point for medium impact item 0.5 point for low impact item (Up to 5 points)
Part 5 – Other Green Features **SUB-TOTAL :**	