Proposed Legislative Framework on Environmental Sustainability for Buildings



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

Presented by Grace Cheok-Chan
Technology Development Division
Building and Construction Authority

Agenda

1. Background
2. Proposed Legislative Framework
3. Responsibilities of QP & Practitioners
3. Administrative Procedures

Background

BCA Green Mark is a voluntary scheme

BCA GREEN MARK

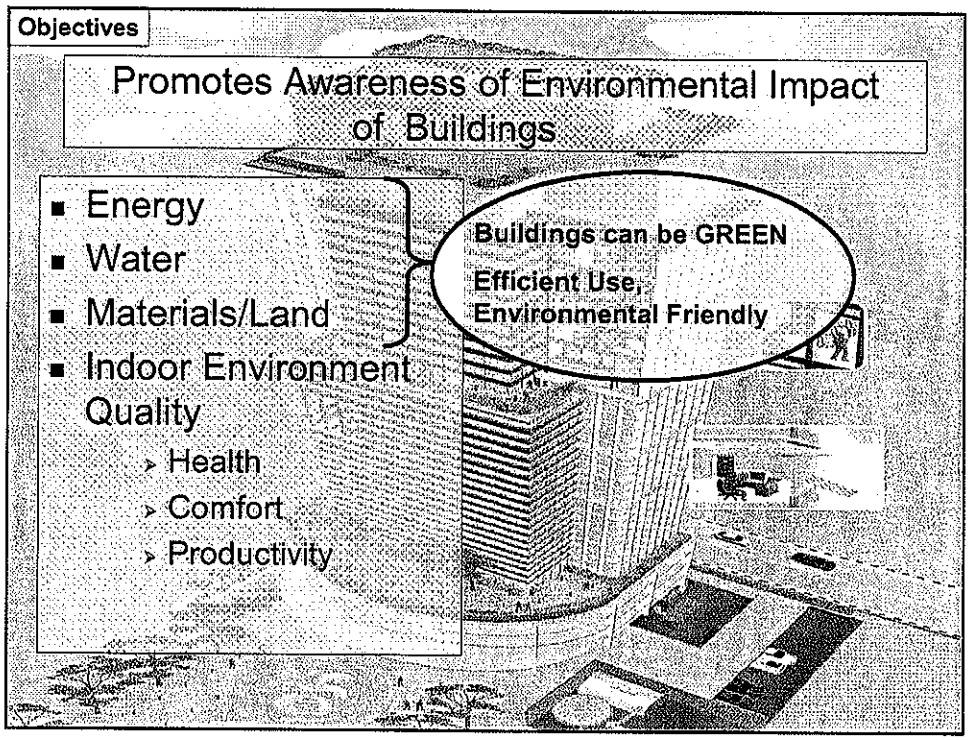
Launched in Jan 2005

Background

BCA Green Mark is a green building rating system to evaluate building for its environmental impact and performance

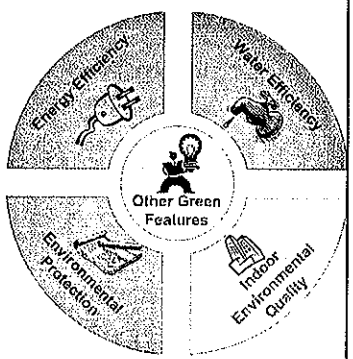
BCA GREEN MARK

Launched in Jan 2005

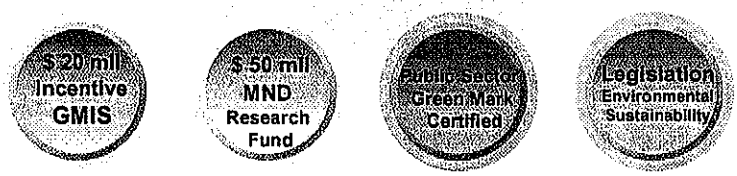


Other Objectives..

- **Recognise the efforts made by developers & building owners and design teams in creating environmentally sustainable buildings**
- **Benchmark and identify good practices in development, design, construction, management and maintenance of green buildings**



BCA Master Plan on Green Building Technologies



Dec 06 | Jan 07 | Apr 07 | Apr 08

Current Regulatory Requirement

Current Legislative Framework

- Building Control (BC) Act
- Building Control Regulations
- Building Control (Accredited Checkers) Regulations
- Building Control (Buildable Design) Regulations
- Building Control (Inspection of Building) Regulations
- Building Control (Temp Bldgs) and (Outdoor Advertising) Regulations
- **Approved Document – Energy Efficiency/ Lighting and Ventilation**

Only new building works need to comply with energy efficiency requirement under Approved Document

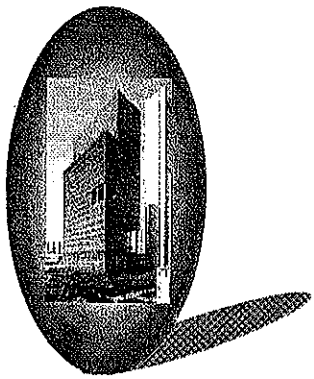
2 Key Requirements

- **ETTV and RTTV = 50 W/m²**
- **Air-Conditioning Equipment and lighting – newly revised code SS530 together with other requirements such as electrical sub metering etc**

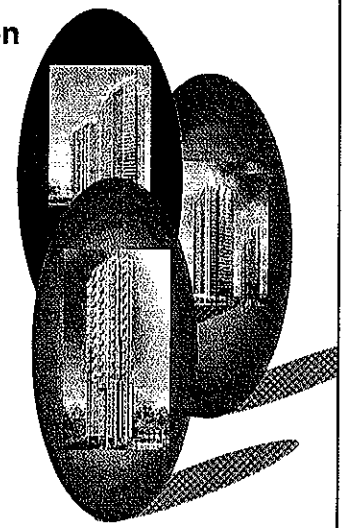
Only if Air-Conditioned Space > 500 m²

Note :
ETTV - Envelope Thermal Transfer Value
RTTV - Roof Thermal Transfer Value

Current Situation - Energy Consumption



Air-Conditioned Buildings
30% of energy use



Non Air-Conditioned Buildings including residential, school, industrial buildings
70% of energy use

Current Regulatory Requirement

Current Legislative Framework

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Only if Air-Conditioned Space > 500 m²

Note :
SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment

Enabling Provision under the Building Control Act



Section 49 (a)(2)(e)(viii)

"Environmental sustainability measures that improve the total quality of life and minimises adverse effects to the environment, both now and in the future;"

Building Control (Amendment) Bill was passed by Parliament on 20 Sep 2007

Proposed Legislative Framework



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



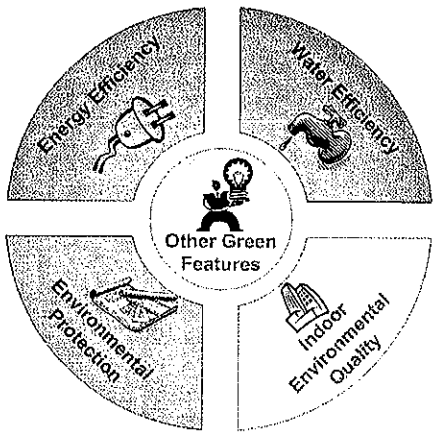
What is the minimum environmental sustainability standard ?

- A minimum energy standard that yields about 10 % -15% energy saving over our revised Energy Efficiency Standard SS 530 and
- Other green requirements which enhance water efficiency, environmental protection, indoor air quality etc

Legislation using BCA Green Mark

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

BCA GREEN MARK



Min 50 points

Set minimum requirements for environmental sustainability – Green Mark Certified Level

Green Mark Rating	Green Mark Points
Platinum	90 & above
GoldPlus	85 to <90
Gold	75 to <85
Certified	50 to <75

Scope of Legislation



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

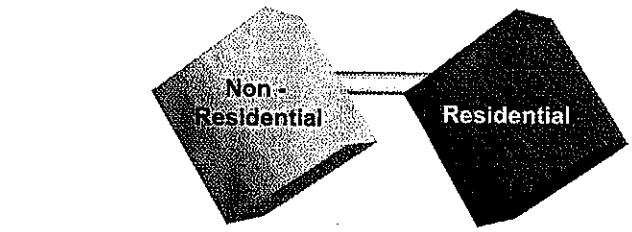
Scope of Legislation

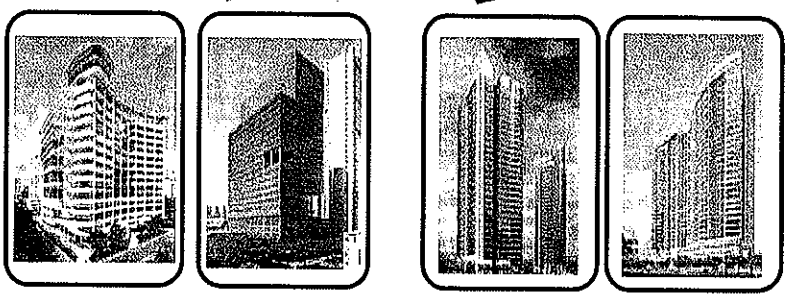


Effective Time Frame

- Application for URA Planning Permission from **Apr 08** onwards

Green Mark Criteria





Criteria for Non-Residential Buildings

To meet Green Mark Score 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

Other Green Requirements Min 20 points

Additional requirements

About 10-15% Energy Saving

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

Part 1 - Energy Efficiency

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

(Air - Con)

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

(Non Air-Con)

- 1-6 Ventilation in Carparks
- 1-7 Ventilation in Common Areas
- 1-8 Lifts and Escalators
- 1-9 Energy Efficient Practices & Features
- 1-10 Renewable energy

(General)

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

Part 2 - Water Efficiency

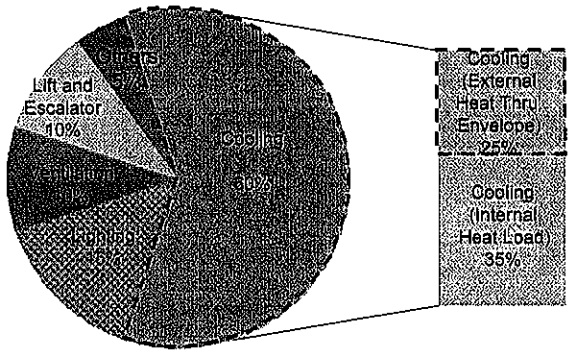
Part 3 – Environmental Protection

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 meet Green Mark Score 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

Other Green Requirements Min 20 points

Additional requirements

About 10-15% Energy Saving

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

Part 1 - Energy Efficiency

- 1-1 Building Envelope- RETV
- 1-2 Dwelling Units Indoor Comfort
- 1-3 Natural Ventilation in Common Areas
- 1-4 Lighting
- 1-5 Ventilation in Carparks
- 1-6 Lifts
- 1-7 Energy Efficient Features
- 1-8 Renewable/Clean energy

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

Part 2 - Water Efficiency

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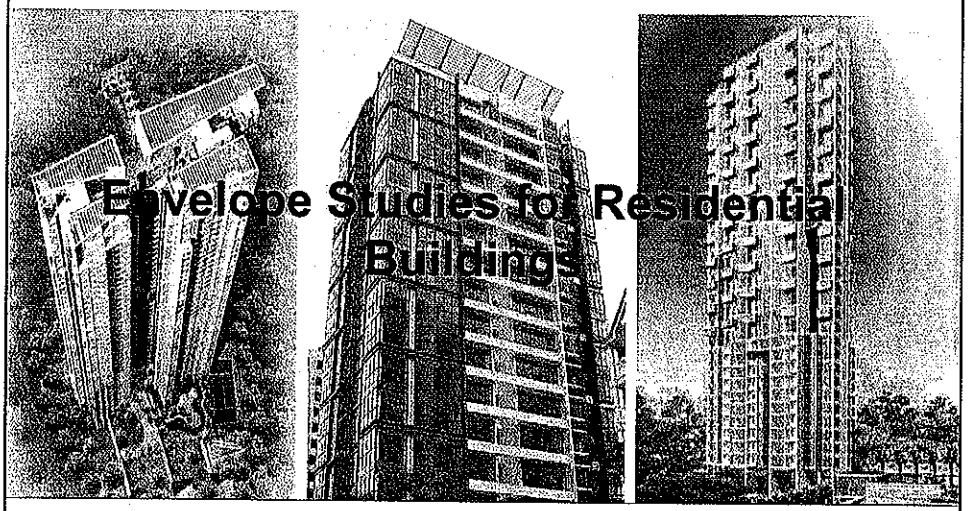
Part 4 - Indoor Environmental Quality

Part 5 – Other Green Features

RETV (Residential Envelope Transmittance Value)



Envelope Studies for Residential Buildings

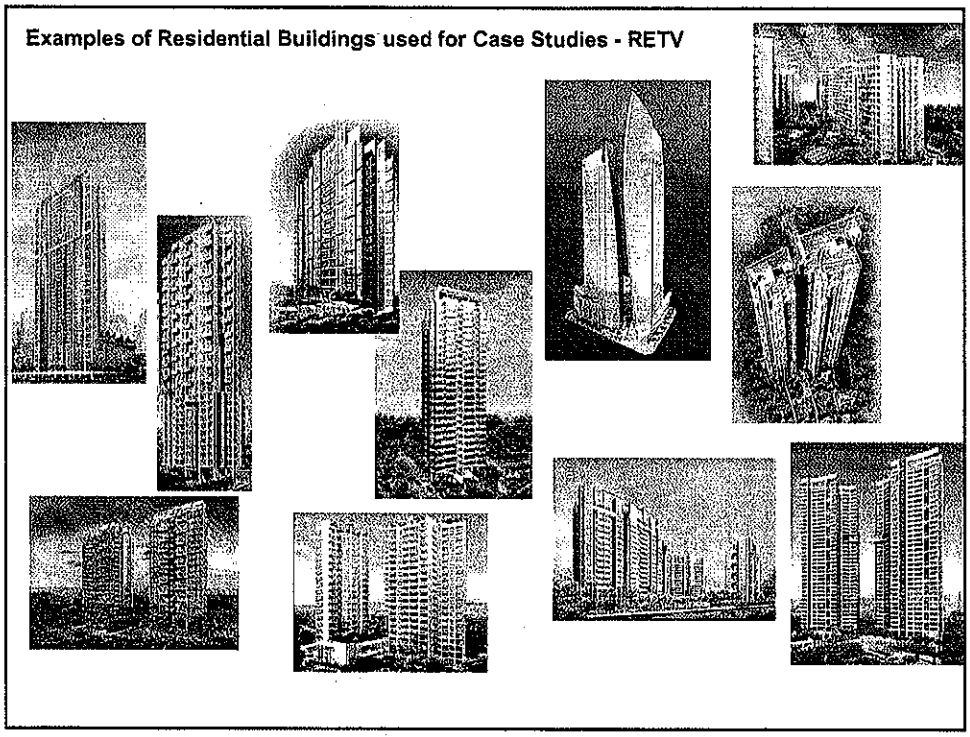
Joint Study with Prof Chou Siaw Kiang

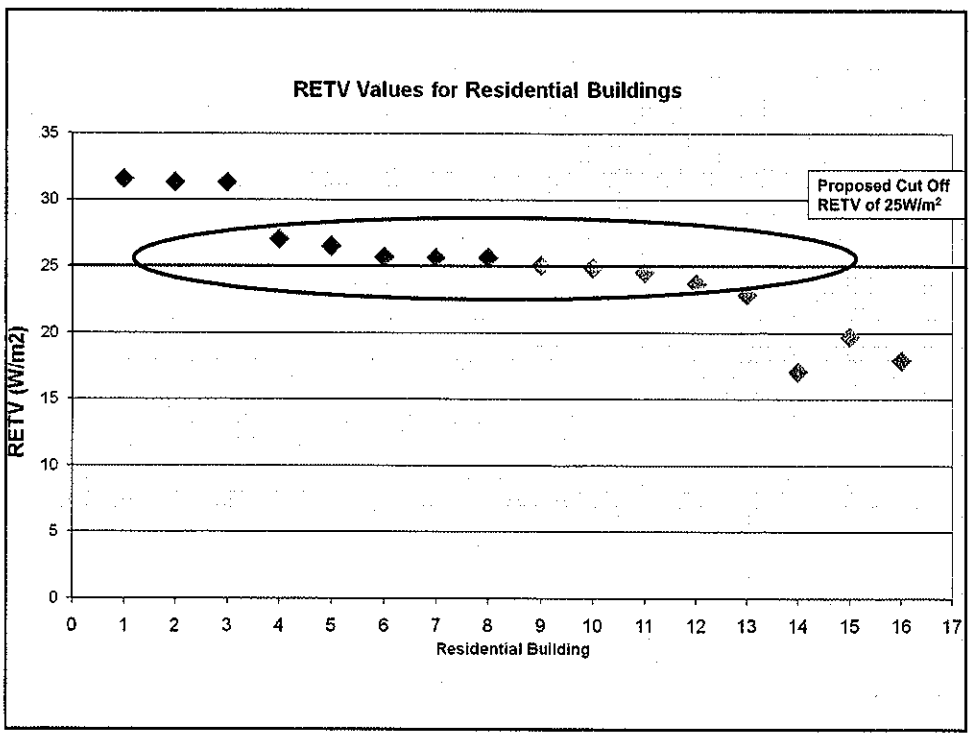
Professor, Department of Mechanical Engineering, NUS

Findings

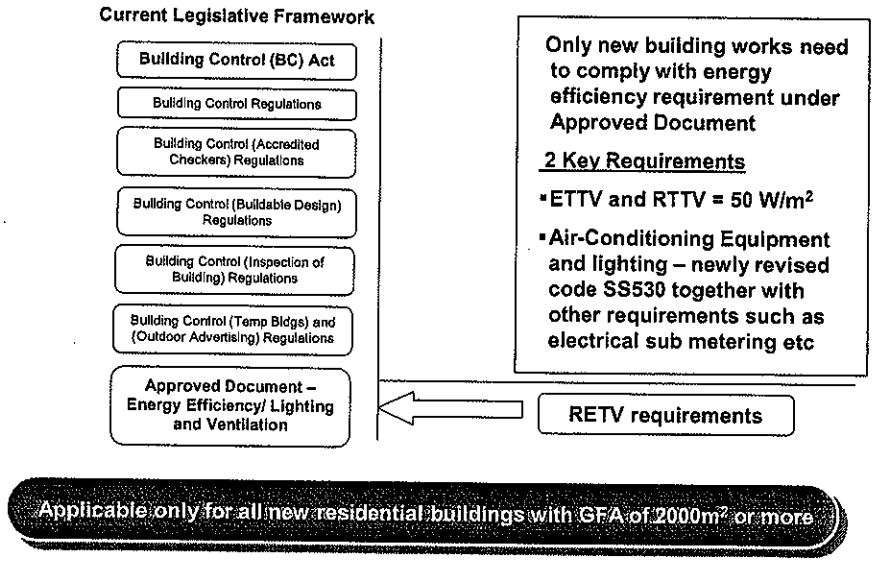
- Usage pattern is different from that of typical air-conditioned commercial building
- Modeling and simulation were carried out
- RETV (Residential Envelope Transmittance value)

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


Examples of Residential Buildings used for Case Studies - RETV


RETV Values for Residential Buildings
RETV (W/m2)
Residential Building
Proposed Cut Off
RETV of 25W/m²
0
5
10
15
20
25
30
35
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

RETV – Part of the Energy Efficiency Requirement under Approved Document



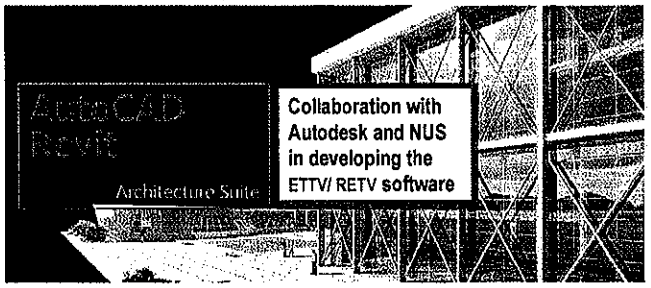
RETV Requirements

- Submission and computation requirements similar to ETTV
- Refer to the new Code on Envelope Thermal Performance for Buildings and Revised Approved Document – Section I – Energy Efficiency

Deem to satisfy provision based on WWR and shading coefficient (SC)

Software Tools

AutoCAD Revit Architecture Suite





Collaboration with NUS to develop a design tool which can be used by engineers, architects and building services professionals to demonstrate compliance with prescriptive and energy performance standards relating residential development (RETV)

Introducing the Building Control (Environmental Sustainability) Regulation

Current Legislative Framework

- Building Control (BC) Act
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- Building Control (Buildable Design) Regulations
- Building Control (Inspection of Building) Regulations
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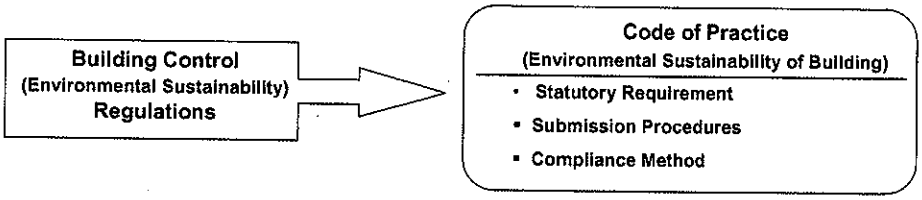
- Approved Document – Energy Efficiency/ Lighting and Ventilation

Proposed New Regulation to be incorporated under BC Act

Building Control (Environmental Sustainability) Regulations 2008

New Building Control (Environmental Sustainability) Regulation

- Code of Practice will spell out the compliance method



Applicable only for all new buildings and existing buildings undergoing major retrofitting works with GFA of 2000m² or more

Responsibilities of QP and Practitioners

Compliance to regulation based on Qualified Person's and Practitioners' Declaration

QP's Responsibility

Who is responsible for the submission ?

Architect

Overall-in-charge to ensure that the minimum environmental sustainability standard is achieved that is Green Mark Score of 50 points

M & E Engineer

To be responsible for their part of the design and the respective points allocated

Definition of Practitioner

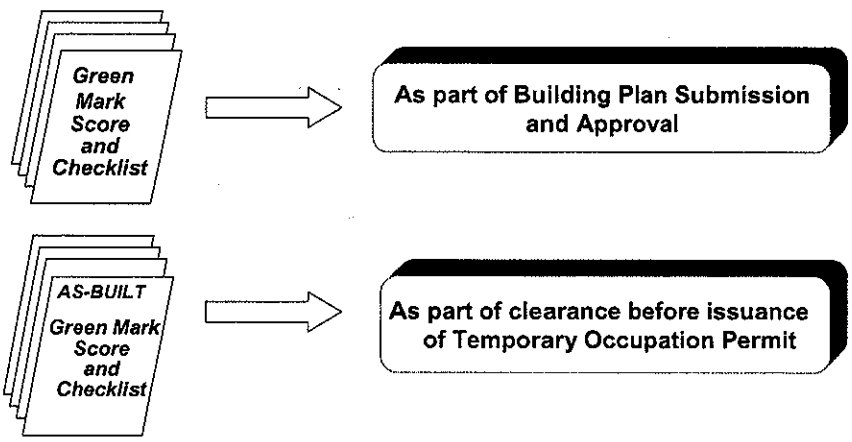
Practitioner in relation to any building works means –

(a) The qualified person appointed to prepare building plans

(b) A professional engineer registered under the Professional Engineers Act in mechanical or electrical engineering who is, under the COP, recognised as competent to certify the related building works

Compliance to Regulation

- Based on Qualified Person's and Practitioners' Declaration

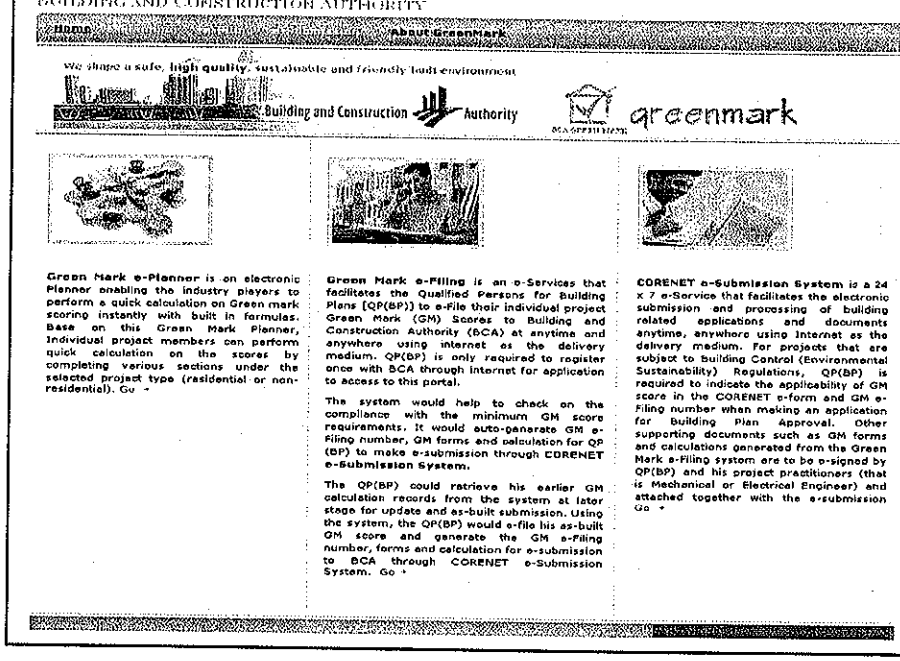


Compliance to Regulation

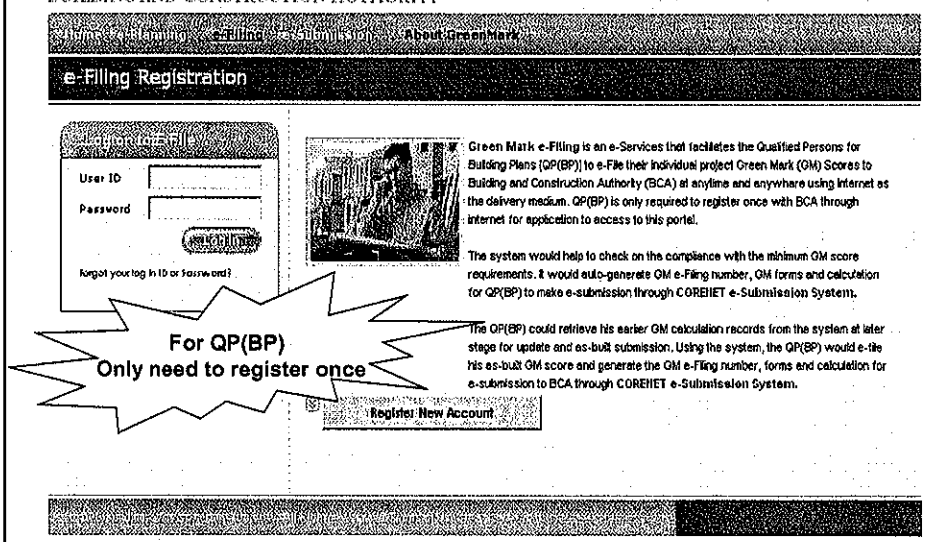
- Random audit and site checks prior or during TOP inspection to be carried out to ensure compliance

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

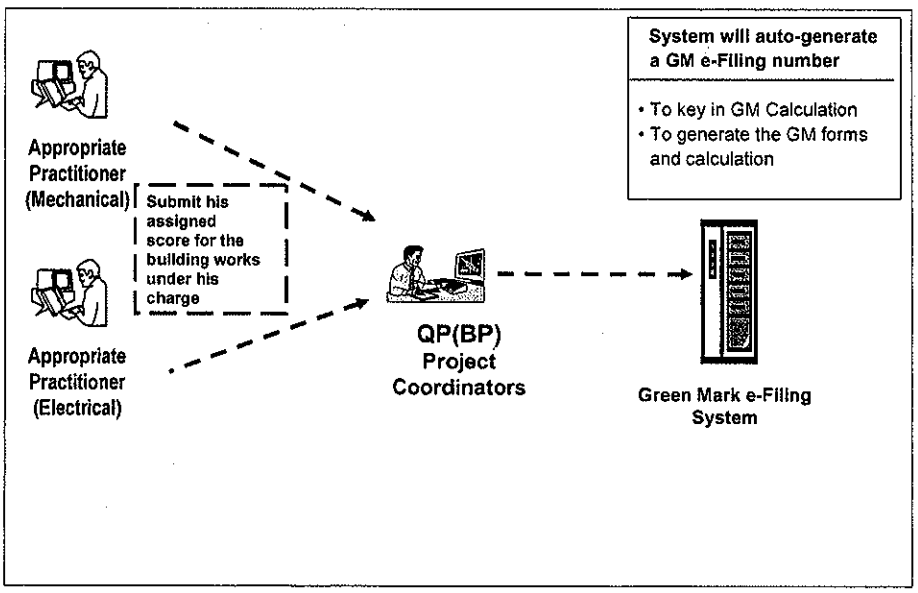
Submission using GM e-Filing and Corenet e-Submission



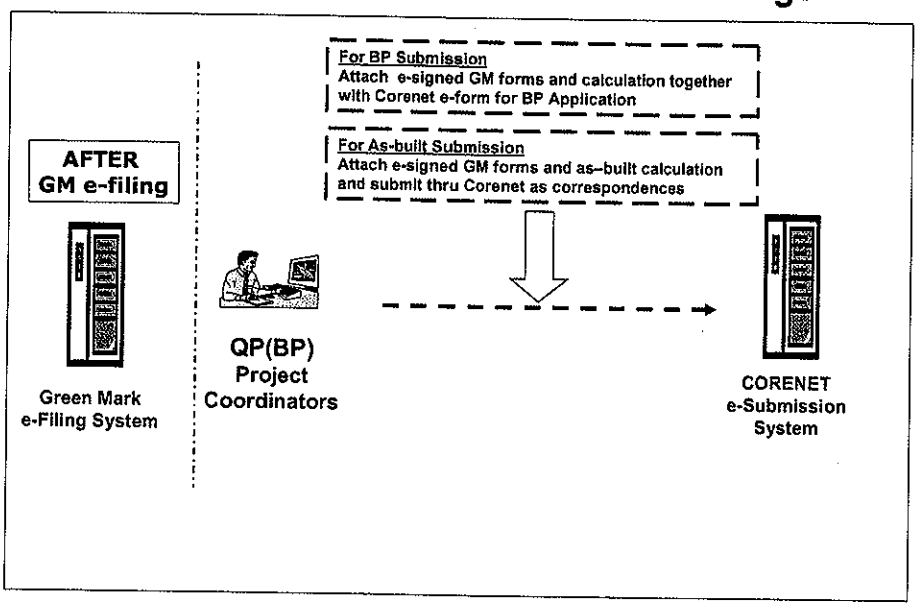
GM e-Filing will be made available at BCA Webpage



Building Plan and As-Built Submission Stage



Building Plan and As-Built Submission Stage



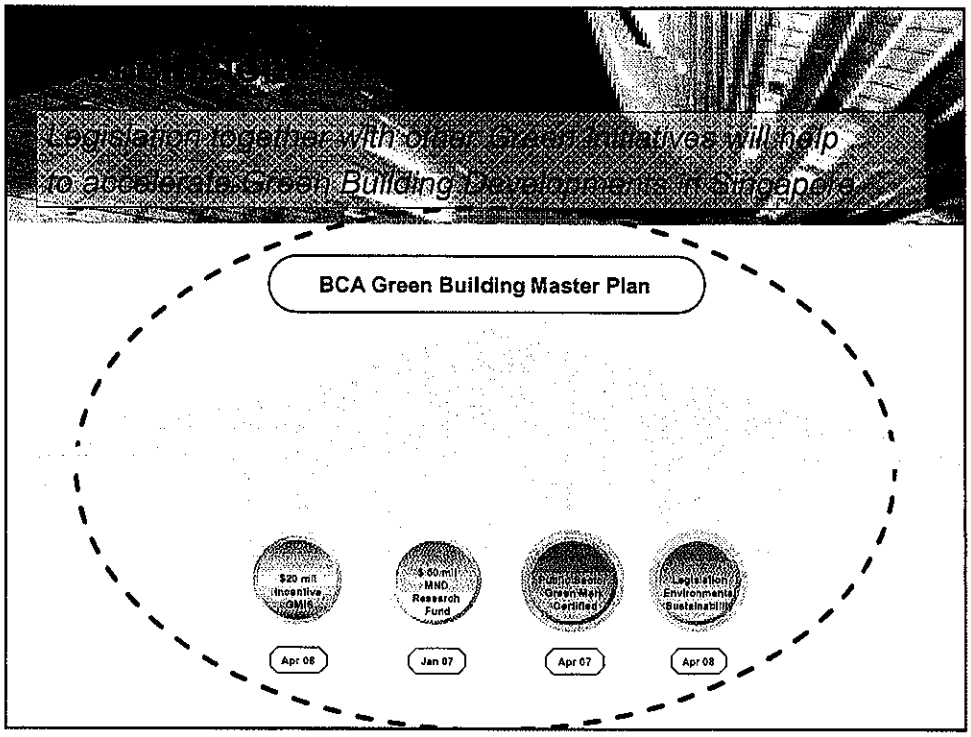
Documentary Evidences

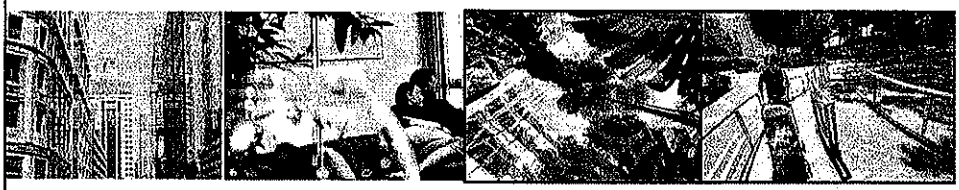
Documentary evidences shall be kept and maintain at the site.

For example :

- Tender specifications or equivalent
- Plan layouts and elevations showing the applicable areas, locations and types of green features
- Computation showing the relevant evidences in meeting the criteria

Submittal of documentary evidences may be required and shall be made in such manner and be in such form as the Commissioner of Building Control requires upon request.





Together we can build a World Class Built Environment

Thank You

BCA GREEN MARK

BCA GREEN MARK CRITERIA
Non-Residential Building

Technology Development Division, BCA

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 30 points)

(Max 50 points *see note 1)

Part 1 - Energy Efficiency

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

NON AIRCON
- 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 Ventilation for Common areas
- 1-8 Lifts and Escalators
- 1-9 Energy Efficient Features
- 1-10 Renewable/Clean energy

TOTAL POINTS AVAILABLE = 79 POINTS

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

Part 3 – Environmental Protection

Part 4 - Indoor Environmental Quality

Part 5 – Other Green Features

TOTAL POINTS AVAILABLE = 61 POINTS

Towards a Sustainable Built Environment

BCA Green Mark Award Rating

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

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/m^2

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

  i.e. full 15 points for ETTV of 42.5 W/m2

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.

  (ai) Air-conditioned Plant (20pt)

  (aii) Air Distribution System (5 pt)

  (b) Unitary Air-conditioners / Condensing Units (25pt)

  (c) Sensor / Automatic Control Devices (2points)

1-2 Air-Conditioning System

- REQUIREMENTS

  (a)(i) Air-conditioned Plant

  Baseline : Minimum efficiency requirement in SS530:2006 and CP13.

  - Chiller, chilled water pump, condenser water pump
    Points=1.45 pts per % improvement i.e. 10% = 14.5pts

  - Cooling Tower
    Points=0.05 pts per % improvement i.e. 10%=0.5pts

  N y plants. (up to 20 points)

1-2 Air-Conditioning System

- REQUIREMENTS

(a)(ii)Air Distribution System

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

Points awarded = 0.5 x (% improvement)
(up to 5 points)

10% improvement = 5 pts

1-2 Air-Conditioning System

- REQUIREMENTS

(b)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.

Points awarded = 1.5 x (% improvement)
(up to 25 points)

10% improvement = 15 pts

1-2 Air-Conditioning System

- District Cooling

For buildings using district cooling system, there is no need to compute the plant efficiency under item (a)(i).

The points obtained will be pro-rated and based on the air distribution system efficiency under item (a)(ii).

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 non-aircon areas > 10% of GFA).

24 pt
- (a) Minimal west facing facade through orientation. (up to 10 points)
- (b)(i) Minimum west facing window
- (b)(ii) Sunshading provision for west windows

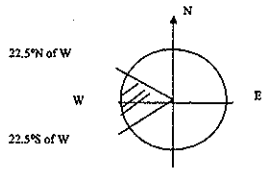
} Up to 10 pts

- (c) Better U-value west wall. (up to 4 points)
- **(d) Better U-value of roof. (up to 5 points)**

1-3a Building Envelope

- REQUIREMENTS

(a) Minimum direct west facing external facade through building design orientation



Points awarded = 10 – 0.2 x (% of direct west facing facade areas over total façade areas)
(Up to 10 points)

i.e. 50% = 0 pts
0% = 10 pts

1-3 Building Envelope

- REQUIREMENTS [to be advised later]

(bi) Minimum west facing window openings.

Points awarded = 10 – 0.1 x (% of west facing window areas over total west facing façade area)

i.e. 0%=10pts, 10%=9pts .....90%= 1pts

(bii) Effective sunshading (30% shading) on west facing window openings.

Points awarded = 0.1 x (% of west facing window areas with effective sunshade over total west facing façade area)

i.e. 0%=0pts, 10%=1pts .....90%= 9pts

max 10 pts for b(i) and b(ii)

1-3 Building Envelope

- REQUIREMENTS

(c) Better thermal transmittance (U-value) of west facing external walls

The U-value of west facing external walls should be equal or less than 2 W/m2K

Points awarded=0.04X(% of ext wall with U-value<2W/m2k over total west facing facade area)
(up to 4 points)

i.e. 100% = 4pts
0% = 0pts

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	0.8
Medium	50 to 230	1.1
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 to reduce the needs of mechanical ventilation (exclude carparks).

- REQUIREMENTS

(a) Proper design of building layout that utilizes prevailing wind conditions to achieve adequate cross ventilation. (up to 8 points)

- *0.8 points for every 10% of units/rooms with window openings facing north and south directions*
- *Points awarded = 0.8 x (% of units/10)*

(b)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)

- *Point will only be awarded provided that the recommendations from ventilation simulations are implemented*

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

Applicable to all - 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 12 points)

Note : If tenant lightings are not provided, the points awarded will be capped at 5 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	1500	3	5	4,500	7,500
			Total	265,800 Σ(AxB)	336,900 Σ(AxC)

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

1-6 Ventilation for Carparks

- AIM

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

- REQUIREMENTS

(a) Carparks designed with 100% natural ventilation (5points)
(b) CO sensor are used to regulate the demand for mechanical ventilation (MV) at basement carparks.

Points awarded based on the mode of mechanical ventilation provided
(1) Fume extract – 4 points OR (2) MV with or without supply - 3 points

1-7 Ventilation for Common Areas

- AIM

  To encourage common areas to be designed for natural or mechanical ventilation – toilets, staircases, corridors, lift lobbies, atriums

- REQUIREMENTS

(a)Natural ventilation – 1.5 points for each area

(b)Mechanical ventilation – 0.5 points for each area

Extent of coverage: at least 90% of the applicable areas

(up to 5 points)

1-8 Lifts and Escalators

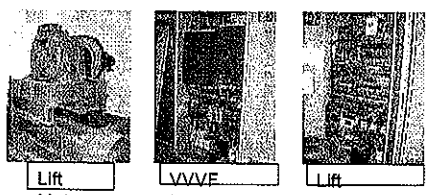
- AIM

  To encourage the use of energy efficient lifts & escalators.

- REQUIREMENTS

(a) Lifts with energy efficient features such as AC variable voltage and variable frequency (VVVF) motor drive (1point) and sleep mode features. (1point)

(b) Escalators with energy efficient features such as motion sensors . (1point)



1-9 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

  a) Computation of energy consumption based on design load in the form of energy efficiency index (EEI).

  (1 point)

  b) 3 points for every 1% reduction in the total energy consumption of the building

  (Up to 11 points)

1-9 Energy Efficient Features

EXAMPLE OF GREEN FEATURES (those not specified in the criteria)

- Use of heat recovery devices
- Light shelves
- Sun pipes
- Motion sensors
- Photo sensors
- Auto-Condenser Tube Cleaning System
- Ductless fan for basement ventilation
- Low-e glass XX

1-10 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

5 points for every 1% replacement of electricity (based on total electricity consumption) by renewable energy

OR

3 points for every 1% replacement of electricity (exclude tenant's usage) by renewable energy

(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

B
- 1-3 Building Envelope – Design/Thermal Parameters
- 1-4 Natural Ventilation

C
- 1-5 Artificial Lighting
- 1-6 Ventilation at Common Areas and Carparks
- 1-7 Ventilation for Common Areas
- 1-8 Lifts and Escalators
- 1-9 Energy Efficient Features

Bonus
- 1-10 Renewable/Clean energy

TOTAL POINTS A+B+C = 79 POINTS
(Cap at 50 points)

2-1 Water Efficient Fitting

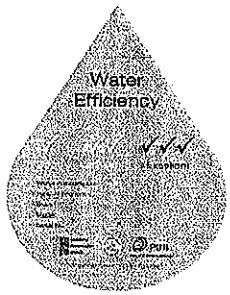
AIM

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

REQUIREMENTS

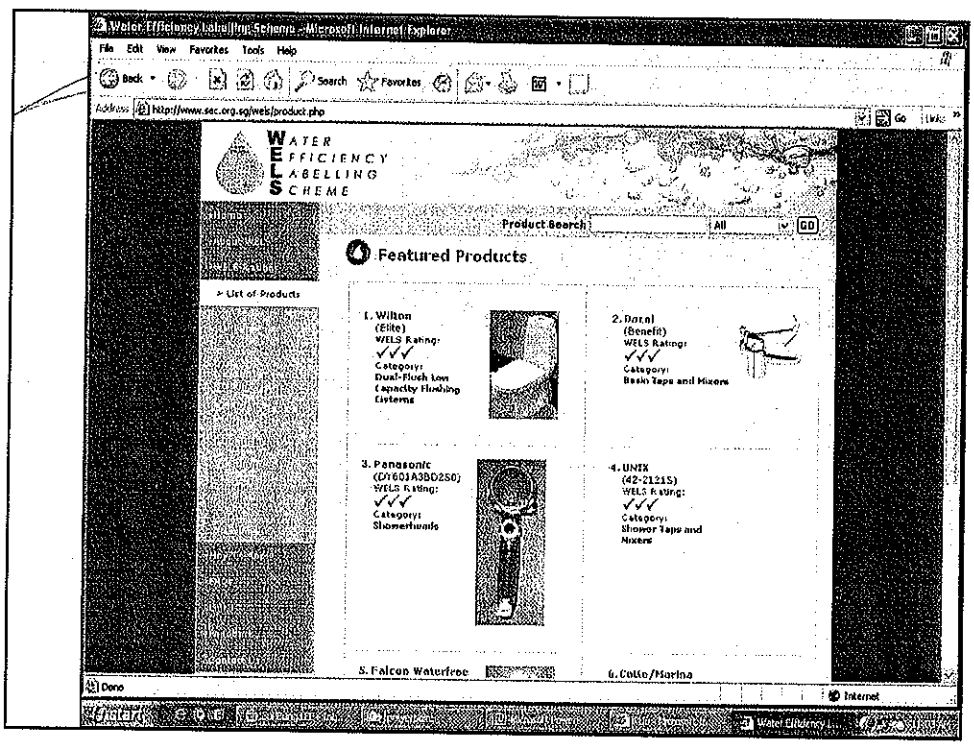
Points shall be awarded for selection of PUB's Water Efficiency Labelling Scheme (WELS)

(up to 8 points)



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

Towards a Sustainable Built Environment



2-1 Water Efficiency

	Rating based on WELS		
Water Efficient Labelling Scheme	**Good** ✓	**Very Good** ✓✓	**Excellent** ✓✓✓
Shower taps and mixers, showerheads, basin taps and mixers, sink/bib taps and mixers, dual-flush low capacity flushing cisterns, urinals and urinal flush valves, clothes washing machines	**4 points**	**6 point**	**8 points**

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 and tenants.(1point)

Linking all sub-meters to BMS to provide a leak detection system. (1point)

2-3 Irrigation System

AIM

To reduce the consumption of PUB water for landscape irrigation.

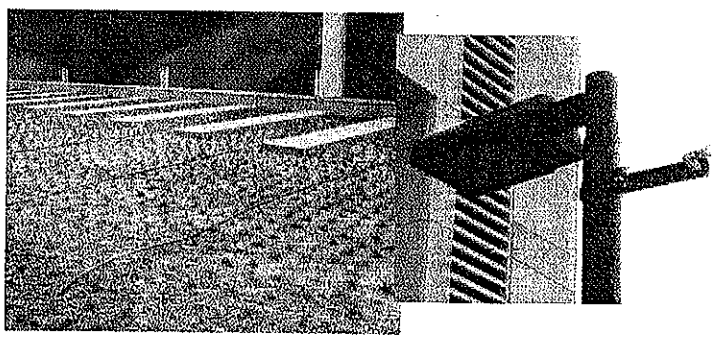
REQUIREMENTS

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

- Use of non potable water such as rainwater collection system (1 point)
- Use of efficient irrigation system (1 point)

2-3 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



2-4 Water Consumption of CoolingTower

- AIM

  To reduce potable water use for cooling purpose.

- REQUIREMENTS

Applicable for Buildings with Water-based Building Cooling Systems

(a) Use of cooling tower water treatment which can achieve 6 or more cycles of concentration (1 point)

(b) Use of NEWater and recycled water. (1 point)

3-1 Sustainable Construction

AIM

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

REQUIREMENTS

Encourage efficient concrete usage for building components

0.1 point for every percentage reduction in the prescribed Concrete Usage Index (CUI) limit for residential buildings (up to 4 points)

3-1 Sustainable Construction

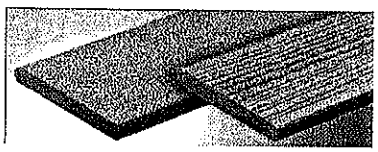
REQUIREMENTS

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

Use of environmental friendly materials (up to 4 points) or recycled material (up to 4 points)

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

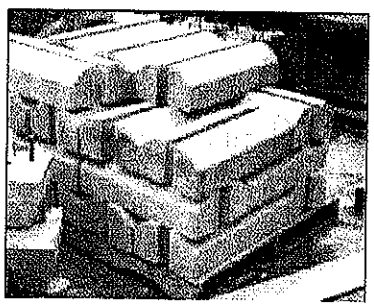


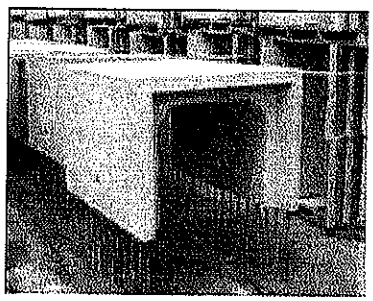


3-1 Sustainable Construction - Example

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 drywall partitions using recycled materials in >50% floor area (1 point)





3-2 Greenery

AIM

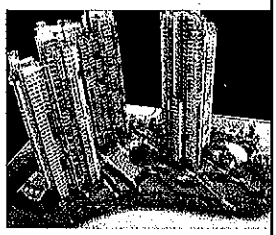
To recognize and encourage greater use of greenery to reduce urban heat island and also to conserve existing natural wherever possible and to restore them

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 (m^2)	140	NA	NA	3	420
landscape area + roof garden area + vertical greening (m^2)	1850	NA	NA	1	1850
				Total green area	**4829.1**

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

3-3 Environmental Management Practice

- AIM

The objectives are to recognize and encourage the adoption of environmental friendly management practice during construction and also later the operation of the buildings.

- REQUIREMENTS

(a) Implement effective environment management programme including monitoring and setting targets to minimise energy use, water use and construction waste. (1 point)

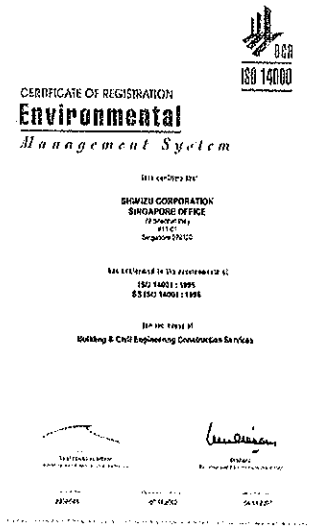
(b) Building quality assessed under Construction Quality Assessment System (CONQUAS) (1 point)

3-3 Environmental Management Practice

- REQUIREMENTS

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

(d) Project team comprises at least one Green Mark Manager (1 Pt) and/or one Green Mark Professional(2 pt)
(up to 3 points)


BSI
ISO 14000
CERTIFICATE OF REGISTRATION
Environmental
Management System
SHIMIZU CORPORATION
SINGAPORE OFFICE
ISO 14001 : 1996
BS ISO 14001 : 1996
Building & Civil Engineering Construction Services

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 for collection and storage of different recyclable waste such as paper, glass, plastic etc. (1point)

3-4 Public Transport Accessibility

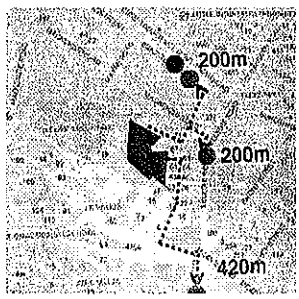
AIM

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

REQUIREMENTS

Provisions for good access to public transport such as MRT/LRT or bus stops (1 point)

Provisions for adequate bicycles parking lots (1 point)



3-5 Refrigerants

- AIM

  To reduce the impact of refrigerants on environmental sustainability.

- REQUIREMENTS

Applicable for Buildings with Air-Conditioning System

Use of refrigerant leak detection system at critical areas of plant rooms containing chillers and other equipments with refrigerants. (1point)

Refrigerants with zero ozone depletion potential (ODP) or with global warming potential of less than 100. (1point)

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%

(2 points)

4-2 Noise Level

- AIM

  To noise levels are maintained at an appropriate level.

- REQUIREMENTS

Applicable for aggregate air-conditioned areas > 500 m2

Occupied spaces in buildings are designed with good ambient sound levels as recommended in SS CP 13. (2points)

4-3 Indoor Air Pollutants

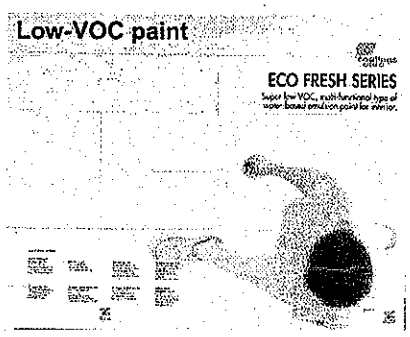
- AIM

  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 OR no composite wood product used. (1point)



4-4 High Frequency Ballasts

- AIM

  To enhance the visual performance of the environment.

- REQUIREMENTS

Applicable for offices, classrooms and the like

High frequency ballasts installed in fluorescent luminaries.

At least 90% of Area covered by fluorescent lightings (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

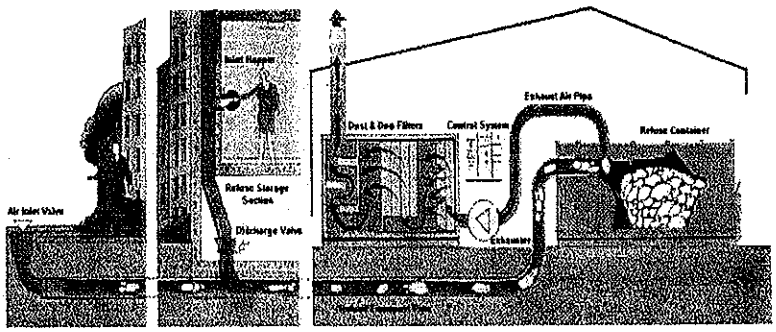
1 points for medium impact item

0.5 point for low impact item

(up to 7 points)

5 Other Green Features - Examples

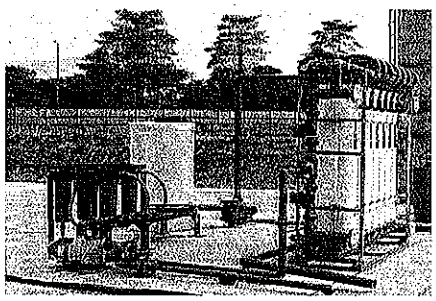
Use of pneumatic waste collection system (1 point)

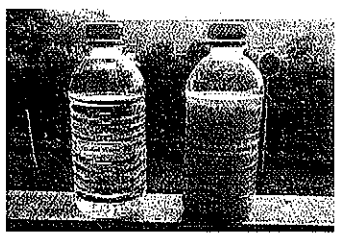


System Overview

5 Other Green Features - Examples

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





5-1 Other Green Features

Criteria	Green Mark Points
Water Efficiency	
•Use of self cleaning façade system for more than 75% of the external walls •Use of grey water recycling system for all blocks	2 points (each item)
•Use of self cleaning façade system for between 51% to 75% of the external walls •Use of grey water recycling system for at least one of the block •Recycling of AHU condensate (more than 75% of AHUs)	1 point (each item)
•Use of self cleaning façade system for between 25% to 50% of the external walls •Use of membrane filtration system to recycling water during construction •Recycling of AHU condensate (50% to 75% of AHUs) •Non-Chemical Water Treatment for Cooling Tower	0.5 points (each item)

5-1 Other Green Features

Environment Protection	Green Mark Points
•Provision of green roof and roof top garden for more than 50% of the roof areas •Provision of vertical greening for more than 50% of the external surface areas	1 point (each item)
•Provision of green roof and roof top garden for 25% to 50% of the roof areas •Provision of vertical greening for at least 25 to 50% of the external surface areas •Use of non-chemical water treatment for swimming pools •Use of non-chemical terminate treatment system such as termite baiting system, anti-termite mesh, etc •Self production of compost by recycling organic waste such as leaves, pruning etc with at least 5 nos. of compost bins	0.5 points (each item)

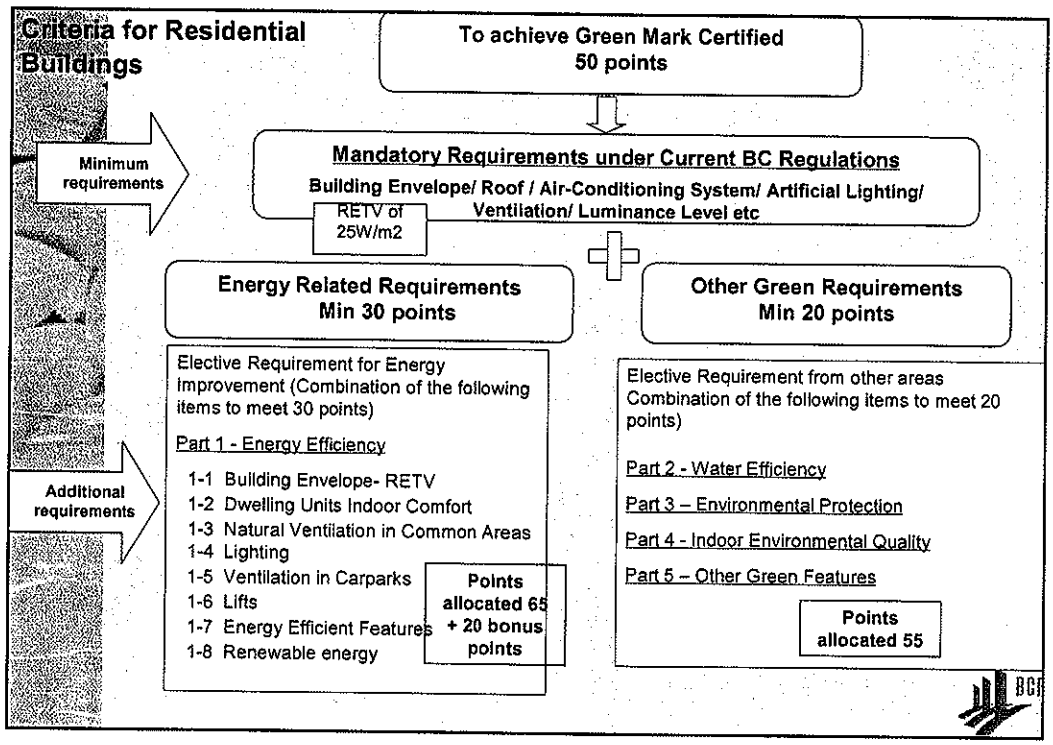
5-1 Other Green Features

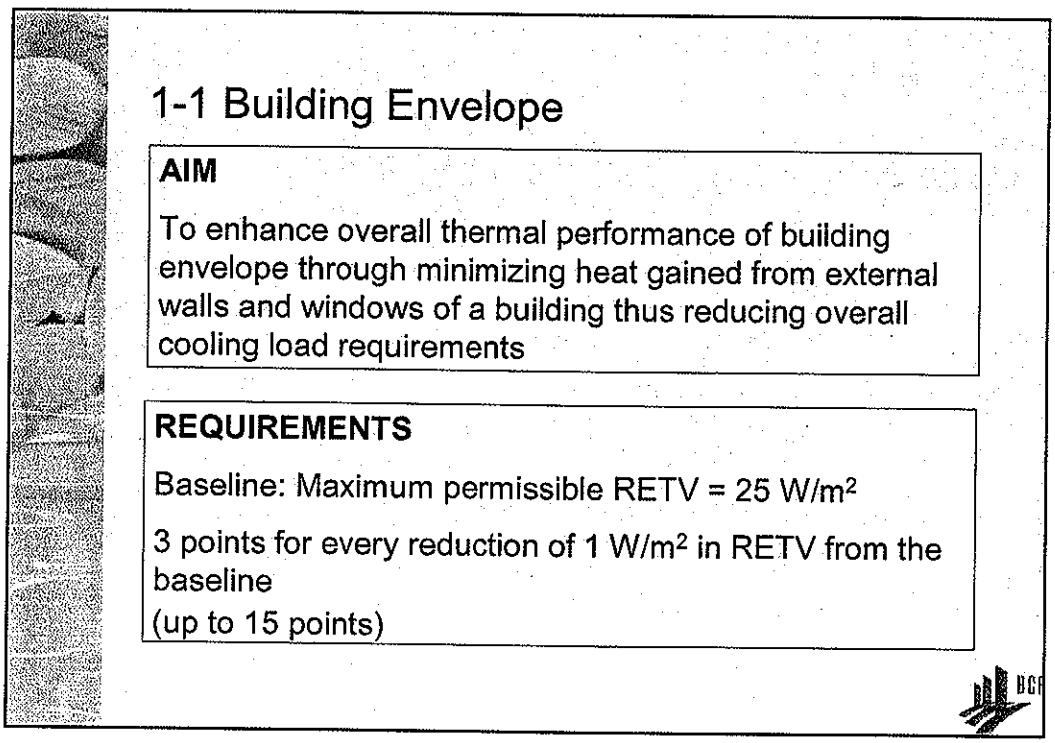
Indoor Air Quality	
•Double refuse chutes for separation of recyclable from non-recyclable waste with pneumatic waste collection system	2 points (each item)
•Single refuse chute with pneumatic waste collection system •Use of Titanium Dioxide solutions to remove odour for more than 50% of the toilets	1 point (each item)
•Use of Titanium Dioxide solutions to remove odour for between 25% to 50% of the toilets •UVC emitters in all AHUs to improve indoor air quality	0.5 points (each item)

Thank You

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

www.greenmark.sg


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 25W/m2
Energy Related Requirements
Min 30 points
Other Green Requirements
Min 20 points
Additional requirements
Elective Requirement for Energy improvement (Combination of the following items to meet 30 points)
Part 1 - Energy Efficiency
1-1 Building Envelope- RETV
1-2 Dwelling Units Indoor Comfort
1-3 Natural Ventilation in Common Areas
1-4 Lighting
1-5 Ventilation in Carparks
1-6 Lifts
1-7 Energy Efficient Features
1-8 Renewable energy
Points allocated 65 + 20 bonus 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
Points allocated 55


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
(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	8mm-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	12.75mm-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 and 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

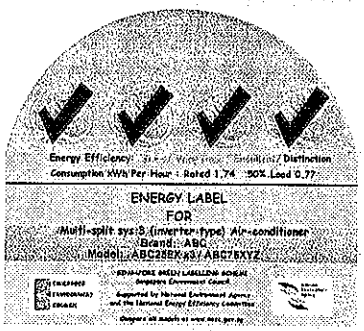
Extent of coverage: at least 90% of the dwelling units' air-conditioners

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 - 12 points



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

1-3 Natural Ventilation in Common Areas

AIM

To encourage the design of natural ventilation in common areas such as lift lobbies, corridors and staircases to reduce the needs of mechanical ventilation

REQUIREMENTS

Natural ventilation in common areas such as

- lift lobby and corridors (1 point)
- staircases (1 point)

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

0.3 points for every percentage improvement above the baseline (up to 12 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 = 0.3 x (30.6%)
= 9.18 points

Type of usage	Total Area (A)	Proposed Design W/m² (B)	Reference Design (SS530) W/m² (C)	Proposed Design Load (Ax B)	Reference Design Load (A x C)
Staircases	860	5	6	4,300	5,160
Corridors	1,540	7	10	10,780	15,400
Car parks	780	3.5	5	2,730	3,900
Exterior lighting	1,750	3	5	5,250	8,750
			Total	23,060	33,210





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 = 0.3 x (63.4%)
= 12 points

Type of usage	Total Area (A)	Proposed Design W/m² (B)	Reference Design (SS530) W/m² (C)	Proposed Design Load (Ax B)	Reference Design Load (A x C)
Staircases	860	3	6	2,580	5,160
Corridors	1,540	3.5	10	5,390	15,400
Car parks	780	2	5	1,560	3,900
Exterior lighting	1,750	1.5	5	2,625	8,750
			Total	12,155	33,210



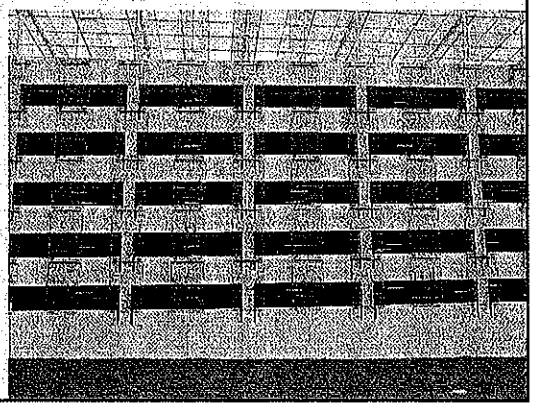
1-5 Natural Ventilation in Carparks

AIM

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

REQUIREMENTS

Carpark designed with 100% natural ventilation – such as multi-storey carpark (8 points)



1-5 Natural Ventilation in 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

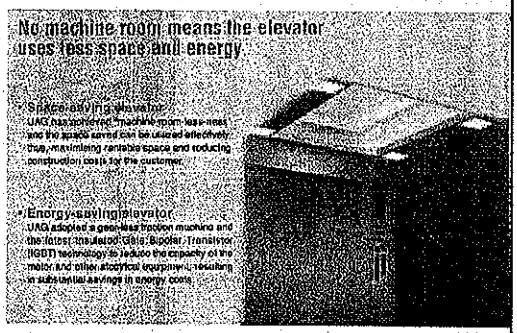
Fume extract – 6 points

MV with or without supply – 4 points



CO monitoring

1-6 Lifts



AIM

To recognize and encourage energy efficient lifts

REQUIREMENTS

Use lifts with AC variable voltage and variable frequency (VVVF) motor drive or equivalent (1 point)

Lifts with energy efficient features such as sleep mode (1 point)

1-7 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

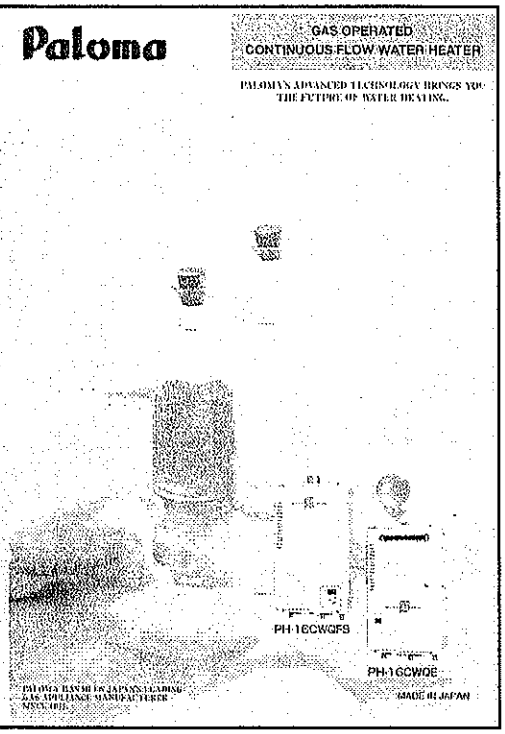
1 points for medium impact item

0.5 point for low impact item

(up to 7 points)

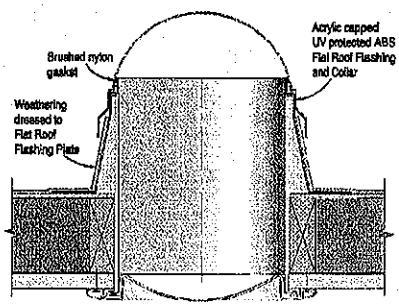
1-7 Energy Efficient Features - Examples

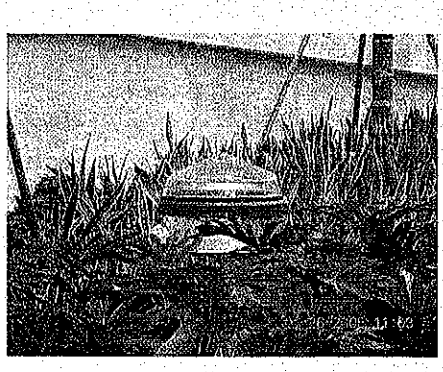
Use of gas water heater in at least 90% of the dwelling units (1 point)



1-7 Energy Efficient Features - Examples

Use of at least 5-10 nos. of sun pipes for natural lighting (0.5 points)





1-8 RenewableEnergy (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

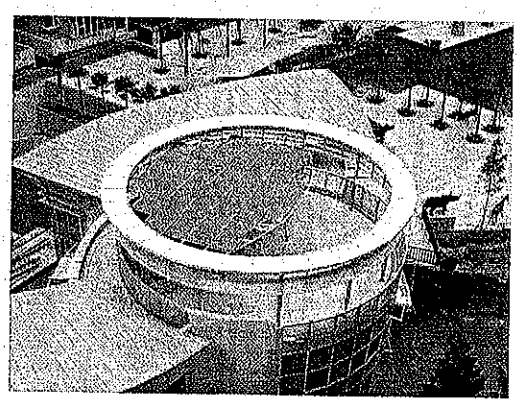
1 point for every 1% replacement of electricity (exclude household's usage) by renewable/ clean energy

(up to 20 points)

1-8 Renewable 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	16	12	•4 ticks A/C
1-3	Natural ventilation in common areas	2	2	•cross ventilation in common areas such as lift lobbies and staircase (2)
1-4	Lighting	15	10	•using PLC at lobbies and T8 lighting at car park (8) •Using daylighting at staircase and lift lobbies (2)
1-5	Lifts	2	2	•VVVF lift with sleep mode
1-6	Natural ventilation in car parks	8	4	•car park with CO (4)
1-7	Energy efficient features	7	0	Nil
1-8	*Renewable/ clean energy*	*20*	*0*	Nil *(Bonus points)*
	Sub-total for Energy Efficiency	**65 + 20 Bonus Pt**	**30**	

2-1 Water Efficient Fitting

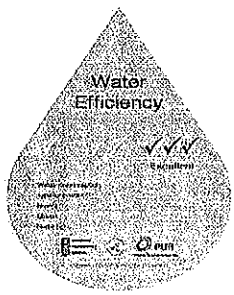
AIM

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

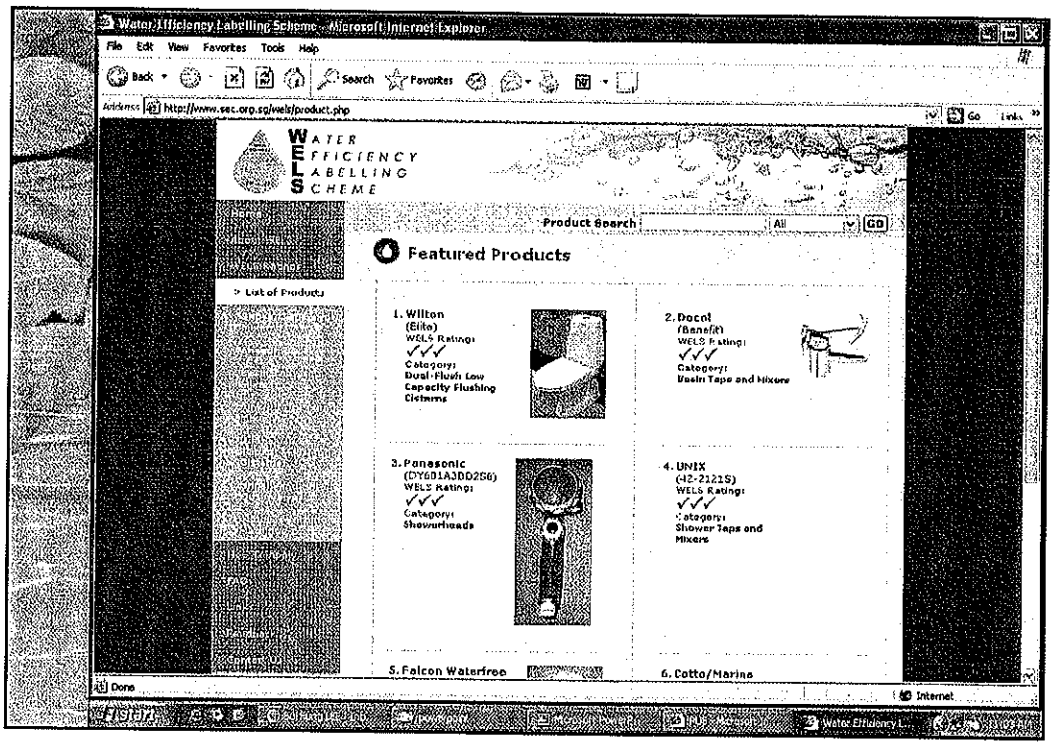
REQUIREMENTS

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

(up to 10 points)



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



2-1 Water Efficient Fitting

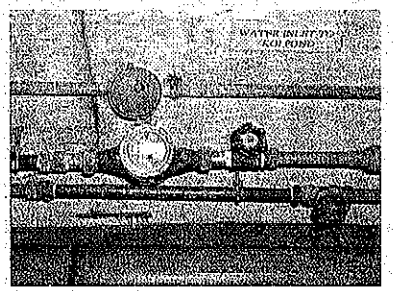
Extent of coverage:
At least 90% of the dwelling units' water fitting type used

	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 – 1 point

2-3 Irrigation System

AIM

To reduce the consumption of PUB water for landscape irrigation.

REQUIREMENTS

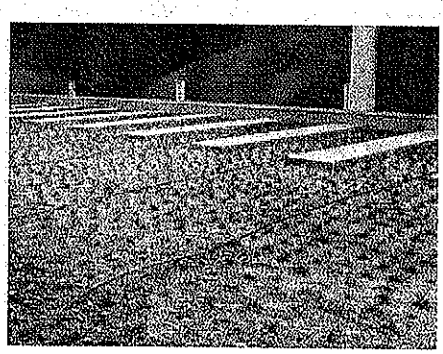
Reduce or eliminated the use of PUB water for site irrigation by the following

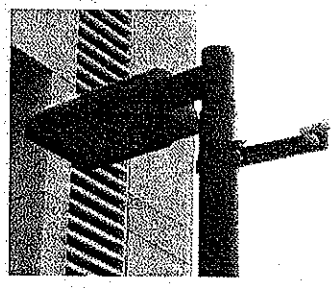
- Use of non potable water such as
  rainwater collection system (1 point) $10 m^3$
- Use of efficient irrigation system (1 point)

2-3 Irrigation System

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 encourage the adoption of building designs, construction practices and materials that are environmentally friendly and sustainable

REQUIREMENTS

Encourage efficient concrete usage for building components

0.1 point for every percentage reduction in the prescribed Concrete Usage Index (CUI) limit for residential buildings (up to 4 points)

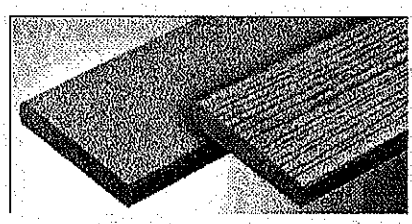
3-1 Sustainable Construction

REQUIREMENTS

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

Use of environmental friendly materials (up to 3 points) or recycled material (up to 3 points)

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

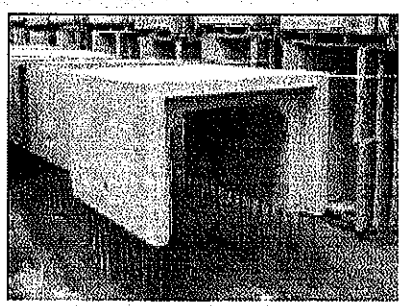


3-1 Sustainable Construction - Example

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 drywall partitions using recycled materials in every dwelling units (1 point)





3-2 Greenery

AIM

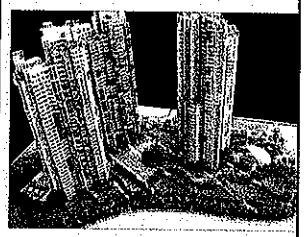
To recognize and encourage greater use of greenery to reduce urban heat island and also to conserve existing natural wherever possible and to restore them

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 (m²)	140	NA	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 practice during construction and also later the operation of the building

REQUIREMENTS

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

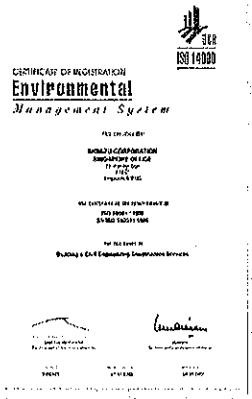
Adoption of CONQUAS and Quality Mark (2 points)

3-3 Environmental Management Practice

REQUIREMENTS

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

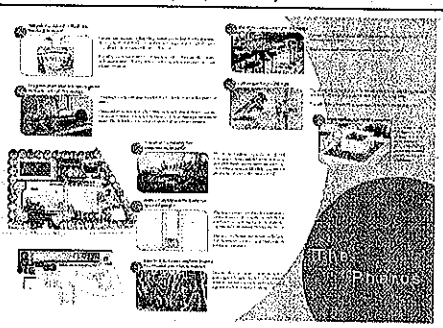
Project team comprises
•one Certified Green Mark Manager (1 point)
•one Certified Green Mark Professional (2 points)

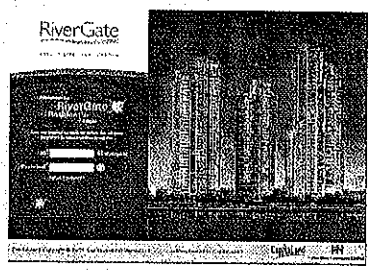


3-3 Environmental Management Practice

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)





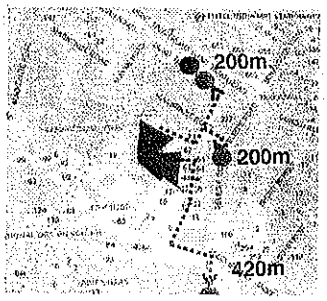
3-4 Public Transport Accessibility

AIM

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

REQUIREMENTS
Provisions for good access to public transport such as MRT/LRT or bus stops (1 point) shuttle bus stop - LRT.

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}

(1 point)

If development is near to a major road, a report from Acoustic Consultant is required to verify how the noise level is achieved.

4-2 Indoor Air Pollutants

AIM

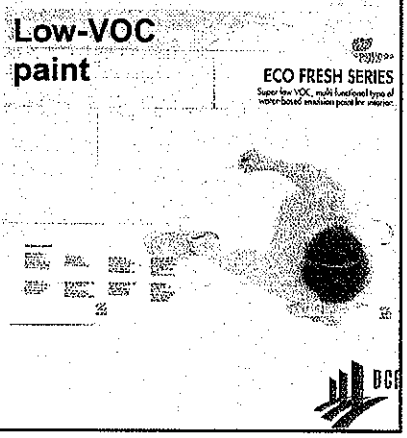
To recognize development that make effort to reduce sources of indoor pollutants.

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

(1 point)

4-4 Indoor Air Quality in Wet Areas

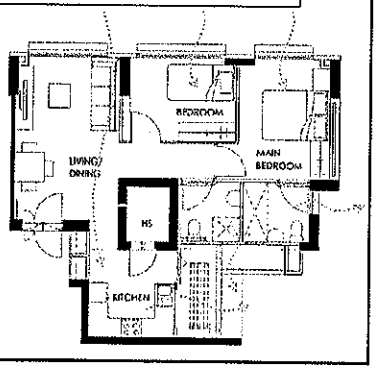
AIM

To recognize development that ensure good indoor air quality to wet areas such as kitchen, bathrooms and toilets through sufficient natural ventilation and day lighting

REQUIREMENTS

Provision of window opening at kitchen, bathrooms and toilets for sufficient natural ventilation and day lighting

(1 point)



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

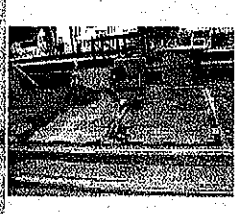
1 points for medium impact item

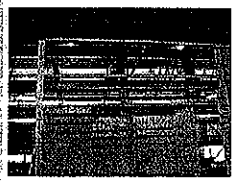
0.5 point for low impact item

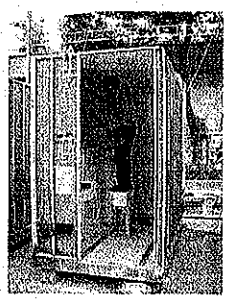
(up to 7 points)

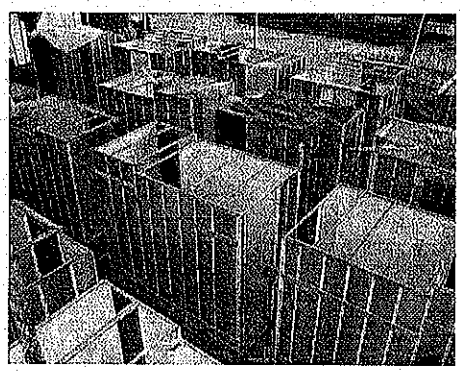
5 Other Green Features - Examples

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



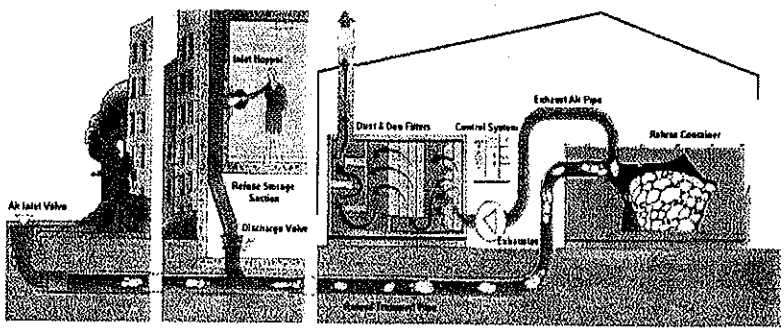






5 Other Green Features - Examples

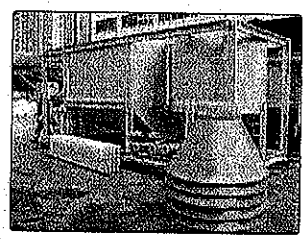
Use of pneumatic waste collection system (1 point)

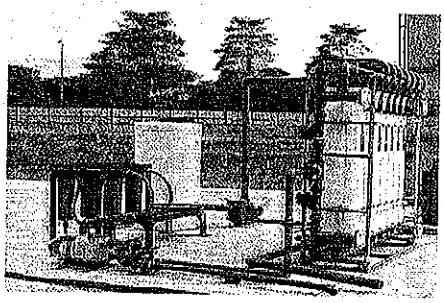


System Overview

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 fitting	10	2	•Water fittings with WELS good rating
2-2	Water usage	1	1	•Provision of sub-metering to major water usage such as irrigation and swimming pool
2-3	Irrigation System	2	0	
3	Environment Protection			
3-1	Sustainable construction	12	4	•Use of recycled materials for internal doors, drywalls partitions and wardrobe •Use of green label waterproofing for internal wet areas
3-2	Greenery	6	3	•Greenery provision (2) •Use of compost recycled from horticulture waste (1)
3-3	Environmental Management Practice	9	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

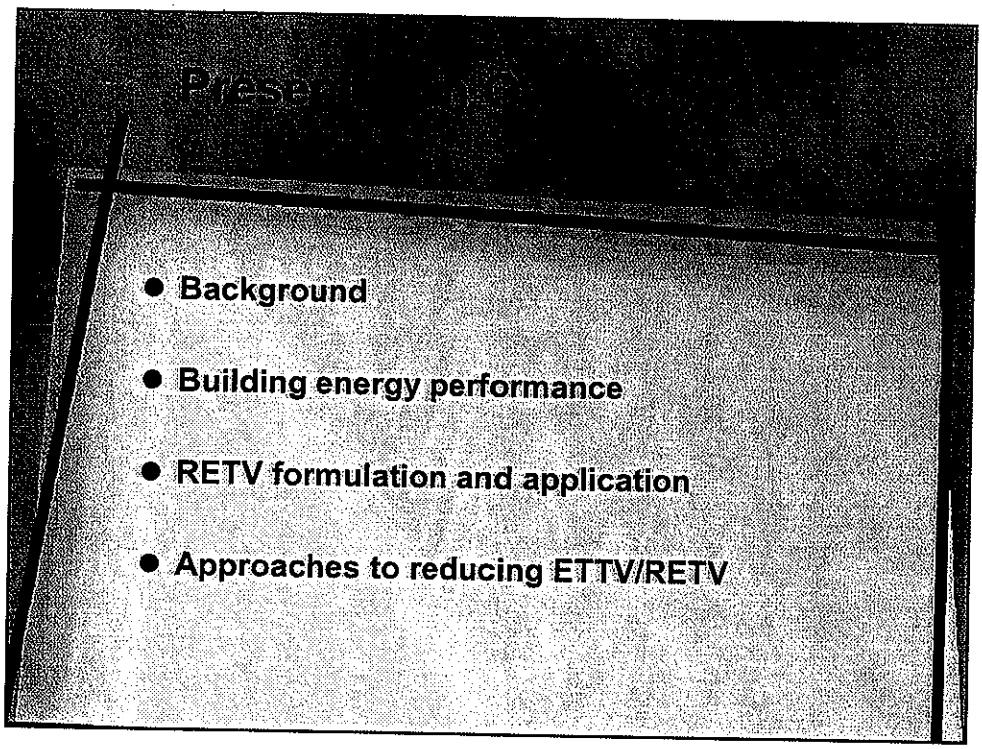
Item	Criteria	Points available	Actual points score	Remarks
3-4	Public Transport Accessibility	2	2	•Within 500m from bus stop or provision of shuttle bus (1) •Provision of bicycle parking lots (1)
4	Indoor Environmental Quality			
4-1	Noise level	1	1	•Tender specified design noise level
4-2	Indoor air 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	Indoor Air Quality in Wet Areas	1	1	•Provision of window opening at kitchen, bathroom and toilets
5	Other Green Features			
5-1	Other Green Features	7	0	
	Sub-total for other green requirements	**55**	**20**	

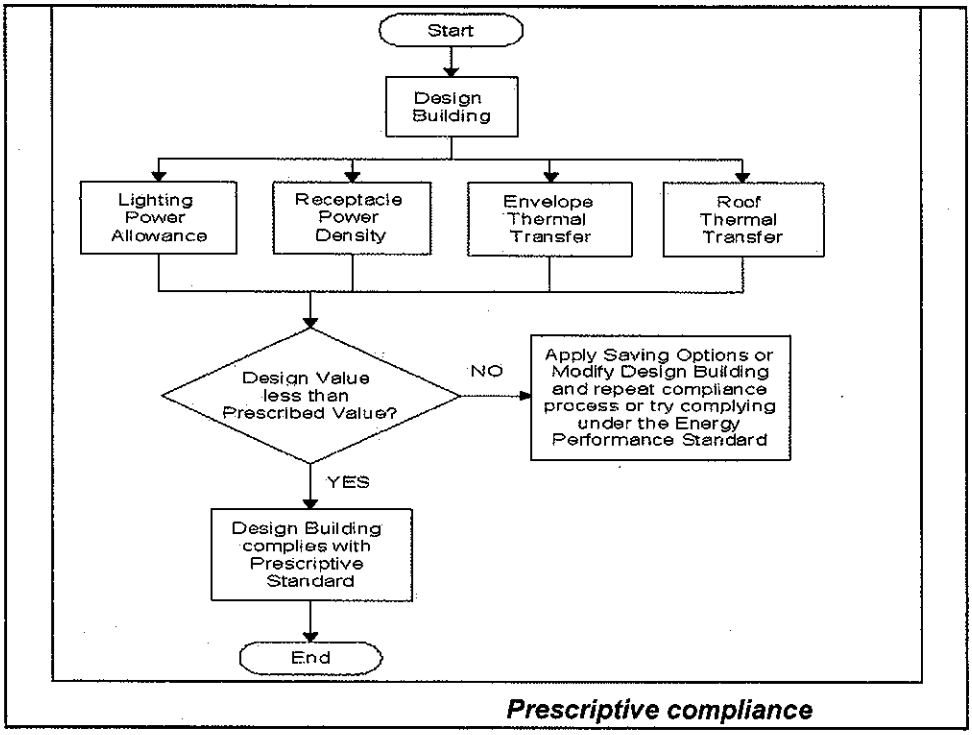


BCA Industry Briefing

New Indicator for the Thermal Performance of a Building Envelope for Residential Development (RETV)

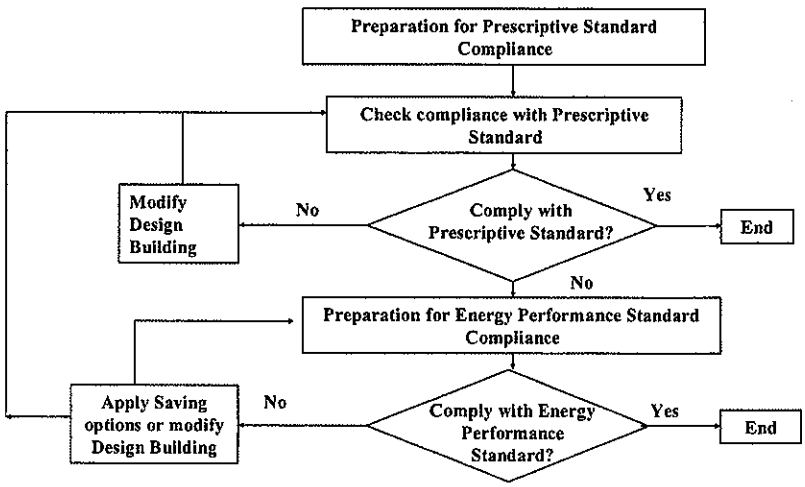
S.K. Chou
Dept of Mechanical Engineering, NUS
3 and 7 March 2008

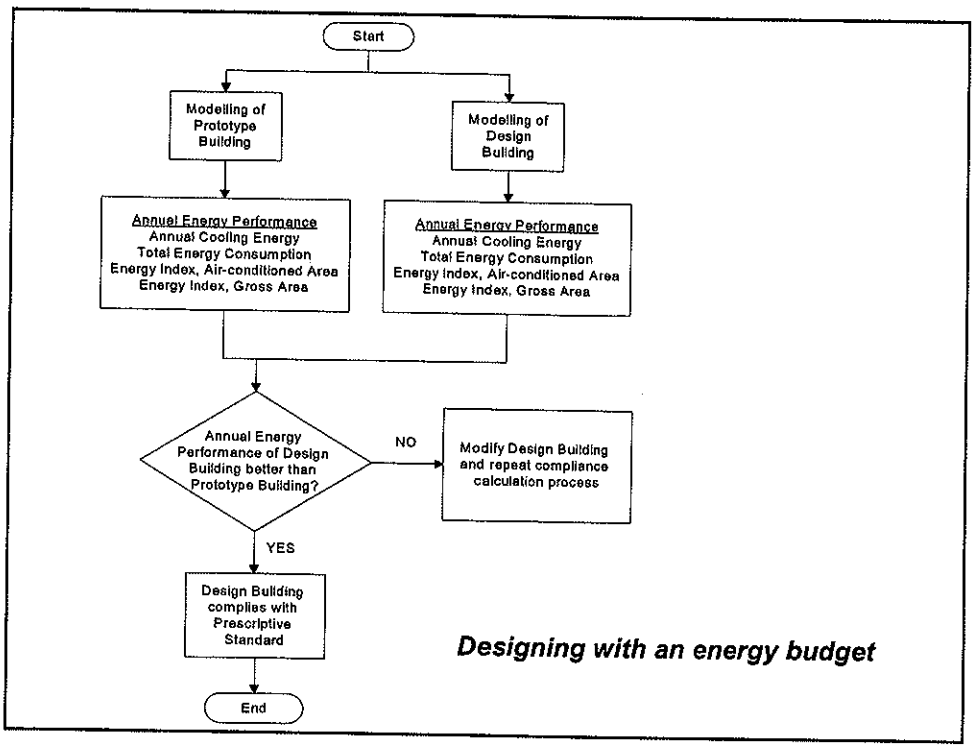




Prescriptive compliance

Designing for Energy Performance





The Envelope Thermal Transfer Equation - ETTV

$$ETTV = \frac{(Aw \times Uw \times TDeq) + (Af \times Uf \times \Delta T) + (Af \times SC \times SF)}{Ao}$$

$$ETTV = TDeq(1 - WWR)Uw + \Delta T(WWR)Uf + SF(WWR)(CF)(SC)$$

The ETTV formula is given as follows:

$$ETTV = 12(1 - WWR)U_w + 3.4(WWR)U_f + 211(WWR)(CF)(SC)$$

where

ETTV	=	envelope thermal transfer value (W/m^2)
WWR	=	window-to-wall ratio (fenestration area / gross area of exterior wall)
U_w	=	thermal transmittance of opaque wall (W/m^{2}K)
U_f	=	thermal transmittance of fenestration (W/m^{2}K)
CF	=	correction factor for solar heat gain through fenestration
SC	=	shading coefficients of fenestration

Residential Envelope Transmittance Value - RETV

The RETV formula is given as follows:

$$RETV = 3.4(1 - WWR)U_w + 1.3(WWR)U_f + 58.6(WWR)(CF)(SC)$$

where

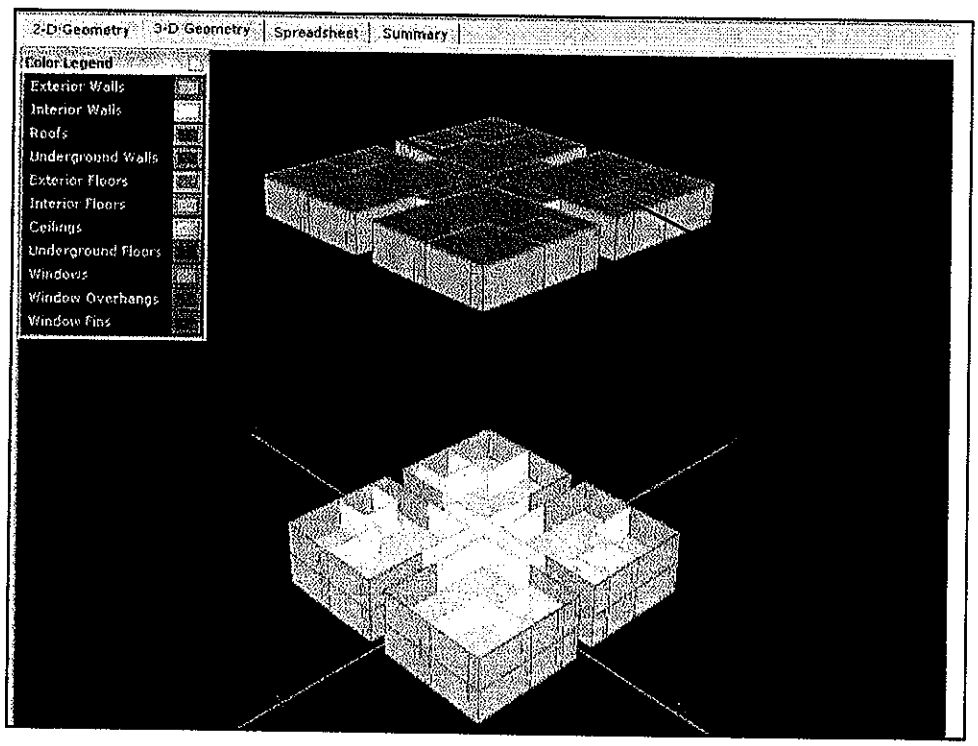
RETV	**= residential envelope transmittance value (W/m2)**
WWR	**= window-to-wall ratio (fenestration area/gross area of exterior wall)**
Uw	**= thermal transmittance of opaque wall (W/m2 oK)**
Uf	**= thermal transmittance of fenestration (W/m2 oK)**
CF	**= correction factor for solar heat gain through fenestration**
SC	**= shading coefficients of fenestration**

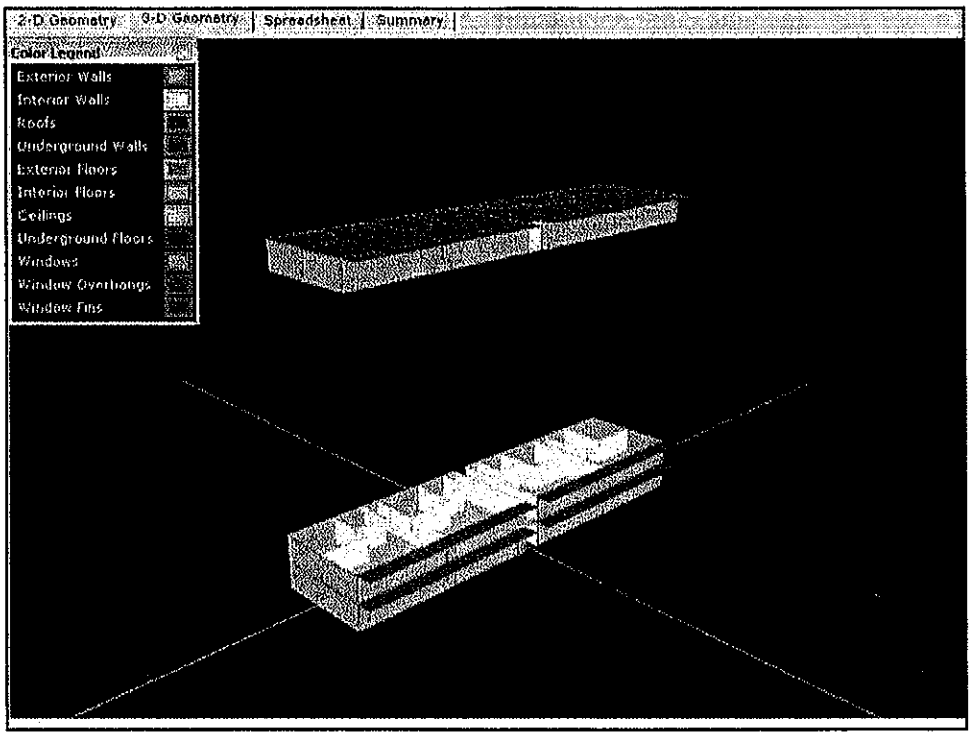
The whole building weighted average RETV is given as

$$RETV = \frac{3.4(A_{w1} \times U_{w1} + A_{w2} \times U_{w2} + \ldots + A_{wn} \times U_{wn})}{A_o} +$$

$$\frac{1.3(A_{f1} \times U_{f1} + A_{f2} \times U_{f2} + \ldots + A_{fn} \times U_{fn})}{A_o} +$$

$$\frac{58.6(A_{f1} \times SC_{f1} + A_{f2} \times SC_{f2} + \ldots + A_{fn} \times SC_{fn})(CF)}{A_o}$$





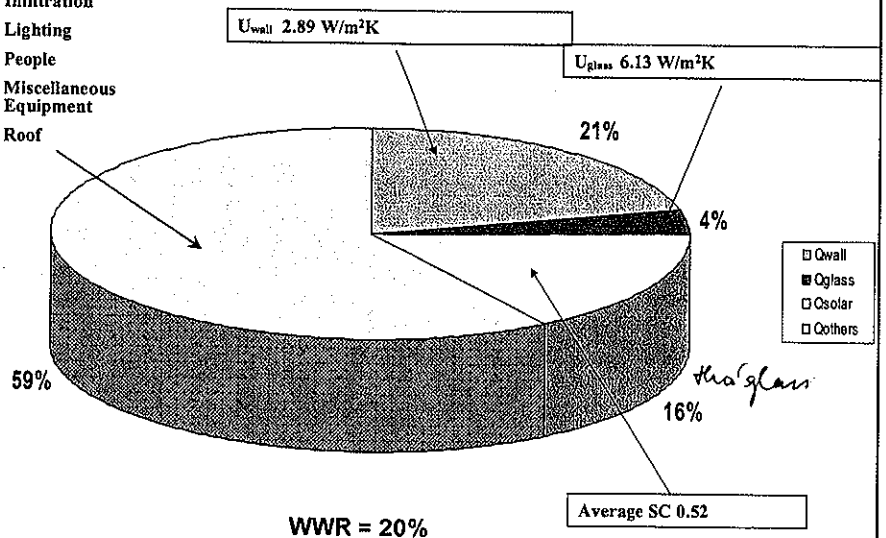
HDB Building Description

System type	Split Unit, rated 7000 Btu/hr to 22,000 Btu/hr per household
Cooling setpoint	24 °C Weekdays (Operation) 22:00-07:00 Weekends (Operation) 22:00-08:00 Rest set point is 37 °C
COP	2.5
Number of occupants in an apartment	A family of 4
Air-conditioned area	Bedrooms, living and dining
Building	12 storeys 4 x 144 m^2
Windows	Opened when A/C is off to provide natural ventilation, closed when A/C is on

HDB Loads Distribution

Includes loads due to:

- Infiltration
- Lighting
- People
- Miscellaneous Equipment
- Roof

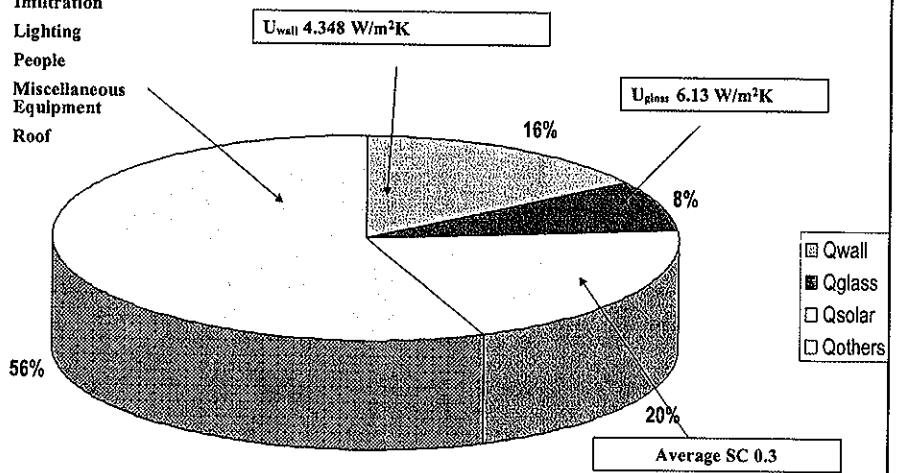


WWR = 20%

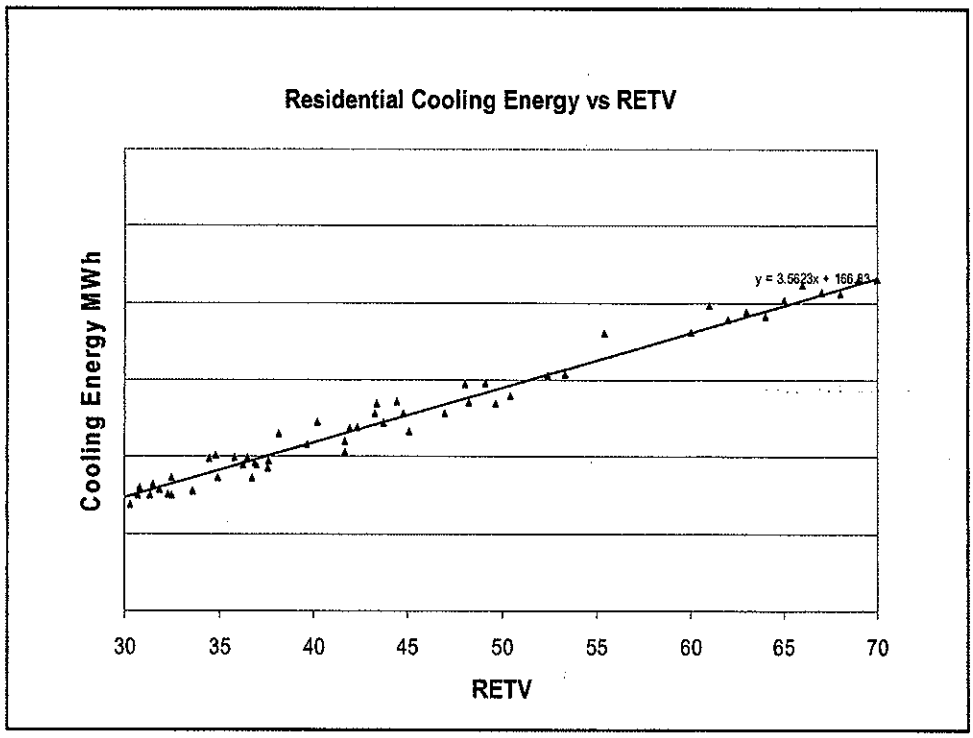
Private Residential Building Loads Distribution

Includes loads due to:

- Infiltration
- Lighting
- People
- Miscellaneous Equipment
- Roof



WWR = 51%



Deemed to have satisfied the RETV criterion

Should the building's WWR and SC fall within any one of the following cases, the building is deemed to have complied with the RETV criterion and, hence, is exempted from computing RETV

$$WWR_{Bldg} < 0.3 \text{ and } SC_{facade} < 0.7$$
or
$$WWR_{Bldg} < 0.4 \text{ and } SC_{facade} < 0.5$$
or
$$WWR_{Bldg} < 0.5 \text{ and } SC_{facade} < 0.43$$

where

WWR = Window to wall ratio
SC = Shading coefficient of fenestration
= SC glass x SC shading device

Approaches to reducing ETTV/RETV

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

