ENERGY SMART
RETAIL MALL

TECHNICAL GUIDE TOWARDS ENERGY SMART RETAIL MALL

Energy Sustainability Unit

Department of Building
National University of Singapore

National Environment Agency

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National Environment Agency
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INTRODUCTION

1.1 Aim

This technical guide is designed to provide shopping mall building owners and managers, and the energy services companies with the following:

(a) an understanding of the background of the Energy Smart Retail Mall Label and the various technical requirements stipulated; and

(b) technical guidance in the preparation of building information, undertaking energy and systems' performance appraisal, and technical report writing for the purpose of the Energy Smart Retail Mall award.

1.2 Overview of Energy Smart Retail Mall label

Shopping malls in Singapore are an important part of today's quality lifestyle for Singaporeans and tourists. It is also a fact that shopping malls are one of the major energy consumers among all types of buildings, owing to their huge lighting load, large and fluctuating number of shoppers and long operating hours. This leads to significant demand for air-conditioning and lighting. Therefore, shopping malls are one of the major building types where building energy efficiency improvement is targeted.

The Energy Smart Retail Mall is part of a National Building Energy Efficiency Labelling System jointly developed by the Energy Sustainability Unit (ESU) of the National University of Singapore (NUS) and the National Environment Agency (NEA), supported by the National Climate Change Committee. It is aimed at promoting best energy management practices through target setting, design and management of buildings.

The Energy Smart Retail Mall label gives recognition to buildings that are in the top 25 percentile of the total cohort of shopping mall buildings ranked using an energy efficiency benchmarking system developed by the ESU. Major energy-consuming systems such as air-

conditioning, lighting, and ventilation are evaluated for their performance. In addition to energy performance, these buildings' indoor environmental qualities such as air quality, ventilation, thermal comfort and lighting performance are set at suitable levels and evaluated to ensure compliance to avoid a compromise in functional performance, and health and comfort in the pursuit for energy efficiency. Once this is verified by an independent and objective process, the shopping mall will receive an Energy Smart label. Hence, an Energy Smart Retail Mall is not only energy efficient; it is a symbol of a healthy and performing building.

Once awarded, an Energy Smart Retail Mall will be reviewed and assessed every three years. This is to ensure continued performance and where applicable, continual enhancement in energy performance of the building. This also facilitates the tracking of progress in the status of energy efficiency among buildings.

The shopping malls participated in the survey are of four types. They are Retail Mall, Entertainment Complex, Mixed-use Centre and Retail Cum Office. However, all types of shopping malls are encouraged to participate in this labelling programme. While those buildings that are within the performance range will be accorded the Energy Smart Retail Mall award immediately, those outside the performance range will be certified and have their current performance range registered. The latter group can then set performance target and work towards achieving an award in the near future.

1.3 Benefits of the Energy Smart Retail Mall

Building energy efficiency is a significant part of the national drive towards our energy sustainability in the future. With rising energy prices, there is growing interest among all stakeholders to design, construct and manage environmentally sustainable buildings that not only save energy but also offer good working environment for its occupants, and at the same time enhance business competitiveness.

Buildings that are awarded the Energy Smart Building label would be able to differentiate themselves by demonstrating that they have taken adequate measures to incorporate energy efficient technologies and cut wastage, and still maintain a comfortable and healthy working environment for their occupants. In addition, they would project an environmentally responsible image.

An energy efficient building sector will also reduce Singapore's greenhouse gas emissions and thereby helping Singapore to mitigate the urban heat island problem, and achieve a less carbon intensive economy.

1.4 Definition of Terms

Shopping Mall: A shopping mall is defined as premises which is typically enclosed, climate-controlled and lit, with or without on-site parking facilities, and is used for providing retail services and other commercial establishments.

GFA: The Gross Floor Area (GFA) of a building is the area enclosed by external walls of the building including lobbies, stairways, lift shafts and mechanical rooms. The total GFA should include all supporting functions such as food preparation and restaurant space, laundry facilities, exercise rooms, health club/spas, storage rooms etc.

Retail Area: Retail area should include net lettable area in a shopping mall such as retail shops, food & beverage area, health or beauty spa, bank, etc.

F & B Area: A space within the shopping mall dedicated to the preparation, service, and storage of food for customers. This can include a restaurant, food court, bakery, beverage facility and etc.

Cinema Area: Cinema Area should include only movie theatre area and should not include other areas of theatre foyer and public recreation area, etc.

ELIGIBILITY CRITERIA FOR ENERGY SMART RETAIL MALL

2.1 Physical Characteristics

The physical characteristics of the building shall meet the requirements as given in Table 1. A physical inspection of the building should be carried out to verify these physical characteristics as documented in the building's design documents and as-built drawings.

Criteria	Eligibility
Gross Floor Area (GFA) using central air conditioning	GFA using central air conditioning > 9000 m^2.
Retail Space	Occupy minimum 27% of the Gross Lettable Area
Design Efficiency (GLA/GFA x 100)	Minimum 50%
Building Age	At least 1 year

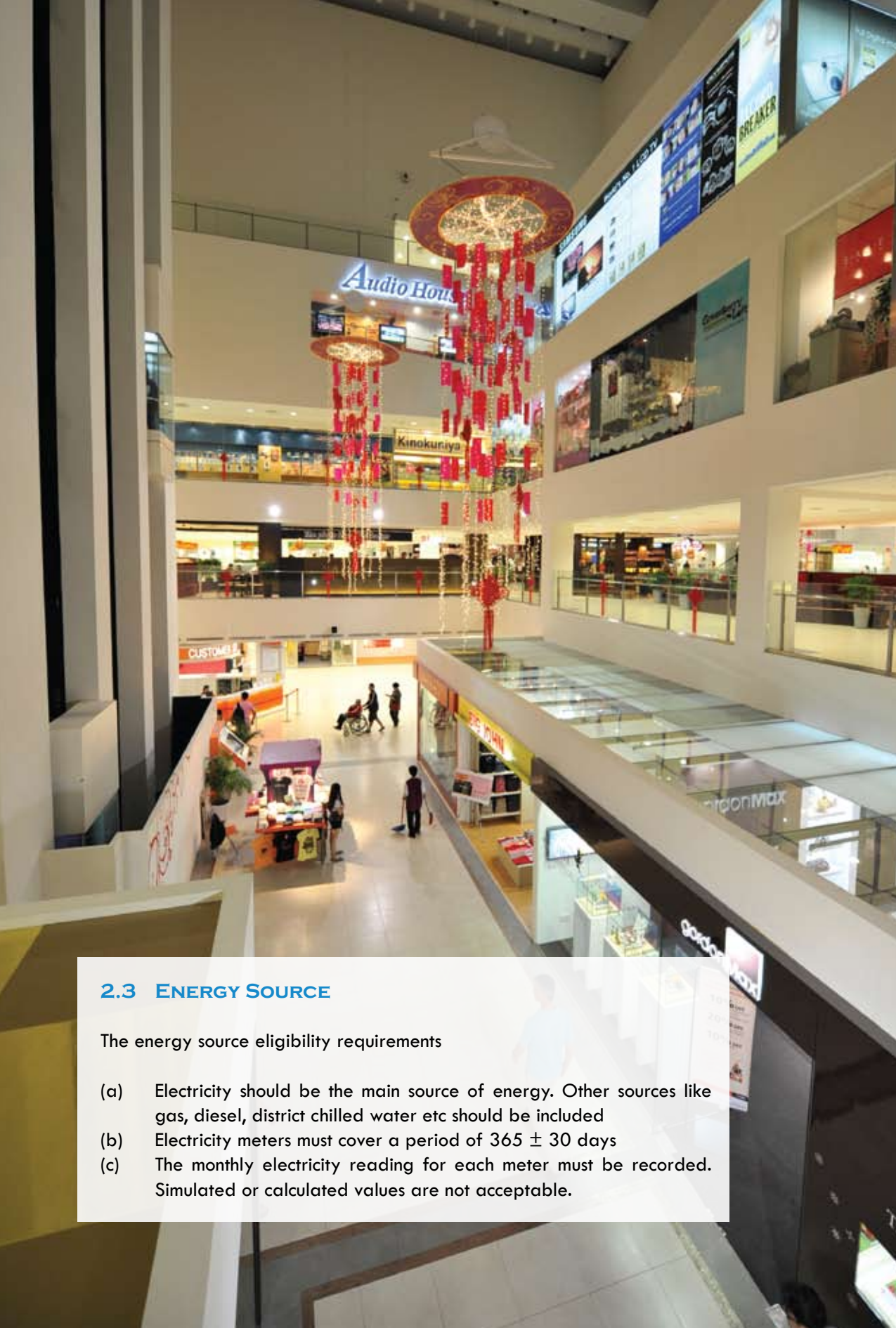
Table 1: Physical Characteristics Requirements for the Building

2.2 Occupancy Characteristics

The occupancy characteristics of the building shall meet the requirements as given in Table 2:

Criteria	Eligibility
Occupancy Rate	Occupancy rate for Net Lettable Area > 60%
Operating Hours	≥ 70 hours per week

Table 2: Occupancy Characteristics Requirements for the Building



2.3 Energy Source

The energy source eligibility requirements

(a) Electricity should be the main source of energy. Other sources like gas, diesel, district chilled water etc should be included
(b) Electricity meters must cover a period of 365 ± 30 days
(c) The monthly electricity reading for each meter must be recorded. Simulated or calculated values are not acceptable.

PERFORMANCE STANDARDS FOR THE ENERGY SMART RETAIL MALL AWARD

3.1 Minimum Energy Consumption

Building systems' design and operating efficiency are fundamental to the overall energy efficiency of a building. Building owners and their management are encouraged to optimise systems' efficiency. Where appropriate, actions should be taken to retrofit systems and upgrade their efficiency to a suitable standard. Taking into consideration existing buildings which have been equipped for a period of time, the ranges of acceptable performance efficiency for the various systems are as given in Table 1. Building owners are encouraged to work towards a higher performance standard within the given range.

Systems	†Eligibility Requirements	Remarks
Air Conditioning	Plant room efficiency < 0.75 kW/RT	Primary and secondary pumps' consumption in kW should be included in the calculation.
Lighting	Lighting power density < 25 W/m^2	Code of Practice for Energy efficiency standard for building services and equipment SS 530: 2006 (Table 7)
Mechanical Ventilation	Mechanical Ventilation Power Density < 2.7 W/m^2	CP 13:1999, Clause 5.3.6 & 7.11.5, for operating units only (stand-by units need not be considered).

† All the ranges given are based on existing data and may be subjected to change.

Table 3: Recommended Ranges for the Building Systems' Energy Performance

3.2 Thermal Comfort

The following standards should be met in order to ensure that the building has adequate thermal comfort:

Parameters	Acceptable range	Reference Standard / Note
Dry bulb temperature (DBT)	22.5 °C to 25.5 °C	Singapore Standard CP 13: 1999, Code of Practice for Mechanical Ventilation and Air Conditioning in Buildings, Clause 7.3.
Relative humidity	< 70 %.	
Air movement	< 0.25 m/s.	
Mean Radiant Temperature (MRT)	MRT-DBT ≤ 2 °C	

Table 4: Acceptable Ranges for Thermal Comfort Parameters

3.3 Illumination

The following standards should be met to ensure that the occupied interior spaces and parking spaces have adequate illumination levels:

Space Type	Illumination* (lux)	
Car parks:	Day	Night
Floors and outdoors	20	10
Driving Aisles	100	--
Ramps and corners	100	50
Entrance and exit	300	50
Entrance hall, lobby, waiting room, lift, corridors, escalators	100-200	
Shopping precinct & arcades	100-200	
Enquiry desk	300-750	
Shops, department stores and show rooms	300-750	
Check-out/ payment area	300-750	
Canteen, food court, café	80-200	
Restaurant kitchens	300	
Lounge, bar	70	
Cinema:		
Auditoria	50-100	
Foyers	100-200	

* Based on CP 38:1999, Code of Practice for Artificial Lighting in Buildings.

Table 5: Illumination Levels for Various Occupied Interior Spaces

3.4 Outside Air Ventilation

The following standards shall be met to ensure that occupied interior spaces and parking spaces of the building are supplied with adequate fresh air:

Type of Occupancy	Outdoor air supply (L/s per m^2 floor area)	Reference Standard
Shops, supermarkets and department stores	1.00	CP 13: 1999, Code of Practice for Mechanical Ventilation and Air Conditioning in Buildings
Lobby, concourses & corridors	0.25	
Restaurants	2.80	
Theatres and cinemas	2.00	

Table 6: Outdoor Air Supply Requirements for Various Occupied Interior Spaces

3.5 Indoor Air Quality

The following standards for indoor air quality parameters which are based on their potential health effects shall be met to ensure that occupied interior spaces and parking spaces of the building have adequate indoor air quality:

Parameter	Maximum concentration for specific indoor air pollutants*	Averaging Time*
Carbon dioxide	1000 ppm (1800 mg/m^3)	8 hours
Carbon monoxide	9 ppm (10 mg/m^3)	Spot measurements
Formaldehyde	0.1 ppm (120 µg/m^3)	Spot measurements
Ozone	0.05 ppm (100 µg/m^3)	Spot measurements
Suspended Particulate matter	150 µg/m^3	Spot measurements
Volatile Organic Compounds	3 ppm	Spot measurements
Bacteria	500 CFU/m^3	Spot measurements
Fungi	500 CFU/m^3	Spot measurements (2 cycles)

* Based on Guidelines for Good Indoor Air Quality in Office Premises, 1st Edition (1996) and CP 13: 1999, Clause 7.6

Table 7: Acceptable Levels for Various Indoor Air Pollutants

IAQ level measured in a space such as retail shop or office-like space within a shopping mall must fulfill the above standards. However, if an IAQ level measured in crowded spaces with unstable conditions such as food court or people circulation area exceeds the above standards, it shall be examined again at least one week after the first measurement. If the exceeding value persists, the source of the problem must be examined and suitable measures be implemented to rectify the condition.

3.6 Occupants' Survey

A survey shall be conducted among the occupants in order to understand their acceptance level of the indoor environment of the shopping mall space. A sample survey questionnaire is available at this website (http://www.esu.com.sg/research2.html). The indoor environment should be acceptable to at least 80% of the occupants for the building to qualify for the Label.

GUIDANCE FOR BUILDING OWNER / MANAGER

4.1 Application Procedure

The application package may be downloaded from the ESU website at www.esu.com.sg. A flow diagram showing the overall application process is given in Annex 1. The applicant may contact ESU for clarification and further information.

The applicant may want to do a preliminary benchmarking as mentioned in section 5.1, to assess their eligibility prior to engaging an ESCO.

4.2 Engaging an ESCO

An accredited Energy Service Company (ESCO) will need to be engaged to evaluate and certify the building's eligibility and conformance vis-à-vis Section 2 and 3 of this technical document. The ESCO shall prepare the necessary documents and reports for submission to ESU for evaluation. ESU will then notify the applicants of the results of the assessment.

The applicant may engage any of the Accredited ESCOs as listed on the ESU website: http://www.esu.com.sg/research1b.html.

4.3 Costs

A nominal fee will be charged by the ESU for the evaluation of the ESCO's report and site visits where necessary to verify certain features and/or measured values, as well as the administration of the award and the cost of preparing the plaque and certificate.

ESU has surveyed the various ESCOs and established an indicative cost of engaging ESCOs to undertake the measurements, process and submit an application for the Energy Smart Retail Mall label. These results are as shown in the indicative cost table (Table 8) below:

	Size of Building		
	Small (5000-10000 m^2)	Medium (10001-25000 m^2)	Large (> 25000 m^2)
Estimated cost of engaging an ESCO	$10,000	$15,000-$20,000	$20,000 - $30,000

(Note: These cost figures are given by ESCOs and may vary depend on the scope of work and complexity of building systems' set up)

Table 8: Costs for Engaging an ESCO

GUIDANCE FOR ESCOs

5.1 Benchmarking

Building energy performance benchmarking can help to determine the consumption intensity of a building as compared with the industry norms. The benchmarking system developed is based on a comprehensive database derived from detailed surveys of 30 shopping mall buildings in Singapore. The data has been processed and verified to ensure data's integrity, accuracy and normality. Outliers from the independent variables, owing to operational peculiarity, were excluded. Step-wise regression technique was adopted. A total of ten independent variables which give good correlation with the total building energy consumption, were examined and analysed. The total building energy consumption has been normalised for the effects of primary factors such as gross floor area (GFA), floor vacancy rate (FLVCR) and weighted operating hours (hours/week). Secondary factors such as retail area, food & beverage area, cinema area, and so on were also evaluated and correlated with the Energy Use Intensity (EUI). The analysis gives rise to the result of a fairly good and accurate benchmarking system. The sampling error has been determined to be about 5%.

ESCOs may use ESU's findings as a basis for more detailed studies to identify the problematic areas within a building, predict building energy saving potential and give recommendations of actions to be taken.

5.2 Measurement and Verification

ESCOs shall make necessary plans and use calibrated instruments to measure and verify all the eligibility criteria and performance standards. Careful planning is required for all measurements to be taken concurrently, and, as far as possible, measurement works shall be completed within one week.

These plans should include measurement methodologies, the measurement instruments used, locations of measurement points, measurement duration and standards being referred to. Supporting documents such as valid calibration certificates, valid laboratory reports, energy bills and relevant equipment manufacturers' manuals shall be furnished in the report. Also, ESCOs shall compile and submit the relevant documents that verify the buildings to have met the eligibility criteria.

ESCOs shall note the following requirements with respect to performance measurements:

No	Systems / Performance Standards	Requirements
1	Central air conditioning	Undertake data logging of chiller plant for about 1 week. The standby chillers need not be measured. Number of measurement points must be sufficient for detailed analysis of system components such as cooling tower, condenser pumps, chilled water pumps and chillers.
2	Mechanical ventilation	Estimate energy consumption from the rated power. Estimate the ventilated areas from drawing plans. Verify by measurement taken from the DB.
3	Thermal Comfort	The temperature, relative humidity and air movement of representative sample space should be measured during the occupied hours. Review indoor air quality report or commission new indoor air quality test with full report to be submitted. Observations and recording should be made to see if there are any signs of significant occupant thermal discomfort such as: • Frequent fanning behaviour by occupants. • Occupant putting on sweaters; It is advisable to take measurements in occupied areas that have visible signs of occupant discomfort. If many of the spaces measured are unable to meet the temperature and humidity conditions required, then further measurements and rectification shall be made.
4	Mean-Radiant Temperature (MRT)	All MRT measurements have to be conducted near the facades especially at the west –facing façade during the late afternoon and at the east-facing façade during the late morning.

5	Illumination	The illumination levels of a representative sample of the occupied interior spaces as well as associated parking facilities should be measured. Care must be taken to position the light meter at the proper height on the work surface at the task location. Shadowing the meter with body and reflections off clothing should be avoided. A 30-minute interval should be allowed between the system switch-on and the first measurement to ensure that the lighting system has reached a stable condition. Illumination should be checked both directly under the fixture and between the fixtures. Areas with occupant-supplied task lights de-lamped fixtures or numerous burned-out lamps should receive additional scrutiny as areas with visual discomfort. Deviation from the recommended illumination levels of roughly 20% is acceptable, given that the lighting design is frequently tailored to the specific occupants' needs and task characteristic of the space.
6	Outside Air Ventilation (fresh air)	The volume of outside air required by the space based on the outside air supply rates specified should be determined. Once the minimum acceptable volume of outside air for the space is known, the volume of outside air entering the supply air fan chamber should be measured. If this is not feasible due to air handling unit design or configuration, the percentage of outside air should be calculated based on the operating characteristics of the air handling unit using mass balance equations. A representative sampling of the occupied spaces should be taken for outside air measurements or calculation. If a significantly sized space is marginally meeting the minimum requirements, then more measurements may be warranted. If there are a significant number of personal fans, which could be an indication of stagnant air, damaged or occupied-altered HVAC equipments like diffusers or thermostats, additional measurements are necessary. In buildings having repetitive occupant and HVAC configurations, direct measurement of a sampling of air handling units may be acceptable. However, each air handling unit should be inspected to determine if they are operating properly.

7	Indoor Air Quality	To highlight any deviations from the list as shown below: • AHU drain pans should be clean and properly sloped and cooling towers should be cleaned and treated in accordance with guidelines specified in the Code of Practice for the control of legionella bacteria in air-conditioning cooling towers in Singapore (Ministry of Environment, August 1992). • The fresh air intake should not be placed near the exhaust, traffic, car park, unloading bays, refuse chutes or other nearby pollution. Intake should not be located below ground level or close to evaporative cooling towers. • Air handling unit rooms should not be used for passage ways or for storage. Where they open to a source of contamination, the doors of the room should remain air-tight. • The building should be free of visible signs of microbiological sources such as mold and mildew. Other indications like stained ceiling tiles, wet carpets, musty odour must be noticed. • Combustion sources should be exhausted directly to the outside and shall be assured of no backdraft. Written preventive maintenance program that includes monitoring, inspecting and cleaning HVAC components should be reviewed. The components of HVAC systems should be inspected and cleaned at least every six months. The information from central energy management system may be used at their discretion upon validation of a representative sample of air handling units to meet the standards.

Table 9: Measurement Requirement for Various Systems and Performance Standards

ESCOs shall refer to the following table for the minimum number of sampling point when measuring the environmental parameters:

	Environmental Parameters	Minimum number of sampling points		
		Small GFA 5000-10000 sqm	Medium GFA 10001-25000 sqm	Large GFA >25001 sqm
1	**Thermal comfort**			
	DBT	8	16	30
	RH	8	16	30
	Wind speed	8	16	30
	MRT	4	8	12
2	**Illumination**			
	lux	8	16	30
3	**IAQ**			
	Carbon dioxide	8	16	30
	Carbon monoxide	8	16	30
	Formaldehyde	8	16	30
	Ozone	8	16	30
	Suspended Particulate matter	8	16	30
	Total Volatile Organic Compounds	8	16	30
	Bacteria	8	16	30
	Fungi	8	16	30
4	**Ventilation (fresh air)**	4	8	10

Table 10: Number of Sampling Points Required for Measuring Environmental Parameters

The sampling probe should be located between 0.75m and 1.20m from the floor at the centre of the room or occupied zone.

At least 1 point or 10% of the above-mentioned number of sampling points, whichever is higher should be conducted in a food court if such facilities are an integral part of the shopping mall.

ESCOs may choose between external laboratory or in-house resources to measure the indoor air quality, which has some common aspects of the thermal comfort except for MRT. Careful planning will be required to avoid double measurement or lapses in measurement.

ESCOs shall conduct the occupants' survey and take heed of the notes as shown below:

- The minimum number of people surveyed should be around 10% of total occupancy or 30 whichever is higher
- A walkthrough must be carried out before finalizing the sample location.
- The sample should be representative of all the floors. In other words, it should include people from lower floor, middle floor as well as higher floors.
- The survey should be conducted during the occupied hours and the people selected should be representative of the building occupants.

In addition, ESCOs shall calculate the normalised Energy Use Intensity for the report by using the formula as shown below:

$$EUI_0 = \{TBEC/(GFA-GLA*(FLVCR/100))\}$$

$$\textbf{Normalised EUI} = \textbf{EUI}_0 - 292.51X_1 - 1179.09X_2 - 1203.06X_3 + 276$$

where:

TBEC	=	Total building annual energy consumption (excluding other consumption such as car park's consumption, residential or apartments' consumption, etc, if separately metered.)
GFA	=	Gross Floor Area (excluding carpark area, hotel or residential area whose energy consumption not included in the above TBEC)
GLA	=	Gross Lettable Area
FLVCR	=	Floor Vacancy Rate %
X_1	=	Fraction of retail area by gross floor area (RTA/GFA)
X_2	=	Fraction of F & B area by gross floor area (FNBA/GFA)
X_3	=	Fraction of cinema area by gross floor area (CINEA/GFA)

5.3 Source Energy

Based on an overall power generation efficiency of 45%, the source energy for electricity generation is estimated to be 2.22 kWh per kWh of energy used on site. This ratio is estimated with consideration to the current situation in the electricity sector of Singapore. This information will be used for computation of source energy usage intensity value.

5.4 Submission

The report shall be prepared according to the format specified in **Annex 2** with necessary supporting documents to verify all measured data. All measurements should be done not more than 6 months before the submission date. The completed documents should be sent to the ESU by post. The applicant will be notified upon receipt of the application.

NOTIFICATION

Successful applicants will be

(a) officially notified within one week of the approval of the application; and

(b) issued a plaque with the Energy Smart Logo for display at a prominent spot of the building

Unsuccessful applicants will be issued a certificate, which indicates areas for improvement in order to qualify for the next assessment after three years. The sample of the certificate is given in **Annex 3**.

REFERENCE MATERIALS

1. Application Guidelines for the Assessment and Accreditation of Energy Service Companies (Auditing Services), March 2005, Energy Sustainability Unit, Department of Building, National University of Singapore

2. Singapore Standard CP 13: 1999, Code of Practice for Mechanical Ventilation and Air-conditioning in Buildings

3. Singapore Standard CP 38: 1999, Code of Practice for Artificial Lighting in Buildings

4. Guidelines for Good Indoor Air Quality in Office Premises, Ministry of Environment, Singapore

5. Code of Practice for Fire Precaution in Buildings

6. Singapore Standard CP 530: 2006, Code of Practice for Energy Efficiency Standard for Building Services and Equipment

ANNEX 1

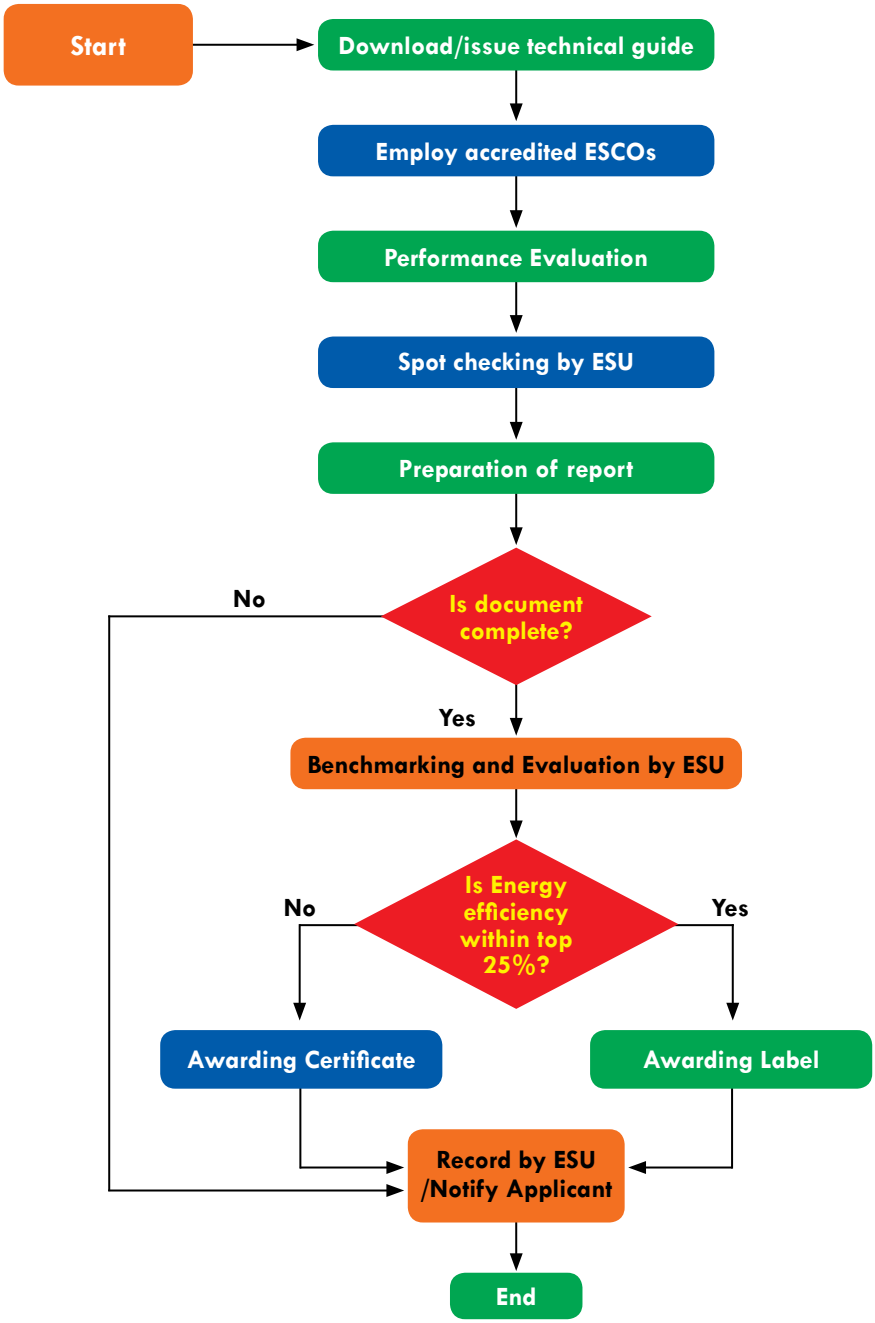
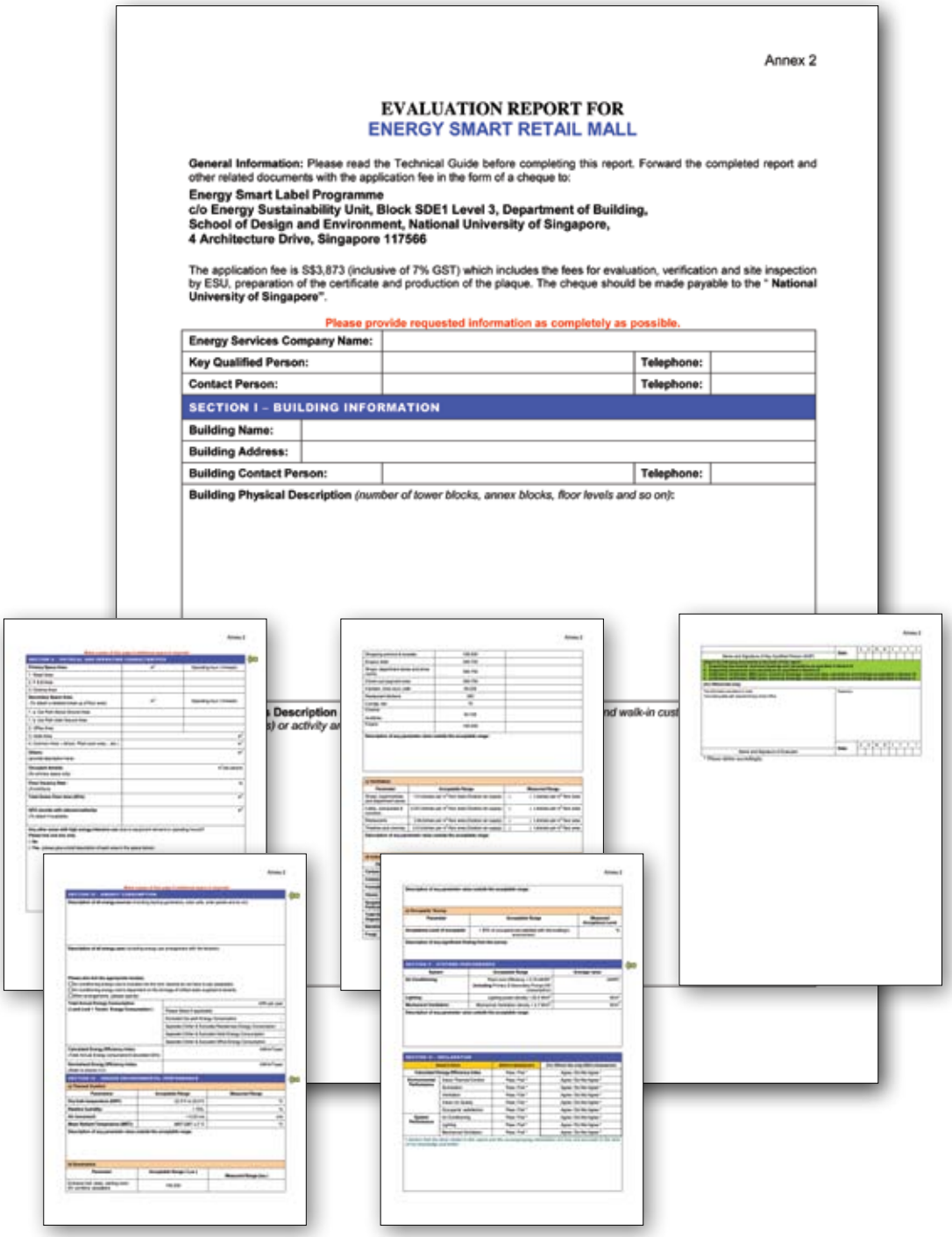


Figure 1 Flow Chart showing the application process

Annex 2



Annex 2

EVALUATION REPORT FOR
ENERGY SMART RETAIL MALL

General Information: Please read the Technical Guide before completing this report. Forward the completed report and other related documents with the application fee in the form of a cheque to:

Energy Smart Label Programme
c/o Energy Sustainability Unit, Block SDE1 Level 3, Department of Building,
School of Design and Environment, National University of Singapore,
4 Architecture Drive, Singapore 117566

The application fee is S$3,873 (inclusive of 7% GST) which includes the fees for evaluation, verification and site inspection by ESU, preparation of the certificate and production of the plaque. The cheque should be made payable to the " **National University of Singapore**".

Please provide requested information as completely as possible.

Energy Services Company Name:			
Key Qualified Person:		**Telephone:**	
Contact Person:		**Telephone:**	
SECTION I – BUILDING INFORMATION			
Building Name:			
Building Address:			
Building Contact Person:		**Telephone:**	
Building Physical Description *(number of tower blocks, annex blocks, floor levels and so on)*:			

Sample of the Certificate

Block SDE 1 Level 3,
Department of Building,
School of Design and Environment,
National University of Singapore,
4 Architecture Drive, Singapore 117566
Tel: (65) 6516 4082
Fax: (65) 6773 3837
www.esu.com.sg/research2.html
www.esu.com.sg