FRAMEWORK FOR ENERGY MODELING FOR GREEN MARK INCENTIVE SCHEME (GMIS)

A. GENERAL

Compliance with Building Regulations and relevant Singapore Standards

1 The Reference Model must adopt the acceptable solutions on energy efficiency, lighting and ventilation in the BCA's Approved Document. These include:

a. SS530:2006 – Energy efficiency standard for building services and equipment.

b. SS CP13:1999 – Code of Practice for mechanical ventilation and air conditioning in buildings.

c. SS CP 38:1999 – Code of Practice for artificial lighting of buildings.

d. ETTV requirements: Guidelines on Envelope Thermal Transfer Value for Buildings.

The Baseline Standards for the Reference Model are in **Appendix A**. For the Proposed Model, the performance requirements in the Approved Document must be met including the ETTV requirement.

Endorsement by Qualified Persons

2 Developer shall engage competent firms to conduct energy modeling for their projects. The submission to BCA must be endorsed by the Qualified Persons (both the Mechanical and the Electrical PE) for the project.

Acceptable Software

3 Energy Modeling shall be carried out using software acceptable to BCA. The criteria are as follows:

a. The software must be able to model the thermal performance of buildings in a multi-zone format and calculate the building's total energy consumption over a continuous 12-months period.

b. The software must be tested by a recognized institution in accordance to the Standard Method of Test for the Evaluation of Building Energy

Analysis Computer Programs - **ANSI/ASHRAE STD 140** or other national equivalent.

B ENERGY MODELING METHODOLOGY

1 To perform energy modeling under the Green Mark incentive scheme, the following steps are required:

a. Extract relevant data from the building plans or other project documentations as inputs for energy modeling. These include:

   (i) Building design layout in terms of shape, size and orientation.

   (ii) Materials for walls, windows, roofs, floors, doors and permanent shading devices, including interior partitions between conditioned and non-conditioned regions.

   (iii) Internal loads such as levels and schedules for occupancy, lighting systems, equipment, appliances and machinery within the building.

   (iv) HVAC equipment, controls and other associated components selected for use in the building.

b. Obtain similar data for the Reference Model.

c. Compute the overall energy consumption of the Reference Model, over a one (1) year period, using the building envelope and all energy-consuming equipment that are selected during the design stage. This includes energy consumed by chillers, air handling systems, plant equipment (eg. water pumps, cooling towers, tube cleaning devices, chillers, etc.), and non-HVAC systems such as lightings, lifts, escalators, ceiling fans and receptacle loads from equipment (eg. photo-copiers, printers, fax machines, computers, laptops, fridges, projectors, audio-cum video systems, water heaters, dryers, washers, etc).

d. Do the same for the Proposed Model and compute the overall energy consumption of the Proposed Model over a one (1) year period.

e. Compare the overall energy consumption of the Reference Model against the Proposed Model.

2 The simulations for both the Proposed Model and Reference Model shall use:

a. the same software,

b. the same weather data[1],

c. the same operating schedules,

d. the same occupancy rates,

e. the same building design in terms of shape, size and orientation,

f. the same receptacle loads,

g. the same indoor environmental conditions in terms of thermal comfort level[2], and

h. the same internal illuminance levels (lux) for space lightings.

3 The Energy Efficiency Index for both the Proposed and Reference Models shall also be computed. This is for reference only. See **Appendix B** for computation of this index.

[1] Appropriate up-to-date weather set should be used for energy modeling such as ASHRAE's International Weather for Energy Calculation data for Singapore.

[2] If a different condition such as higher space temperature is used in the Proposed Model, there must be evidence to demonstrate that the overall thermal comfort level is not lower than that of the Reference Model.

C SUBMISSION FOR GREEN MARK INCENTIVE SCHEME

1 Under the Green Mark Incentive Scheme, the developer shall arrange for energy modeling to be conducted for the project and the results to be analyzed, summarized and submitted to BCA at each of the two following stages; upon finalisation of building design and at the steady-operation stage (site validation). The submission shall be endorsed by the Qualified Persons (both the Mechanical Professional Engineer and the Electrical Professional Engineer).

Upon finalisation of building design (at the Green Mark Certification stage)

2 The submission shall include the following:

a. Appendix C: Form GMIS-1 – Submission Form for Energy Modeling for Green Mark Incentive Scheme

b. Appendix C: Form GMIS-1.1 – Summary of Space and Building Envelope

c. Appendix C: Form GMIS-1.2 – Comparison of Reference Model versus Proposed Model

d. Appendix C: Form GMIS-1.3 – Summary of Energy by End Use including Energy Efficiency Index for both models

e. Summary printout from energy modeling software for the Reference Model (including summary of weather data set and documentation of testing certification for the energy modeling software).

f. Summary printout from energy modeling software for the Proposed Model.

At the steady-operation state (validation under GMIS)

3 When the building starts to operate in a steady state, the developer shall within 2 years after TOP (ie. within the validity period of BCA Green Mark certification), commence to gather data[3] on actual site operation for the next 12 months period. The Facilities Manager of the building who is responsible for the proper running of the facility to achieve the projected energy savings shall make sure that the data gathered is accurate and is a correct representation of the performance of the building. The data to be gathered shall include:

[3] If necessary, the developer should engage a competent firm (e.g. data logging specialists, BMS vendors, ESCOs, etc.) to either perform on-site data logging or make use of existing BMS for necessary trend logging/data acquisition. All sensors and meters used shall be properly installed and calibrated to ensure that all readings obtained for monitoring and targeting are accurate and are true reflection of the actual performance of the building and systems.

a. occupancy of the building expressed in terms of occupied Gross Floor Area[4]

b. operating schedules of all major M&E equipment such as chillers, AHUs and lighting systems

c. monthly monitoring of energy consumption of M&E equipment (eg. air-conditioned plant[5], lift, escalators, domestic pumps, irrigation pumps, etc) through electrical power consumption meters

d. monthly readings from the master power consumption meter for the entire building

4 The submission shall include the following:

a. Appendix D: Form GMIS-2 – Submission Form for Energy Modeling for Green Mark Incentive Scheme (Validation)

b. Appendix D: Form GMIS-2.1 – Summary of Space and Building Envelope (required if there is change)

c. Appendix D: Form GMIS-2.2 – Summary of Energy by End Use including Energy Efficiency Index

d. Summary printout from energy modeling software for the Reference Model (required if there is change in space use, scheduling or occupancy).

5 Using the data on actual site operation and the same energy modeling software adopted at the design stage, a revised energy modeling shall be performed to compare the annual energy consumption of the Reference Model with the actual consumption of the building. The flowchart for this process is shown in **Appendix E**.

6 If the building is unable to achieve the savings in energy consumption required under the Green Mark Incentive Scheme, the developer shall arrange to conduct another validation over the next 12 months.

7 If the building is still unable to achieve the savings in energy consumption required under the Green Mark Incentive Scheme, there will be no disbursement of the 2nd tranche of the incentive and the developer shall provide a detailed explanation on why the building was unable to achieve the savings.

[4] Gross Floor Area (GFA) means the Gross Floor Area which has been permitted under Section 14 of the Planning Act (Cap 232) to be developed.
[5] Chilled Water System (chillers, water pumps and cooling towers)