

# GREEN MARK INCENTIVE SCHEME FOR EXISTING BUILDINGS AND PREMISES (GMIS-EBP)

APPLICATION GUIDELINES FOR BUILDING OWNERS (13 JULY 2018)

#### GUIDELINES FOR APPLICATION OF GREEN MARK INCENTIVE SCHEME FOR EXISTING BUILDINGS AND PREMISES, (GMIS-EBP) FOR BUILDING OWNERS

## 1.0 OBJECTIVE

- 1.1 The Green Mark Incentive Scheme for Existing Buildings and Premises (GMIS-EBP) (the "Scheme") aims to encourage building owners to undertake Energy Improvement Works (as defined hereafter) involving the installation of energy efficient equipment approved by BCA in their buildings to achieve substantial improvements in energy efficiency. It provides a cash incentive amounting to up to 50% (subject to a cap as set out in para 5.0 below) of the Qualifying Costs (as defined hereafter) (excluding any tax chargeable under the Goods and Services Tax Act (Cap. 117A)) incurred solely for the purposes of energy efficiency improvements in existing buildings.
- 1.2 The Scheme is targeted mainly at the following buildings and premises:-
  - (a) existing private commercial and business parks' buildings such as shopping malls, hotels, office buildings and other approved buildings,
  - (b) existing Non-Governmental Organisation (NGOs), Voluntary Welfare Organisation (VWOs) and religious organisation' buildings, and
  - (c) tenanted premises such as offices, retail, restaurant and supermarkets.
- 1.3 This Application Guidelines is meant for applicants who are applying under the category of (a) building owners who are SMEs, (b) building owners of Non-Governmental Organisation (NGOs), Voluntary Welfare Organisation (VWOs), religious organisation, and (c) building owners who are not SMEs but have at least 10% of its tenants who are SMEs.
- 1.4 The qualifying criteria and co-funding rates for building owners are categorized into (a) buildings with central chilled water air-conditioning plants and (b) buildings with Variable Refrigerant Flow (VRF) system.

## 2.0 DEFINITIONS & INTERPRETATIONS

2.1 In these Guidelines:-

'Actual Energy Savings' shall mean the actual energy savings based on the actual energy consumptions derived from the utility bills before and after the Energy Improvement Works.

'Aircon System Efficiency' shall mean the system efficiency of the central chilled water air-conditioning plant or the variable refrigerant flow system.

'Applicant' refers to the person or legal entity who/which submits the Application. For Energy Performance Contracting, 'Applicant' refers to both the Building owner and EPC Contractor who jointly submit the Application and where the context otherwise requires, 'Applicant' may refer to either Building owner or EPC Contractor.

'Application' means the applicant's application to participate in the Scheme through the submission of his Application Form.

'Application Form' means the application form to be downloaded from BCA's website (http://www.bca.gov.sg/GreenMark/others/GMISEB\_applyform.pdf), and submitted by the applicant for participation in the Scheme.

'Approved Equipment' shall mean the equipment set out in Annex A hereto.

'BCA' shall mean the Building and Construction Authority.

'Building' shall refer to the building in which the Energy Improvement Works are to be carried out.

'Energy Performance Contracting" or "EPC" shall mean the financial arrangement that uses cost savings from reduced energy consumption to repay the cost of energy conservation measures installed by energy service companies.

"EPC Contractor" shall mean the contractor hired to provide Energy Performance Contracting. An EPC Contractor may also include the Professional Services Consultant.

'Energy Improvement Works' in relation to a Building shall mean energy improvement works involving the installation of Approved Equipment and aimed at improving the energy efficiency of the Building.

'Estimated Qualifying Costs' means the genuine indicative estimate made and submitted by the applicant in the Application Form in relation to the estimated costs

(excluding GST) to be incurred by the applicant for the purchase and installation of the Approved Equipment and the procurement of Professional Services.

'Green Mark Rating' refers to the rating given pursuant to the Green Mark assessment conducted by BCA, based on the criteria set out in the Green Mark for Existing Non-Residential Buildings Version 3 which can be found at www.bca.gov.sg/GreenMark/green\_mark\_criteria.html.

'GST' means the tax chargeable in respect of the Approved Equipment and/or Professional Services, under the GST Act.

'GST Act' means the Goods and Services Tax Act (Cap. 117A)

'Optimisation' shall refer to energy improvement works that will improve the energy efficiency of the Building, and which does not involve replacement of the chillers. The works shall be verifiable via energy savings and could include installation of variable speed drives for the pumps and cooling tower motors, using high efficient motors, removing unnecessary pressure losses from the redundant valves, improvement on the control and operation strategy, etc. as set out in Annex B hereto.

'Professional Engineer' means a professional engineer registered and having the practicing certificate pursuant to the Professional Engineers Act (Cap. 253)

"Professional Services" shall mean the consultancy services on the design, project management, Green Mark certification and other services with respect to the Energy Improvement Works.

"Professional Services Consultant" shall mean the consultant hired to perform the Professional Services.

'Projected Energy Savings' shall mean the anticipated energy savings which are anticipated to be made after the energy improvement Works.

'Qualifying Costs' means the actual costs (excluding GST) involved in the Energy Improvement Works which consists only of the following items:

- (a) cost of such Approved Equipment;
- (b) cost of installation of such Approved Equipment; and
- (c) Professional Services.

'Small and Medium Enterprises (SME)' refers to companies governed by the Companies Act where (i) at least 30% of the company's ordinary shares are held directly or indirectly by Singaporean/Singapore PR(s) and (ii) either the company's Group annual sales turnover is not more than S\$100 million or company's Group employment size is not more than 200 employees. Notwithstanding the above, BCA shall decide in its sole discretion whether a company/tenant is a SME.

'Total Incentive Amount' means the total cash incentives the Applicant may receive under the Scheme, which shall be the sum derived by multiplying the Qualifying Costs by the Percentage Qualifying Costs. 'Percentage Qualifying Costs' shall have the meaning assigned in paragraph 5.1 of these Guidelines.

'Variable Refrigerant Flow (VRF) System' refers to a multi split system which provides cooling on an individual basis to multiple rooms from a common condensing unit, and the refrigerant flow is varied in response to the cooling load of the air-conditioned spaces.

2.2 Any reference to the "Building Owner" shall refer to the "Applicant" and vice versa.

## 3.0 ELIGIBILITY CRITERIA

## 3.1 Applicant that is a SME

To qualify for participation in this Scheme, the Applicant must submit documentary proof meeting the criteria below:

- (a) an Applicant must be a Building owner and must demonstrate to BCA that the Applicant is a SME;
- (b) the Applicant's Building must be an existing non-residential commercial development with a Gross Floor Area of at least 1,000 square metres and must have a central chilled water air-conditioning plant or will be upgrading to a central chilled water air-conditioning plant or optimising the existing central chilled water air-conditioning plant; or must have a Variable Refrigerant Flow (VRF) system or will be upgrading to a VRF system or optimising the existing VRF system.
- (c) In respect of the Green Mark Rating for the Building,
  - i) the Building must have attained a Green Mark Rating which is still in its validity period preceding the application; or
  - ii) the Applicant must, at the time of Application, have applied for Green Mark certification in respect of the Building and the Green Mark assessment has not commenced or been completed, or the outcome of the Green Mark assessment has not been conveyed to the Applicant; or
  - iii) the Applicant must, at the time of Application, be applying simultaneously for Green Mark certification in respect of the Building.
- (d) The Energy Improvement Works must include the replacement, upgrading or optimisation of the chiller plant or variable refrigerant flow system. Under

optimisation, building owner is required to adopt Energy Performance Contracting (EPC), where EPC Contractor must guarantee the committed energy savings.

- (e) Buildings with Variable Refrigerant Flow system, the applicant must comply with these additional eligibility criteria:
  - (i) GFA  $\leq$  8,000 m<sup>2</sup>
  - (ii) Achieve minimum 10% energy savings for Total Building Energy Consumption, to be computed from the utility bills for before and after the Energy Improvement Works.

# 3.2 Applicant that is from Non-Governmental Organisation (NGOs), Voluntary Welfare Organisation (VWOs), Religious Organisation

To qualify for participation in this Scheme, the Applicant must submit documentary proof meeting the criteria below:

- (a) an Applicant must be a Building owner;
- (b) the Applicant's Building must be an existing non-residential commercial development with a Gross Floor Area of at least 1,000 square metres and must have a central chilled water air-conditioning plant or will be upgrading to a central chilled water air-conditioning plant or optimising the existing central chilled water air-conditioning plant; or must have a Variable Refrigerant Flow (VRF) system or will be upgrading to a VRF system or optimising the existing VRF system.
- (c) In respect of the Green Mark Rating for the Building,
  - i) the Building must have attained a Green Mark Rating which is still in its validity period preceding the application; or
  - ii) the Applicant must, at the time of Application, have applied for Green Mark certification in respect of the Building and the Green Mark assessment has not commenced or been completed, or the outcome of the Green Mark assessment has not been conveyed to the Applicant; or
  - iii) the Applicant must, at the time of Application, be applying simultaneously for Green Mark certification in respect of the Building.
- (d) The Energy Improvement Works must include the replacement, upgrading or optimisation of the chiller plant or variable refrigerant flow system. Under optimisation, building owner is required to adopt Energy Performance Contracting (EPC), where EPC Contractor must guarantee the committed energy savings.

- (e) Buildings with Variable Refrigerant Flow system, the applicant must comply with these additional eligibility criteria:
  - (i) GFA  $\leq$  8,000 m<sup>2</sup>
  - (ii) Achieve minimum 10% energy savings for Total Building Energy Consumption, to be computed from the utility bills for before and after the Energy Improvement Works.

## 3.3 Applicant where at least 10% of the tenants in the Applicant's Building are SMEs

To qualify for participation in this Scheme, the Applicant must submit documentary proof meeting the criteria below:

- (a) an Applicant must be a Building owner and must demonstrate to BCA that at least 10% of the tenants (by numbers) in the Applicant's Building are SMEs.;
- (b) the Applicant's Building must be an existing non-residential commercial development with a Gross Floor Area of at least 1,000 square metres and must have a central chilled water air-conditioning plant or will be upgrading to a central chilled water air-conditioning plant or optimising the existing central chilled water air-conditioning plant; or must have a Variable Refrigerant Flow (VRF) system or will be upgrading to a VRF system or optimising the existing VRF system;
- (c) In respect of the Green Mark Rating for the Building,
  - i) the Building must have attained a Green Mark Rating which is still in its validity period preceding the application; or
  - ii) the Applicant must, at the time of Application, have applied for Green Mark certification in respect of the Building and the Green Mark assessment has not commenced or been completed, or the outcome of the Green Mark assessment has not been conveyed to the Applicant; or
  - iii) the Applicant must, at the time of application, be applying simultaneously for Green Mark certification in respect of the Building.
- (d) The Energy Improvement Works must include the replacement or upgrading or optimisation of the chiller plant or variable refrigerant flow system.
- (e) Buildings with Variable Refrigerant Flow system, the applicant must comply with these additional eligibility criteria:
  - (i) GFA  $\leq$  8,000 m<sup>2</sup>

- (ii) Achieve minimum 10% energy savings for Total Building Energy Consumption, to be computed from the utility bills for before and after the Energy Improvement Works.
- (f) in respect of the Green Mark Rating for,
  - the building owner must have, at the time of Application, on behalf of the SME tenants, applied for Green Mark certification through the Green Mark Portfolio Programme and the Green Mark assessment has not commenced or been completed, or the outcome of the Green Mark assessment has not been conveyed to the SME tenants; or
  - ii) the building owner must have, at the time of Application, on behalf of the SME tenants, be applying simultaneously for Green Mark certification in respect of their units.

or

The Energy Improvement Works in each unit of at least 10% of the SME tenants in the Applicant's Building must include the replacement or upgrading of the lightings.

- 3.4 Each Applicant shall duly fill in all required information in the Application Form and shall submit the Application Form to BCA with the following documents and written information:
  - a) Accounting & Corporate Regulatory Authority (ACRA) business profiles of Applicant, Applicant's tenants and corporate shareholders (both direct and indirect) of both Applicant and Applicant's tenants (where applicable).
  - b) Turnover eligibility
    - a. (For Applicants)
      - If the Applicant does not belong to a Group of companies (includes entities where applicant has >50% shares ownership in or owned by), its individual financial statements will be used to check its Turnover eligibility.
      - ii. If the Applicant **belongs** to a Group of companies, the <u>consolidated</u> <u>financial statements</u> of its ultimate holding company will be used to check its Turnover eligibility. In the absence of a holding company, the consolidated financial statements of the Applicant will be used to account for its subsidiaries.
    - b. (For Applicant's tenant)

- i. If the Applicant's tenant **does not belong** to a Group of companies (includes entities where tenant has >50% shares ownership in or owned by), Applicant's tenant to fill in the declaration form to confirm its Turnover eligibility.
- ii. If the Applicant's tenant **belongs** to a Group of companies, Applicant's tenant to fill in the declaration form to confirm its Turnover eligibility.
- c) A table showing the <u>detailed breakdown</u> of <u>each</u> Energy Improvement Works and Approved Equipment, actual contract cost, consultancy services and fees.
- d) A <u>detailed calculation</u> of the Projected Energy Savings for <u>each</u> of the Energy Improvement Works and Approved Equipment to be installed.
- e) A table showing the <u>summary</u> of the Energy Improvement Works and consultant services, Projected Energy Savings (in kWh and \$ using \$0.25/kWh), actual contract costs of the supply and installation of the Approved Equipment and/or Energy Improvement Works and the consultancy services fees.
- f) Copies of all utility bills in respect of the Building issued during the 12 months preceding the application. A table showing the summary of the building energy consumption for the 12 months shall also be submitted. This shall be the baseline of the building energy consumption for the computation of the energy savings.
- g) Contract documents and such other documents including Letter of Award to the contractors and Purchase Orders showing the details and costs of each of the Energy Improvement Works, which shall inter alia, act to provide evidentiary proof and/or basis of the Estimated Qualifying Costs.
- h) Contract document stating the consultancy and professional fees between Applicant and the consultant or BCA Registered Energy Auditor or green consultant showing the details and cost of the consultancy services, which shall inter alia, act to provide evidentiary proof and/or basis of the Estimated Qualifying Costs.
- Schedule or timelines including the dates for the start and completion for the whole Energy Improvement Works. If there are different schedules for the different works, the applicant shall submit a summary or the master schedule. The Applicant is to note that the timelines indicated by him in the Application Form shall be binding on the Applicant and any deviation from the indicated timelines shall require the prior written consent of BCA.
- j) Energy audit report of the existing chiller plant before the replacement work. The energy audit shall be approved and endorsed by a BCA Registered Energy

Auditor or Professional Mechanical Engineer and the report format shall comply with the requirements set out in Annex A of the Health Check Audit Report Guidelines.

- k) Documentary evidence of building ownership
- I) Certified true copy of tenancy agreement made between Applicant and Applicant's tenant, including supplemental agreements
- m) Such other documents as requested by BCA from time to time
- 3.5 Applications submitted without the required and complete supporting documents mentioned in paragraph 3.4 above, will be rejected.
- 3.6 The Scheme is not applicable in relation to any Energy Improvement Works or any equipment which had already commenced or already been installed before the time of application for participation in this Scheme.
- 3.7 BCA shall be entitled to reject any Application at its discretion notwithstanding the Applicant's compliance with this paragraph 3.0 without assigning any reason and without being liable to the Applicant in damages (direct damages, indirect damages or otherwise) or otherwise.
- 3.8 If BCA accepts the Application, BCA will issue a formal letter of offer (the "Letter of Offer") incorporating and / or modifying the terms herein and / or setting out further terms, and by which BCA offers the Applicant participation in the Scheme. If the Applicant wishes to accept BCA's offer as set forth in the Letter of Offer, the Applicant shall sign and return the letter of acceptance (the "Letter of Acceptance") appended to the Letter of Offer by the date stipulated in the Letter of Offer and if no stipulated date is mentioned in the Letter of Offer, a calendar month from the date of the Letter of Offer.

## 3A Removal, Alteration, or Obstruction of Energy Improvement Works

The Applicant shall not remove, alter or obstruct or cause the removal, alteration or obstruction of any Energy Improvement Works that comprise the Qualifying Costs and are made part of the Total Incentive Amount for **at least** \*7 **years, starting from the date of 2**<sup>nd</sup> **disbursement.** 

Where in the opinion of BCA any of the Energy Improvement Works have been removed, altered or obstructed, BCA shall be entitled to recover from the Applicant part or all the monies disbursed.

## 4.0 OBLIGATIONS OF APPLICANT

4.1 Within 24 calendar months from the receipt of the Letter of Acceptance by BCA (the "Expected Completion Date"), the Applicant shall complete the Energy Improvement Works (including testing and commissioning works) as proposed pursuant to paragraph 3.4 above. If the Applicant is unable to complete the Energy Improvement Works by the Expected Completion Date, the Applicant may send a written request at least 14 days prior to the Expected Completion Date setting out the reasons for his inability to complete the said works by the Expected Completion Date for BCA's consideration. BCA may, at its sole discretion, consent to an extension to the Expected Completion Date by sending a written notice to the Applicant, stipulating the extended Expected Completion Date and any other terms and conditions that BCA may impose on the Applicant in consideration of BCA granting the said extension. The said further extension to be granted by BCA (if any) is purely at BCA's sole discretion and nothing contained herein shall act to impose an obligation on BCA to agree to further extend the Expected Completion Date.

4.2 From the time of the commencement of Energy Improvement Works as indicated in the Application Form submitted by the Applicant, until the expiry of 12 months from the date of the completion of the Energy Improvement Works or the disbursement of the Third Tranche (as defined hereafter), whichever is later, the Applicant shall permit BCA's designated staff to enter the Building for the purposes of inspecting the Energy improvement Works or the installed Approved Equipment, provided that BCA shall give 1 week's written notice of its intention to carry out such inspection.

## 5.0 DISBURSEMENT OF GRANTS

5.1 Subject to the Applicant complying with all the terms and conditions of these Guidelines, BCA shall, at its sole discretion disburse the Total Incentive Amount to the Applicant. The Total Incentive Amount is dependent on the Green Mark Rating achieved or to be achieved by the Applicant in regards of the Building as indicated in his Application Form and the Aircon System Efficiency. The 'Percentage of Qualifying Costs' refers to the percentage of the Qualifying Costs, which percentages are as shown in the Table 1a, 1b and 1c below having regards to the Green Mark Rating.

Percentage of Qualifying Costs	Green Mark Rating		Aircon System Efficiency (kW/RT)		Airside Efficiency (kW/RT)*
35%	Gold or better	+	0.7 or better	+	0.28 or better
40%	Gold <sup>plus</sup> or better		0.65 or better	-	0.25 or better
50%	Platinum		0.6 or better		0.22 or better

Table 1a: Percentage of Qualifying Costs for Buildings using <u>water-cooled chilled</u> <u>water system</u>

\*Requirement for Airside Efficiency is applicable only when Energy Efficiency works include replacement of AHU/FCU.

Percentage of Qualifying Costs	Green Mark Rating		Aircon System Efficiency (kW/RT)
35%	Gold or better		0.9 or better
40%	Gold <sup>plus</sup> or better	+	0.85 or better
50%	Platinum	-	0.75 or better

## Table 1b: Percentage of Qualifying Costs for Buildings using VRF system

## Additional eligibility criteria:

(1) GFA  $\leq 8,000 \text{ m}^2$ 

(2) Achieve minimum 10% energy savings for Total Building Energy Consumption

Table 1c: Percentage of Qualifying Costs for Buildings undergoing Optimisation

Percentage of Qualifying Costs	Green Mark Rating		Aircon and Airside* System Efficiency (kW/RT)			
35%	Gold or better	+				
40%	Gold <sup>plus</sup> or better		To follow Green Mark Existing Non-Residential Building (GM ENRB) criteria			
50%	Platinum					

\*Requirement for Airside Efficiency is applicable only when Energy Efficiency works include replacement of AHU/FCU.

## 5.2 The Total Incentive Amount will be disbursed in 3 tranches:

- (a) First disbursement for the Professional Services ("First Tranche")
- (b) Second disbursement upon successful completion and commissioning of the Energy improvement Works ("Second Tranche"), and
- (c) Third and final disbursement upon verification of the air-conditioning system efficiency and commitments made for the Green Mark certification ("Third Tranche").

## 5.3 <u>First Disbursement</u>

5.3.1 For disbursement under the <u>First Tranche</u>, the Applicant shall submit a written request/application to BCA for this disbursement. The following list of documents and written information must be submitted together with this application:-

- (a) Certified true copy of the original tax invoices of the consultancy fees which have been paid to the consultants for the Professional Services
- (b) A table stating the scope of works and consultancy fees for each of the appointed consultants.
- (c) BCA's Letter of Offer and Building Owner's Letter of Acceptance for the Green Mark Incentive Scheme for Existing Buildings and Premises (GMIS-EBP)
- (d) Letter of Award of the Green Mark certification issued in respect of the Building;

For applications under Energy Performance Contracting, BCA shall, at its sole discretion determine and disburse the First Tranche subject to the following conditions:-

- (a) certified true copy of the original duly signed EPC agreement made between the Building owner and the EPC Contractor ("EPC Agreement");
- (b) certified true copy of original tax invoices and receipts of payments in respect of the Professional Services fees between: (1) EPC Contractor and the Professional Services Consultant; or (2) Professional Services Consultant and the Building owner.
- (c) (if the Applicant is a management corporation strata title) certified true copy of council resolution or resolution passed at a general meeting approving MCST entering into the EPC Agreement;
- (d) certified true copy of director's resolution approving Applicant entering into the EPC agreement
- 5.3.2 The disbursement under the First Tranche shall be no higher than the FT Cap listed in Table 2a, 2b and 2c below and shall be calculated in accordance with the FT Percentage shown in the table below:-

First Tranche co-funding rate (percentage of Total Incentive Amount ) ("FT Percentage")	Cap on First Tranche ("FT Cap")	Green Mark Rating	+	Aircon System Efficiency (kW/RT)	+	Airside Efficiency (kW/RT)*
5%	\$150,000	Gold or better		0.7 or better		0.28 or better
8%	\$300,000	Gold <sup>plus</sup> or better		0.65 or better		0.25 or better

10%	\$600.000	Platinum		0.6 or better	0.22 or
10%	<b>\$000,000</b>	Tiadinam			better

\*Requirement for Airside Efficiency is applicable only when Energy Efficiency works include replacement of AHU/FCU.

## Table 2b: First Tranche for Buildings using VRF system

First Tranche co- funding rate (percentage of Total Incentive Amount ) ("FT Percentage")	Cap on First Tranche ("FT Cap")	Green Mark Rating		Aircon System Efficiency (kW/RT)
5%	\$75,000	\$75,000 Gold or better		0.9 or better
8%	\$150,000	Gold <sup>plus</sup> or better		0.85 or better
10%	\$200,000	Platinum		0.75 or better

## Additional eligibility criteria:

(1) GFA ≤ 8,000 m<sup>2</sup>

(2) Achieve minimum 10% energy savings for Total Building Energy Consumption

## Table 2c: First Tranche for Buildings undergoing Optimisation

First Tranche co- funding rate (percentage of Total Incentive Amount) ("FT Percentage")	Cap on First Tranche ("FT Cap")	Green Mark Rating		Aircon and Airside* System Efficiency (kW/RT)	
5%	\$75,000	000 Gold or better		To follow Green	
8%	\$150,000	Gold <sup>plus</sup> or better		Non-Residential	
10%	\$200,000 Pla			Building (GM ENRB) criteria	

\*Requirement for Airside Efficiency is applicable only when Energy Efficiency works include replacement of AHU/FCU.

5.3.3 BCA shall, at its sole discretion determine and disburse the First Tranche subject to BCA's receipt of the documents mentioned in Para 5.3.1.

## 5.4 Second Disbursement

- 5.4.1 For the Second Tranche, Applicant shall submit his written application to BCA within 3 calendar months from the date of completion of the Energy Improvement Works. The disbursement under the Second Tranche shall be a percentage of the Qualifying Costs shown at Table 3a and 3b below, which shall supported by evidentiary proof submitted by the Applicant. The Second Tranche shall be disbursed subject to the following conditions:-
  - (a) the completion of the Energy improvement Works including testing and commissioning; and
  - (b) submission of the following documents to BCA:-
    - (i) Green Mark certificate or letter of award issued in respect of the Building; if the same was not furnished at the time of application;
    - (ii) testing and commissioning reports showing, to BCA's satisfaction, that the Energy Improvement Works have been completed;
    - duly signed completion certificate or written document from the building owner or Applicant to the contractor, stating the date of completion of the Energy Improvement Works; and
    - (iv) Certified true copies of purchase orders, tax invoices, receipts of payments, utility bills and / or such other documents that BCA may require showing the actual costs of the Energy Improvement Works and the Approved Equipment installed.
    - (v) Letter of Approval for first disbursement issued in respect of the Energy Improvement Works.
    - (vi) Operating System Efficiency (OSE) report verifying the Aircon System Efficiency, the report format shall be in accordance with the template in Annex B. This shall be approved and endorsed by a BCA Registered Energy Auditor or Professional Mechanical Engineer.
  - (c) For applications under Energy Performance Contracting:
    - (a) certified true copy of the original duly signed EPC agreement made between the Applicant and the EPC Contractor ("EPC Agreement");
    - (b) (if the Applicant is a management corporation strata title) certified true copy of council resolution or resolution passed at a general meeting approving MCST entering into the EPC Agreement and Master Financial Payment Agreement;
    - (c) certified true copy of director's resolution approving Applicant entering into the EPC agreement and Master Financial Payment Agreement; and certified true copy of original tax invoices and receipts of payments

in respect of the fees for the Upgrading or Retrofitting Works between: (1) any third party vendor and EPC Contractor; or (2) EPC Contractor and the Building owner.

5.4.2 The disbursement under the Second Tranche shall be subject to the ST Cap listed in Table 3a, 3b and 3c below and shall be no higher than the Total Incentive Amount less the amount disbursed in the First Tranche times the ST Percentage listed in Table 3 below.

Second Tranche co-funding rate (percentage of Total Incentive Amount) ("ST Percentage")	Cap on Second Tranche ("ST Cap")	Green Mark Rating	+	Aircon System Efficiency (kW/RT)	+	Airside Efficiency (kW/RT)*
17.5%	\$750,000	Gold or better		0.7 or better		0.28 or better
20%	\$1,125,000	Gold <sup>plus</sup> or better		0.65 or better		0.25 or better
25%	\$1,500,000	Platinum		0.6 or better		0.22 or better

## Table 3a: Second Tranche for Buildings using water-cooled chilled water system

\*Requirement for Airside Efficiency is applicable only when Energy Efficiency works include replacement of AHU/FCU

## Table 3b: Second Tranche for Buildings using VRF system

Second Tranche co- funding rate (percentage of Total Incentive Amount) ("ST Percentage")	Cap on Second Tranche ("ST Cap")	Green Mark Rating		Aircon System Efficiency (kW/RT)
17.5%	\$250,000	Gold or better	+	0.9 or better
20%	\$300,000	Gold <sup>plus</sup> or better		0.85 or better
25%	\$350,000	Platinum		0.75 or better

## Additional eligibility criteria:

- (1) GFA  $\leq 8,000 \text{ m}^2$
- (2) Achieve minimum 10% energy savings for Total Building Energy Consumption

Table 3c: Second Tranche for Buildings undergoing **Optimisation** 

Second Tranche co- funding rate (percentage of Total Incentive Amount) ("ST Percentage")	Cap on Second Tranche ("ST Cap")	Green Mark Rating		Aircon and Airside* System Efficiency (kW/RT)
17.5%	\$250,000	Gold or better	+	To follow Green
20%	\$300,000	Gold <sup>plus</sup> or better		Non-Residential
25%	\$350,000	Platinum		ENRB) criteria

\*Requirement for Airside Efficiency is applicable only when Energy Efficiency works include replacement of AHU/FCU.

5.4.3 BCA shall, at its sole discretion determine and disburse the Second Tranche subject to BCA's receipt of the documents mentioned in Para 5.4.1.

## 5.5 Third Disbursement

- 5.5.1 For the Third Tranche, the Applicant shall submit the request/application to BCA after 12 months but not later than 14 months from the date of completion of the Energy Improvement Works. The following list of documents and written information must be submitted together with this application:-
  - (a) all utility bills in respect of the Building issued in the 12 months following the date of completion of the Energy Improvement Works;
  - (b) a detailed calculation of the Actual Energy Savings based on the total building energy consumption from utility bills before (refer to the baseline as mentioned in Para 3.4 (c)) and after the Energy Improvement Works;
  - (c) document stating the amount of the incentive given in the first and second disbursements issued in respect of the Energy Improvement Works; and
  - (d) Operating System Efficiency (OSE) report verifying the Aircon System Efficiency, the report format shall be in accordance with the template in Annex B. This shall be approved and endorsed by a BCA Registered Energy Auditor or Professional Mechanical Engineer.
- 5.5.2 BCA shall determine at its sole discretion if the calculations by the Applicant of the Actual Energy Savings and Aircon System Efficiency, are accurate. BCA shall be entitled to substitute its own calculations for those by the Applicant if it is of the view that the Applicant's calculation(s) is / are not accurate. BCA shall also be entitled to substitute the Registered Energy Auditor or Professional Mechanical Engineer determination of the Aircon System Efficiency with its own if it is of the view that the Aircon System Efficiency figure(s) as stated in the OSE report is not accurate. BCA's

determination of the Actual Energy Savings and Aircon System Efficiency shall prevail and be conclusive.

- 5.5.3 BCA reserves the right to withhold the disbursement under the Third Tranche if:-
  - (a) any or all of the supporting documents mentioned in paragraph 5.5.1 is/are missing;
  - (b) the targeted and/or required Aircon System Efficiency is not achieved; and/or
  - (c) the projected Actual Energy Savings is not achieved.

In the event BCA exercises its right to withhold disbursement under the Third Tranche as described in this paragraph 5.5.3 or elsewhere in these Terms and Conditions and notwithstanding anything to the contrary contained herein, BCA shall not be held liable to the Applicant under any circumstance whatsoever and howsoever arising.

- 5.5.4 The disbursement of the Third Tranche shall be in accordance with Table 4a, 4b and 4c. The Third Tranche shall be derived or calculated as follows:-
  - (a) the Third Tranche shall be the Total Incentive Amount, which amount shall not in any event, exceed the IA Cap listed in Table 4 below;
  - (b) the Third Tranche shall be the positive difference between the Total Incentive Amount as indicated in Table 4a and 4b; and the total of all disbursements under the First Tranche and Second Tranches;
  - (c) the Third Tranche represents the cumulative total amount of cash incentive to be disbursed, inclusive of the First Tranche and Second Tranche, i.e. the whole of the Total Incentive Amount;
  - (d) the Total Incentive Amount shall represent the Percentage of Qualifying Costs, as indicated in Table 1a and 1b.
  - (e) (for Energy Performance Contracting) certified true copy of original tax invoices and receipts of payments in respect of the fees for the Upgrading or Retrofitting Works between: (1) any third party vendor and EPC Contractor; or (2) EPC Contractor and the Building owner.

Table 4a: Third Tranche for Buildings using water-cooled chilled water system

Co-funding Rate (percentage of Total Incentive Amount)	Cap on Incentive Amount ("IA Cap")	Green Mark Rating	+	Aircon System Efficiency (kW/RT)	+	Airside Efficiency (kW/RT)*
---	---	----------------------	---	---	---	-----------------------------------

("TT Percentage")				
35%	\$1,500,000	Gold or better	0.7 or better	0.28 or better
40%	\$2,250,000	Gold <sup>plus</sup> or better	0.65 or better	0.25 or better
50%	\$3,000,000	Platinum	0.6 or better	0.22 or better

\*Requirement for Airside Efficiency is applicable only when Energy Efficiency works include replacement of AHU/FCU

Table 4b: Third Tranche for Buildings using VRF system

Co-funding Rate (percentage of Total Incentive Amount) ("TT Percentage")	Cap on Incentive Amount ("IA Cap")	Green Mark Rating		Aircon System Efficiency (kW/RT)
35%	\$500,000	Gold or better	+	0.9 or better
40%	\$600,000	Gold <sup>plus</sup> or better		0.85 or better
50%	\$700,000	Platinum		0.75 or better

## Additional eligibility criteria:

(1) GFA  $\leq 8,000 \text{ m}^2$ 

(2) Achieve minimum 10% energy savings for Total Building Energy Consumption

## Table 4c: Third Tranche for Buildings undergoing Optimisation

Co-funding Rate (percentage of Total Incentive Amount) ("TT Percentage")	Cap on Incentive Amount ("IA Cap")	Green Mark Rating		Aircon and Airside* System Efficiency (kW/RT)	
35%	\$500,000	Gold or better	+	To follow Green	
40%	\$600,000	Gold <sup>plus</sup> or better		Non-Residential	
50%	\$700,000	Platinum		ENRB) criteria	

\*Requirement for Airside Efficiency is applicable only when Energy Efficiency works include replacement of AHU/FCU.

If the Total Incentive Amount is less than the First Tranche and Second Tranche already disbursed, the Applicant:-

- (a) shall not be entitled to the any disbursement under the Third Tranche; and
- (b) shall pay to BCA the difference between the First and Second Tranches and the Total Incentive Amount forthwith upon written demand as a debt.

## 6.0 SUBMISSION PROCEDURES

6.1 All applications should be made in the format found in GMIS-EBP (Building Owners) Application Form and sent to:

> Director Green Building Policy Department GREEN MARK INCENTIVE SCHEME FOR EXISTING BUILDINGS AND PREMISES (GMIS-EBP) c/o Building and Construction Authority 52 Jurong Gateway Road, #11-01 Singapore 608550

## 7.0 MISCELLANEOUS

- 7.1 The Annexes hereto form an integral part of these Guidelines. In the event of any inconsistency between the contents of the Annexes and the contents of this main document, the contents of these Guidelines shall prevail.
- 7.2 Without prejudice to the rights of BCA at common law, equity or otherwise, in the event:-
  - (a) of any failure by the Applicant to discharge its obligations set out in paragraph 4 above; or
  - (b) that BCA shall determine, at any time after the Applicant has accepted BCA's offer for participation in the Scheme, that any information supplied to or declaration made to BCA by the Applicant and any of the Applicant's tenants

arising from or in connection with the Applicant's participation in the Scheme, whether in the application form or elsewhere, is false or misleading,

then BCA:-

- (i) shall, if the Third Tranche has not been disbursed, be entitled to terminate the Applicant's participation in the Scheme and shall be under no obligation to make further payments which would otherwise be paid; and
- (ii) shall, whether or not the Third Tranche has been disbursed, be entitled to recover from the Applicant all monies disbursed.
- 7.3 Any risk associated with and damages arising from the Applicant's participation in the Scheme shall be borne solely by the Applicant. BCA shall not be liable in contract, tort or any other cause of action for any damages, loss or expense including without limitation, direct, indirect, special or consequential damage or economic loss, however sustained by the Applicant arising out of the applicant's participation (direct or indirect) in the Scheme and/or any use (direct or indirect) of, provision of or reliance on the Scheme or these Guidelines or any part thereof. BCA specifically excludes the same to the fullest extent permitted by law even if BCA has been advised in advance of the possibility of such damages.
- 7.4 BCA expressly disclaims any and all representations or warranty regarding the Scheme, whether express or implied, including but not limited to warranties as to accuracy, timeliness, completeness, compliance with a particular description or any implied warranty arising from the course of performance or otherwise, to the fullest extent permitted by law. BCA makes no warranty that the Scheme and/or the provision of the cash incentives thereunder will meet the requirements of the Applicant.
- 7.5 The Applicant indemnifies and keeps indemnified BCA and its servants and/or agents against all damages (including without limitation, direct, indirect, special or consequential damage or economic loss) BCA and/or its servants and/or agents may sustain or incur (including those sustained or incurred as a result of a claim by a third party against BCA or its servants and/or agents) directly or indirectly relating to or in connection with
  - (a) the Applicant's breach of any terms and conditions contained herein, howsoever arising;
  - (b) any injury to or death of any person whomsoever or damage to any property whatsoever due to any act or omission of the Applicant or any party acting on behalf of the application arising out of or in any way relating to the Scheme and/or these Guidelines; and/or
  - (c) any negligence, fraud or unlawful act or omission of the Applicant or any party acting on behalf of the applicant.

- 7.6 These Guidelines shall be interpreted, construed and governed by the laws of the Republic of Singapore and all parties under the Scheme pursuant to these Guidelines submit to the exclusive jurisdiction of the courts of the Republic of Singapore.
- 7.7 From the time of issuance of the Letter of Acceptance until the disbursement of the Total Incentive Amount under the Third Tranche, the Applicant shall:-
  - ensure that the Building is used strictly for the purpose indicated in the Application Form, which in any event shall be solely for non-residential purposes;
  - (b) not -effect any change in the use of the Building without the prior written consent of the Authority; and
  - (c) remain the owner of the Building.
- 7.8 The Applicant shall not assign or attempt to assign or otherwise transfer any right or obligation arising out of or in relation with these Guidelines or the Scheme without the written consent of BCA.
- 7.9 Notwithstanding anything set out herein, BCA shall be entitled to amend any of the contents herein or in the annexes hereto at any time upon provision of written notice to the Applicant.
- 7.10 Time shall be of the essence in regards to the Applicant's participation in the Scheme, both as regards the dates and periods mentioned in these Guidelines and as regards any dates and periods which may be substituted for them in accordance with these terms and conditions.
- 8.11 For the purposes of the Contracts (Rights of Third Parties) Act (Chapter 53B), any agreement between BCA and the Applicant is not intended to, and does not, give any person who is not a party to it any right to enforce any of its provisions.
- 8.12 The Applicant undertakes that he shall obtain all and any necessary approvals, licences and/or permits as may be required by any relevant competent authority in regards to any and all aspects of the Building. The Applicant further undertakes that he shall comply with all applicable codes and standards set by any relevant competent authority in respect of the design of the air-conditioning system and/or the Energy Improvement Works in relation to the Building, which shall include without limitation engaging a Professional Engineer to endorse on the design, where necessary.
- 7.13 BCA is entitled from time to time, through its Audit Agents, to conduct ad-hoc onsite audits to ensure that the terms of the Agreement (as defined in the Letter of Offer) are being, or were met and that reports and all information submitted to the BCA by the grantee are accurate, correct and not misleading.

- 7.14 The grantee shall ensure that BCA's Audit Agents are given full access to all accounts, records, documents, assets and premises in connection with the grant, and shall provide BCA and its Audit Agents with all reasonable cooperation and assistance in connection with the audits.
- 7.15 The Parties shall bear their own respective costs and expenses incurred in respect of compliance with their obligations under this clause, unless the audit identifies a material breach or default of this agreement by the grantee, in which case the grantee shall reimburse BCA for all of BCA's reasonable costs incurred in connection with the audit.
- 7.16 For the purpose of this clause, the term "Audit Agents" means such auditor as may be appointed by BCA."

## 8.0 ENQUIRIES

For enquiries on the application, please contact the officers listed in BCA's website: <a href="http://www.bca.gov.sg/GreenMark/gmisebp.html">http://www.bca.gov.sg/GreenMark/gmisebp.html</a>

# LIST OF COMMONLY APPROVED ENERGY EFFICIENCY EQUIPMENT & ENERGY IMPROVEMENT WORKS

- 1) Variable Speed Drives (VSD)
- 2) Chillers
- 3) Chilled Water Pumps
- 4) Condenser Water Pumps
- 5) Cooling Towers
- 6) Chiller Plant Energy Optimization System
- 7) Chiller Auto Condenser Tube Cleaning System
- 8) Building Automation System (BAS)
- 9) Energy Efficient Lightings, e.g. T5 & PLC
- 10) Lighting Control System
- 11) Light Emitting Diodes (LED) Lightings
- 12) Efficient Air Handling Units and Fan Coil Units (to show minimum 10% improvement in energy efficiency)
- 13) CO2 Sensors for AHU System
- 14) CO Sensors for Carpark Ventilation Control System
- 15) Photo Sensors
- 16) Motion Sensors
- 17) Heat Pumps
- 18) Regenerative drives for lifts
- 19) Motion sensors for escalators
- 20) Solar panels or other renewable energy sources
- 21) Permanent Measuring and Verification instrumentations i.e. flow meters, temperature sensors and power meters; for monitoring central chilled water plant system efficiency. Accuracy shall comply with BCA's requirements.
- 22) Variable Refrigerant Flow system or equivalent system
- 23) Piping and electrical cablings related to the Energy Improvement Works.
- 24) Consultancy fees

Note: Any other equipment not in the above common list will be subjected to review and approval from BCA.

## LIST OF OPTMISATION WORKS

The list of these optimisation works shall include, but not limited to the following: -

- 1) Installation of Variable Speed Drives (VSD) for cooling tower fans' motors, pumps; motors, AHU motors and fans' motors
- 2) Removal of existing throttling valves or fittings to reduce the high pressure losses/resistance in the system
- 3) Replacement of pipe works to have a smoother flow (45 degrees bend instead of 90 degrees bend) and reduce resistance in the system
- 4) Trimming or replacing impeller for oversized pumps
- 5) Replacement to high efficient motors and in-fills for cooling towers
- 6) Installation of Chiller Plant Optimization System to optimize the chiller plant operations and controls and achieve better plant system efficiency; and shall have the capability to compute heat balance
- 7) Installation of permanent Measuring and Verification instrumentations i.e. flow meters, temperature sensors and digital power meters; for monitoring central chilled water plant system efficiency. Accuracy shall comply with BCA's requirements
- 8) Installation of automatic condenser tube cleaning system for the existing chillers
- Replacement of cooling coils, blower and motors for Air Handling Units and Fan Coil Units
- 10) Installation of digital power meter for Air Handling Units
- 11) Installation of volume control dampers and controls for fresh air for the Air Distribution System
- 12) Installation of Carbon Dioxide (CO2) sensors and controls
- 13) Installation of Carbon Monoxide (CO) sensors and controls
- 14) Replacement to Re-generative motors or AC variable voltage and variable frequency motor drives for lifts
- 15) Replacement of approved energy efficiency equipment & energy improvement works (excluding chiller replacement) as stated in Annex A

Note: Any other optimization measures not in the above list will be subjected to review and approval from BCA.

ANNEX C

Date: DD/MM/YYYY

# ENERGY AUDIT REPORT FOR BUILDING COOLING SYSTEM

## FOR

## ENTER BUILDING NAME

# At

# **ENTER BUILDING ADDRESS**

# (BUILDING IMAGE)

Submitted By

Enter name of PE/Energy Auditor :

Signature of PE/Energy Auditor :

PE (Mech) Registration No\*: Enter No.

Energy Auditor Registration No\*: Enter No.

\*Delete whichever is not applicable

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\*required if using wet bulb temperature as set point

## 1.0 Executive Summary & Recommendation

## (Example)

This report highlights the findings and recommendations obtained from the energy audit performed at <u>Enter Building Name</u> from [Enter Period of Audit] DD/MM/YYYY to DD/MM/YYYY for 24 hrs.

- 1) <Description of findings>
- 2) <Description of findings>
- 3) <Description of findings>

#### Recommendations for maintenance improvements and low cost energy conservation measures.

- 1) <Description of recommendations>
- 2) <Description of recommendations>
- 3) <Description of recommendations>

Please indicate "NIL" if there is no recommendations.

## Recommendations which would incur capital expenditure.

- 1) <Description of recommendations>
- 2) <Description of recommendations>
- *3) <Description of recommendations*

Please indicate "NIL" if there is no recommendations.

# 2.0 Building Information

Enter a brief description of the building here. XXXXXXXXXXXX

Green Mark Reference Number	:
Building Name	:
Building Address	:
Postal Code	:
Building Type	:
Building Age	:
Date of last Energy Audit Submission	:
Gross floor area (GFA), m²	:
Air conditioned area, m <sup>2</sup>	:
Number of guest rooms (for hotels/service apartments)	:

## 3.0 Energy Audit Information for Building Cooling System

**Enter PE(Mechanical) / Energy Auditor Name** was appointed by **Enter Owner Name/ MCST**, owner of **Enter Building Name** to be the Energy Auditor for the submission of the operating system efficiency (OSE) of the centralized Chilled Water Plant. The report will present the performance of centralized Chilled Water Plant efficiency based on the measurements from the permanent instrumentations installed on site.

Location	:	Enter location of Chilled Water Plant
Energy Audit Period	:	Enter Energy Audit period
		*Note: Minimum 1 week
Data Logging Interval	:	1 minute sampling
Trend Logged Parameters*	:	Chilled Water Supply main header temperature
		Chilled Water Return main header temperature
		Chilled Water flow rate at chilled water return main header
		Condenser Water Supply main header temperature
		Condenser Water Return main header temperature
		Condenser water flow rate at condenser water return main header
		Power input to Chiller(s)
		Power input to Chilled water pump(s)
		Power input to Condenser water pump(s)
		Power input to Cooling tower(s)

\* Trend logged parameters are not limited to the above and may vary depending on the piping and electrical circuit design.

## 3.1 Chilled Water Plant Design information\*

ID	Description	Туре	Name plate motor (kW)	Total Cooling Capacity (RT)	Chilled water LWT/EW T	Chilled water ∆T	Rated Efficiency kW/RT	Year Installed
CH01	Chiller 1	Centrifugal	239	440	6.7 °C - 12.24 °C	5.54°C	0.543	2014
CH02	Chiller 2	VSD Screw	239	440	6.7 °C - 12.24 °C	5.54°C	0.543	2014
CH02	Chiller3	Screw	239	440	6.7 °C - 12.24 °C	5.54°C	0.543	2014

 Table 1: Chiller Information (Example)

ID	Description	Name plate motor (kW)	Pump Head (m)	Flow rate (L/S)	Rated Pump/ Fan efficiency	Rated Motor Efficiency
CHWP 1	Chilled water pump 1	30	25	67.65	81.5%	93.2%
CHWP 2	Chilled water pump 2	30	25	67.65	81.5%	93.2%
CHWP 3	Chilled water pump 3	30	25	67.65	81.5%	93.2%
CWP 1	Condenser water pump 1	18.5	17	84.18	80.5%	92.2%
CWP 2	Condenser water pump 2	18.5	17	84.18	80.5%	92.2%
CWP 3	Condenser water pump 3	18.5	17	84.18	80.5%	92.2%
CT 1	Cooling tower 1	5.5 x 3 Cells	-	82.61	75%	86%
CT 2	Cooling tower 2	5.5 x 3 Cells	-	82.61	75%	86%
CT 3	Cooling tower 3	5.5 x 3 Cells	-	82.61	75%	86%

 Table 2: Ancillary equipment Information (Example)

\*Based on equipment design specifications and name plate ratings

## 3.2 Chilled Water Plant Normal Operating Hours

Monday to Friday	:	1000 – 2100 Hrs
Saturday	:	No operations
Sunday	:	No operations

Note: The operating hours should follow the table in clause 6.1.4

## 3.3 Description of Plant Control Strategy

Summary of the present plant control strategy adopted for the applicant's building chiller plant systems' operation. You may include but not limited to the following:

## 1) Chiller sequencing

Describe how the chiller(s) operate to handle the varying building cooling load e.g. chiller cut-in/out sequence varying with building load and addressing peak and off peak load based on (supply water temperature, and/or building load, and/or compressor current running load amps) and time delay.

## 2) Chilled water pump (if applicable)

Describe the parameters used to control chilled water pumps e.g. pump speed modulate based on ((differential) pressure sensor located at chiller header, or remote AHU cooling coil, or several zones of AHU cooling coil, or optimising pump pressure by critical valve control), set-point(s) and bypass valve controls to ensure chillers operate at minimum flow rate.

## 3) Condenser water pump (if applicable)

Describe the parameters used to control condenser water pumps e.g. modulate to maintain condenser water differential temperature set point or gpm/ton and the set-point(s).

## 4) Cooling tower (if applicable)

Describe the parameters used to control cooling towers e.g. Modulate base on cooling tower approach temperature (difference between CT leaving water temperature and ambient wet-bulb temperature) set point (adjustable), or scheduled cooling tower leaving temperature set point, or dynamic optimized cooling tower leaving water temperature set point and the set-point(s)

## 5) Other optimisation (if applicable)

## Describe any other optimisation used

e.g. Chilled water supply temperature reset. At off-peak period, reset based on outdoor air temperature/humidity, or VPF bypass control, or predefined schedule. (Note: Resetting CHW temperature may incur higher pump power and may compromise on space temperature and relative humidity)

## (Example)

Chiller Configuration: <x> unit(s) of <x> RT chiller & <x> unit(s) of <x> RT chiller

Variable Primary Chilled Water System

Variable Condenser Pump

## 1) Chiller sequencing

Scenario for Cut-in: Chilled water supply header temperature is above set point of <x> °C + <deadband> <u>OR</u> total system tonnage is above <x> RT for a period of <x> minutes.

*Scenario for Cut-out:* Chilled water supply header temperature is below set point of <x> °C + <deadband> <u>AND</u> total system tonnage is below <x> RT for a period of <x> minutes.

*Time delay:* Whenever any chiller cuts-in/out, there is <x> minutes delay to allow system to stabilize.

## 2) Chilled water pump (CHWP)

Primary CHWP speed is modulated to maintain a differential pressure set point of <x> psi + <deadband>. Differential pressure sensors are installed at chilled water pipe headers. CHWP speed is limited to <x> Hz to ensure chillers running at minimum flow. When CHWP speed ramps down to minimum and differential pressure rises above set point, the bypass valve will open to maintain DP set point and minimum flow rate.

## 3) Condenser water pump (CWP) <fixed/variable>

Minimum running speed of CWP is <x> Hz. When condenser flow rate is reduced to set point of <x> l/s or <x> gpm/ton, CWP speed would be increased and vice versa.

## 4) Cooling Tower (CT)

CT fan speed is modulated to maintain leaving condenser water temperature set point of <x>  $^{\circ}$ C which is equal to outdoor air wet-bulb temp plus <x>  $^{\circ}$ C. When chiller(s) is in operation, all CTs would be turn on. When CT leaving water temperature falls below the set point, CT fan speed would be decreased until minimum speed of <x> Hz.

## 5) Other Optimisation

Chilled water temperature set point is reset to <x> °C during off-peak period from 2000hrs to 0800hrs.

## 4.0 Instrumentations

Accurate measuring instruments complying with the Code on Environmental Sustainability Measures for Existing Buildings or the Code for Environmental Sustainability of Buildings (2<sup>nd</sup> edition and onwards) that is prevailing at the time of installation were used during the audit to gather information on the power consumption, temperatures and flow rate.

ID /	Description	Sensor	Installation	Measurement/	Measurement	Last	Calibration
Serial No.		Туре	Location	Calibration	Uncertainty	Calibration	Laboratory
	Duran d V	10V O	CHWG		(%)	Date	
EP80367	Drand A Temperature Sensor	Thermistor	Header	0.01°C – 29.765°C	±0.03 °C	09/05/2014	XX laboratory
ED90264	Brand X	$10K \Omega$	CHWR	0.01°C –	10.02 °C	00/05/2014	VV laboratory
EF 80304	Temperature Sensor	Thermistor	Header	29.765°C	±0.03 C	09/03/2014	AA laboratory
EP80361	Brand X Temperature Sensor	10K Ω Thermistor	CWS Header	0.01°C – 29.765°C	±0.03 °C	09/05/2014	XX laboratory
ED00262	Brand X	$10K \Omega$	CWR	0.01°C –	.0.02 .00	00/05/2014	XXX 1 1 (
EP80303	Temperature Sensor	Thermistor	Header	29.765°C	±0.03 °C	09/05/2014	XX laboratory
3k672013	Brand X	Magnetic Full Dama	CHWR	0 l/s- 288.63 l/s	0.5%	29/10/2013	XX laboratory /
43004	CHW Flow Meter	Full Bore	Header				Tactory calibration
18063	CW Flow Meter	Ultrasonic	Header	0 l/s- 483.33 l/s	0.5%	09/05/2014	factory calibration
38498	Brand X Incoming Power 1	True RMS, 3 phase	MSB Incoming 1	60 - 600  kW	0.5%	08/07/2014	XX laboratory / factory calibration
1402404	Brand X Incoming Power 2	True RMS, 3 phase	MSB Incoming 2	0 – 99999 MW	0.2%	08/07/2014	XX laboratory / factory calibration
38491	Brand X Chiller 1	True RMS, 3 phase	CH/6-1	0 – 99999 MW	0.2%	08/07/2014	
38487	Brand X Chilled Water Pump 1	True RMS, 3 phase	CHP/6-1	0 – 99999 MW	0.2%	08/07/2014	
38490	Brand X Condenser Water Pump 1	True RMS, 3 phase	CWP/6-1	0 – 99999 MW	0.2%	08/07/2014	-
38499	Brand X Cooling Tower 1	True RMS, 3 phase	CT/6-1	0 – 99999 MW	0.2%	08/07/2014	-
38497	Brand X Chiller 2	True RMS, 3 phase	CH/6-2	0 – 99999 MW	0.2%	08/07/2014	-
38483	Brand X Chilled Water Pump 2	True RMS, 3 phase	CHP/6-2	0 – 99999 MW	0.2%	08/07/2014	-
1402325	Brand X Condenser Water Pump 2	True RMS, 3 phase	CWP/6-2	0 – 99999 MW	0.2%	08/07/2014	-
38572	Brand X Cooling Tower 2	True RMS, 3 phase	CT/6-2	0 – 99999 MW	0.2%	08/07/2014	-
1402399	Brand X Chiller 3	True RMS, 3 phase	CH/6-3	0 – 99999 MW	0.2%	08/07/2014	-
38574	Brand X Chilled Water Pump 3	True RMS, 3 phase	CHP/6-3	0 – 99999 MW	0.2%	08/07/2014	-
38485	Brand X Condenser Water Pump 3	True RMS, 3 phase	CWP/6-3	0 – 99999 MW	0.2%	08/07/2014	-
38486	Brand X Cooling Tower 3	True RMS, 3 phase	CT/6-3	0 – 99999 MW	0.2%	08/07/2014	-

The points of measurements are listed in the following table:

 Table 3: Instrumentation Table (Example)

## 5.0 Chiller Plant Performance Analysis (1 week data)



Figure 1: Super-imposed plot of 24 hr Cooling Load Profile RT (Example)



Figure 2: Histogram of Cooling Load Occurrences (Example)



Figure 3: Super-imposed plot of daily chilled water supply/return temperature °C (Example)



Figure 4: Super-imposed plot of daily chilled water temperature difference °C (Example)



Figure 5: Super-imposed plot of daily condenser water supply/return temperature °C (Example)



Figure 6: Super-imposed plot of daily condenser water temperature difference °C (Example)



Figure 7: Super-imposed plot of daily chilled water GPM/RT (Example)



Figure 8: Super-imposed plot of daily condenser water GPM/RT (Example)



\*Figure 9: Cooling Tower Approach Temperature (Example)

\*required if using wet bulb temperature as set point



Figure 10: Super-imposed plot of daily chiller efficiency kW/RT (Example)

<sup>+</sup>Weighted average:  $\sum kW$ -hr /  $\sum RT$ -hr



Figure 11: Super-imposed plot of daily chilled water pump efficiency kW/RT (Example)



Figure 12: Super-imposed plot of daily condenser water pump efficiency kW/RT (Example)



Figure 13: Super-imposed plot of daily cooling tower efficiency kW/RT (Example)



Figure 14:Super-imposed plot of daily chiller plant system efficiency kW/RT (Example)



Figure 15: Scatter plot of chiller plant efficiency over cooling load (Example)



Figure 16: Scatter plot of chilled water pump efficiency over cooling load (Example)



Figure 17: Scatter plot of condenser water pump efficiency over cooling load (Example)



Figure 18: Scatter plot of cooling tower efficiency over cooling load (Example)

Daily Average Reading	Pe	Unit	
Daily Average Reauning	Daytime^	Night-time~	
Cooling Load			RT
Cooling Load Density (Air-con area)			m2/RT
Power Consumption			kW
Chilled water supply temperature			°C
Chilled water return temperature			°C
Chilled water delta T			°C
Chilled water flow rate			1/s
Chilled water flow rate vs cooling load			USgpm/RT
*Condenser heat rejection			HRT
*Condenser water supply temperature			°C
*Condenser water return temperature			°C
*Condenser water delta T			°C
*Condenser water flow rate			1/s
*Condenser water flow rate vs cooling load			USgpm/RT
Chiller(s) efficiency			kW/RT
Chilled water pump(s) efficiency			kW/RT
*Condenser water pump(s) efficiency			kW/RT
*Cooling tower(s) efficiency			kW/RT
Overall chiller plant efficiency			kW/RT

## 5.1 Summary of Chilled Water Plant Operating Performance

#### **Table 4: Chilled Water Plant Performance Summary**

\*Not applicable to air-cooled Chilled Water Plant

~For hotels and other developments with 24-hour operations only; Night-time shall refer to the period from 11pm - 7am;

 $^{\rm A}$  For hotels and other developments with 24-hour operations, day-time shall refer to the period from 7am – 11pm; for all other developments, daytime shall refer to the normal operating hours shown below:-

Office Buildings:Monday to Friday (9am to 6pm)Retail Malls:Monday to Sunday (10am to 9pm)

Hotels/Hospitals: Monday to Friday (24 hours)

Other building types: To be determined based on the operating hours

## 6.0 Summary of Heat Balance



Figure 19: System Level Heat Balance Plot (Example)

	Quantity	Unit	Formula
Sum of total electrical energy used		kWh	(A)
Sum of total cooling produced		RTh	(B)
Sum of total heat rejected		RTh	(C)
Chiller Plant Efficiency		kW/RT	(A) / (B)
Total Heat Balance Data Count		-	(D)
Data Count > + 5% error		-	(E)
Data Count < - 5% error		-	(F)
Data Count within ±5% error		-	(G) = (D) - (E) - (F)
% Heat Balance within ±5% error		%	100 x (G) / (D)

**Table 5: Heat Balance Summary** 

# 7.0 Schedule of space operating conditions

## (10 points Spot measurements)

	*Room name (ie Air conditioned Habitable Spaces)	Dry Bulb Temperature (°C)	Relative Humidity (%)	CO2 Concentration (ppm)
1	Office 1			
2	Office 2			
3	Meeting Room 1			
4	Meeting Room 2			
5				
6				
7				
8				
9				
10				

Table 6: Space Condition Schedule (Example)

## APPENDIX

# **Checklist of Plant Operating Condition (for best practices)**

	Yes	No	Actual value
Is Chilled water delta T lower than 5.5 or design?			
Is the cooling tower approach temperature 1.5 °C higher than outdoor wet bulb temperature?			
Is the Chilled water pump efficiency higher than 0.03 kW/RT?			
Is the Condenser water pump efficiency higher than 0.035 kW/RT?			
Is the Cooling Tower efficiency higher than 0.03 kW/RT?			
Are all Chilled water pumps installed with VSD?			
Are all Condenser water pumps installed with VSD?			
Is the Cooling Tower installed with VSD?			
Does Refrigerant Condenser approach exceed range of 0.5 °C to 1.5 °C?			
Does Refrigerant Evaporator approach exceed range of 0.5 °C to 1.5 °C?			

Table 7: Checklist of Plant Operating Condition (for best practices)