CLEAN DEVELOCMENT MECHANISM
SMALL-SCALE PROGRAMME OF ACTIVITIES DESIGN DOCUMENT FORM
(CDM-SSC-POA-DD) Version 01

CONTENTS

Annexes

NOTE:

(i) This form is for the submission of a CDM POA whose CPAs apply a small scale approved methodology.

(ii) At the time of requesting registration this form must be accompanied by a CDM-SSC-CPA-DD form that has been specified for the proposed POA, as well as by one completed CDM-SSC-CPA-DD (using a real case).

SECTION A. General description of small-scale programme of activities (POA)

A.1 Title of the small-scale programme of activities (POA):

Climate Action Response Enterprise (CARE) for Energy Efficiency in Chiller Plants.

VERSION 5 – dated August 27, 2012

A.2. Description of the small-scale programme of activities (POA):

1. General operating and implementing framework of POA:

   The program is intended to promote Energy Efficiency in Singapore's building sector by replacing inefficient Chiller Plants with those of a more efficient design and technology to achieve an efficiency of 0.65KW/TR or better. The program aims to achieve this by a holistic system approach rather than a purely chiller / chiller component based approach. Climate Resources Exchange (CRX) as Coordinating & Managing Entity (CME) will co-ordinate each small scale CPA by ensuring replacement of chiller plants and proper and measurable monitoring and verification systems thereafter.

2. Policy/measure or stated goal of the POA:

   The POA aims to help achieve Energy Efficiency and reduce consumption of electricity in Singapore in turn leading to a reduction in GHG emissions from burning of fossil fuels from power generation and from refrigerant usage in chiller plant systems. It also aims to promote well-designed chiller plants systems that operate at levels better or in accordance with the factory-designed equipment(s) that can be measured accurately and reduce emissions in a real, long term and measurable manner which increases capacity building and enhancement while preserving environmental integrity.

3. Confirmation that the proposed POA is a voluntary action by the coordinating/managing entity.

   There is no mandatory guideline in Singapore to achieve high efficiencies of 0.65kW/TR or better in chiller plant operations in buildings. There are also no mandatory guidelines for these chiller plants to implement highly accurate measurement, monitoring and verification systems. Hence, this POA is completely voluntary.

A.3. Coordinating/managing entity and participants of SSC-POA:

1. The CME of the POA is CRX. SB is the buyer of the resultant CERs. CRX and SB will be joint focal points with respect to communication to the CDM Executive Board.

2. Project participants will be building owners and/or their appointed accredited Energy Service Companies (ESCOs)

Name of Party Involved(*) ((host) includes a host party)	Private and/or public entity(ies) project participants(*) (as applicable)	Party involved wishes to be included as project participant (Yes/No)
Singapore (host)	Climate Resources Exchange Pte Ltd (CRX) (private entity)	No
United Kingdom of Great Britain and Northern Ireland	Standard Bank Plc (SBP) (private entity)	No
(*) In accordance with the CDM modalities and procedures at the time of making the CDM-PDD public at the stage of validation, a party may or may not have provided its approval. At the time of requesting registration, the approval of the party(ies) is required.		

A.4. Technical description of the small-scale programme of activities:

The program intends to provide for the replacement of inefficient, large size chiller plants[1] (capacity 100TR [2] or more), in Singapore. The average energy consumption of both CFC and non-CFC chiller plants developed between the 1980s through the 2000s is about 1.2-1.8kW/TR (Kilowatt per ton of refrigeration) – the same chillers are still in use and are also being installed in Greenfield projects. This, in spite the fact that chiller plants today can achieve energy consumptions as low as 0.56kw/TR [3], which represents a 51%-78% improvement in energy efficiency.

This POA seeks to promote conversion to chiller plans with efficiency of at least 0.65kW/TR (or better) measured in 1-minute intervals. In addition – the PoA aims to replace the use of higher GWP refrigerants with lower GWP refrigerants that also reduce CO_{2eq} emissions significantly during the crediting period each CPA. All the buildings being considered in this POA draw power from the local grid in Singapore.

Most importantly, the POA sets out an extremely stringent and highly accurate design approach and monitoring plan that makes it very difficult to qualify for entry and which is a non-prevailing practice in the market. The purpose is to achieve real, long-term and measurable emission reductions which when monetized, alleviates the high cost of stringent and highly accurate monitoring systems. Chiller plant room equipment is expected to operate at manufacturing (factory) standards. A verification system is further employed to calculate the heat balance of the system to ensure consistency in data gathering, computation and delivery of Certified Emission Reductions (CERs).

---

[1] A chiller is a machine for cooling commercial and industrial building facilities. Electrical energy is used to drive a refrigerant compressor. The refrigerant gas is alternately compressed and expanded. The cooling effect of the gas expansion phase is used to chill water, or a water/antifreeze mixture, which is then circulated around the space to be cooled. Heat removed from buildings is then released into the environment through a cooling tower for water-cooled chillers or through fan-coil condensing units for air-cooled systems.

[2] The cooling load of chillers is measured in tons refrigeration (TR), which is 12,000 BTU/hour by definition or 3.5712 kW per refrigerant ton.

[3] New Chiller Plant that was considered under the CDM and will be the first proposed CPA.

The program also intends to completely phase out chillers that are based on R11 and R12 refrigerants, replacing them with currently allowable and more environmentally friendly refrigerants.

A.4.1. Location of the programme of activities:

The Republic of Singapore

A.4.1.1. Host Party(ies):

The Republic of Singapore

A.4.1.2. Physical/ Geographical boundary:

Definition of the boundary for the POA in terms of a geographical area (e.g., municipality, region within a country, country or several countries) within which all small-scale CDM programme activities (SSC-CPAs) included in the POA will be implemented, taking into consideration the requirement that all applicable national and/or sectoral policies and regulations of each host country within that chosen boundary;

The Republic of Singapore is located and is an island country off the southern tip of the Malay Peninsula, 137 kilometres (85 mi) north of the equator, in the Southeast Asian region of the Asian continent with coordinates given as: Between latitudes 1° 09' North, 1° 29' North and longitudes 103° 36' East, 104° 25' East. ***(reference: Singapore Facts & Figures 2006 published by the Singapore Government)***

A.4.2. Description of a typical small-scale CDM programme activity (CPA):

A typical CPA shall be a commercial or industrial building in Singapore that can achieve an energy efficiency coefficient of 0.65kW/TR or better which EEC must be measured and monitored at 1 minute intervals and is also within the eligibility criteria as set out in the PoA itself.

A.4.2.1. Technology or measures to be employed by the SSC-CPA:

The POA will involve:

a) A complete retrofit and/or replacement of components of the chiller plants including one or more of the following: the chillers itself; the chilled water pumps; the condensed water pumps; the air handling units; and the cooling towers. All retrofits/ replacements will be with equipment of much higher efficiency.

AND/OR

b) complete revision of the design of the chiller plants including whether the current (baseline scenario) scenario is of the most optimal loading (including backups).

The above activities will be based on a thorough energy audit/technical carried out by technicians of calibre towards achieving an overall system efficiency of 0.65kW/TR that is measurable or better.

A.4.2.2. Eligibility criteria for inclusion of a SSC-CPA in the POA:

The eligibility criteria shall cover the following in accordance with the guidelines set out in Section A & B of EB65 meeting report Annex 3:

(a) The geographical boundary of the CPA including any time-induced boundary consistent with the geographical boundary set in the PoA –

- The CPA must be within the geographical location of The Republic of Singapore as stated in section A.4.1.2 of the PoA-DD

(b) Conditions that avoid double counting of emission reductions like unique identifications of product and end-user locations (e.g. programme logo);

- As per the conditions set out in in the operation and management plan of the PoA – as defined under section A.4.4.1 (Operational and management plan of the PoA-DD). Each CPA shall have a unique identification number (UIN) based on its precise geo-coordinates (GPS) and assigned under the building owner's name. The CME will have this recorded in the database of the operating and management software/hardware system. In addition, a CARE PoA Logo printed sticker with the UIN number shall be issued and must be displayed on the control infrastructure of the chiller plant system of each CPA.

(c) The specifications of technology/measure including the level and type of service, performance specifications including compliance with testing/certifications;

- Each CPA must implement water-cooled chiller technology and shall comply with ASHRAE 14 guidelines and AHRI 550 calibration standards and shall implement a building automation software technology that is able to measure and monitor the performance of the chiller plant system in order to achieve a minimum energy efficiency coefficient of 0.65kW/TR at 1-minute intervals and be able to store such data that the DOE can verify on an annual basis during the crediting period of the CPA.

- Each CPA must have completed an energy audit on the chiller plant system and conducted by a registered Energy Service Company (ESCO) accredited by the National Environment Agency (NEA) and prove through a comprehensive report that the measurements and computation that the chiller plant system efficiency was not better than 0.65kW/TR in the baseline scenario.

(d) Conditions to check the start date of the CPA through documentary evidence;

- Each CPA to be considered for inclusion under the PoA must prove that the start date is after the start date of the PoA, i.e. the date that the PoA was first published for Global Stakeholder Consultation – April 6 2010. The documentary evidence must show and prove that any Purchase or Works Order made out to the technology provider or main contractor must be after this date.

(e) Conditions that ensure compliance with applicability and other requirements of single or multiple methodologies applied by CPAs;

- Each CPA must prove that it adheres to the baseline and monitoring methodology of AMSIIC Version 13.

(f) Conditions that ensure that CPAs meets the requirements pertaining to the demonstration of additionality as per Attachment A of Appendix B of Simplified modalities and procedures for small-scale CDM project activities;

- The additionality is demonstrated at the PoA level using Attachment A of Appendix B of simplified modalities and procedure for small-scale CDM project Activities. The most appropriate barrier selected is the Prevailing practice barrier and detailed justification of additionality due to prevailing practice in the host country Singapore is provided in the PoA-DD section A.4.3 and it is extended to all CPA's. Based on the description of the Prevailing practice barrier, the following key criteria are identified to demonstrate CPA additionality:

  - Each CPA must demonstrate that in the absence of the guidance of the PoA it would not have been able to achieve a chiller plant system efficiency of 0.65kW/TR measured at 1-minute Intervals based on the integrated design-approach for the retrofit of the old Chiller plant systems.

  - Each CPA implements the proposed voluntary measure of the PoA and is not a result of any other policy or measure applied within the boundary of the PoA hence, it would not exist in the absence of the PoA.

  - Each CPA increases enforcement of the mandatory policy/regulation that would systematically not be enforced, or increases compliance with those requirements for which non-compliance is widespread in the country/region, hence, it results in an increased level of enforcement or compliance that would not be reached in the absence of the PoA;

  - Each CPA increases enforcement of the existing mandatory policy/regulation to a level that would not be reached in the absence of the PoA.

(g) The PoA-specific requirements stipulated by the CME including any conditions related to undertaking local stakeholder consultations and environmental impact analysis;

- Each CPA must meet the EIA requirements as stated in the EIA Section C – below. Each CPA must also demonstrate and present records that equipment replaced have been scrapped and independently verified. The local stakeholder consultation has already been done at the PoA level and so each CPA does not need to undergo such a separate stakeholder consultation.

(h) Conditions to provide an affirmation that funding from Annex I parties, if any, does not result in a diversion of official development assistance;

- Each CPA shall provide documentary evidence for their source of funding for developing their respective retrofit project.

(i) Where applicable, the requirements for the de-bundling check, in case CPAs belong to small-scale (SSC) or micro-scale project categories.

- Each CPA shall undergo a de-bundling check as prescribed under section A.4.4.1 (Operational and management plan of the PoA-DD) and verified by the DOE prior to inclusion.

(j) Condition in determining the difference in the loading capacity of the chiller plant system in the baseline scenario as compared to the project activity.

- CPAs where cooling load capacity changes significantly between the baseline and the project activity, i.e. less than 10% or more than 50% as compared to the baseline shall be excluded from this PoA in accordance with the applied methodology AMS IIC Version 13.

(k) Condition to determine if the CPA falls within the requirement of an SSC-CPA.

- Each CPA shall not generate an electrical energy savings of more than 60GWh per annum post retrofit.

(l) Condition to determine if the CPA is eligible to be included in the PoA if parts of the system are shut down and/or if there is no actual retrofit but only optimization or calibration works performed to improve chiller plant system efficiency.

- Such CPAs will not be included.

(m) Conditions to determine if a CPA is eligible to be included in the PoA based on Refrigerant Usage

- CPAs switching from use of older refrigerants R11/R12/R22 to a non-CFC refrigerant such as R134a or R123 are allowed.

- CPAs switching from any of R134a or R123 refrigerants to a new refrigerant that is commercially available that is CFC-free and which refrigerant has a lower GWP than any of R134a or R123 refrigerants in the future is allowed.

A.4.3. Description of how the anthropogenic emissions of GHG by sources are reduced by a SSC-CPA below those that would have occurred in the absence of the registered POA (assessment and demonstration of additionality):

Attachment A to Appendix B of the "Simplified Modalities & Procedures for small-scale CDM Project Activities – is applied for demonstration of additionality to this small-scale POA, wherein: a project shall provide an explanation to show that the project activity would not have occurred anyway due to at least one barrier.

Barriers

The main barrier chosen is as under clause (c) of Attachment A to Appendix B: **"Barrier due to prevailing practice: prevailing practice or existing regulatory or policy requirement would have led to implementation of a technology with higher emissions."**

There is no mandatory requirement to achieve an energy efficiency coefficient of 0.65 kW/TR or better in Singapore and to accurately measure and verify the accuracy of data measured and computed under the guidance of ASHRAE 14 at 1-minute intervals which data is to be stored for a period of 10 years – this despite the various grants and schemes provided for.

This thus leads to another barrier that can be precisely described as a technological Barrier from the design-approach perspective that would have led to implementation of a new or retrofitted chiller plant system with higher emissions.

Most ESCOs and Technology providers find it very difficult to achieve an efficiency of 0.65 kW/TR or better, and maintain it over a period of 10 years with a Performance Guarantee as it requires very sophisticated energy management systems and a database operating at a high-speed to handle the complex per minute computation and store that information in a manner that can be retrieved easily. Since a combination of water-cooled chillers and system design is also of paramount consideration, it can be construed that only water-cooled centrifugal type chillers (at this point of time) and corresponding chiller plant equipment installed in the correct design and configuration can achieve the necessary energy efficiency required for entry into the PoA. It addition – this combination has the lowest noise, lowest vibration and lowest emission levels.

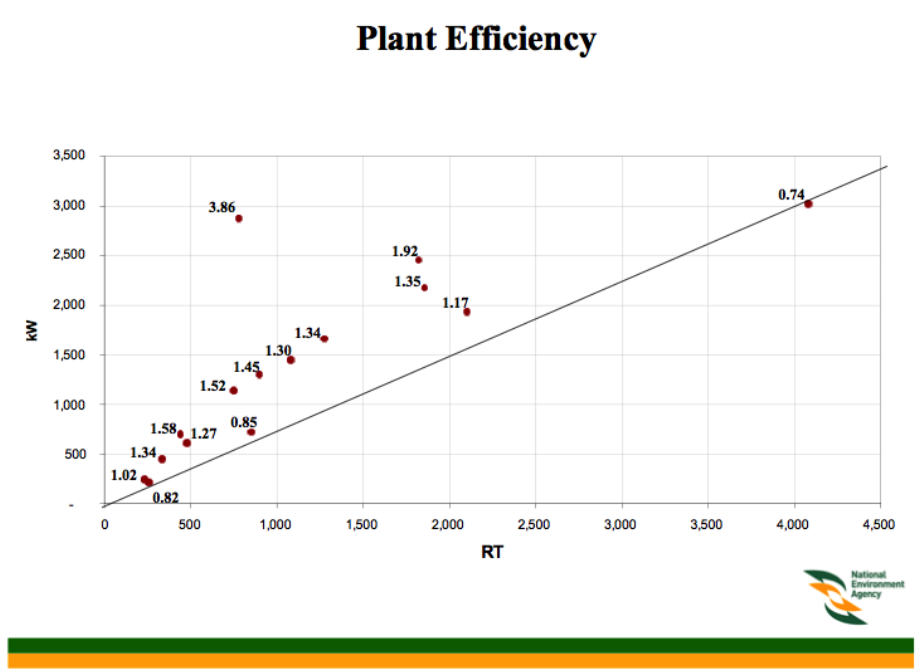
There is currently no alternative scenario that can achieve the objective of the PoA that is to have a minimum energy coefficient of 0.65KW/TR measured at 1-minute intervals with water cooled chillers, efficient system design and stringent measurement, monitoring and verification system procedures.

At the time of selection of Technology the CME has considered various available options for the Chiller System and these options are described in the following table:

CHILLER PLANT TECHNOLOGY & REFRIGERANT ALTERNATIVES

Baseline Chiller Technology	Refrigerant used in baseline	Project Activity Chiller Technology	Refrigerant used in project activity	Result
Air-cooled screw –type	R134a	Air-cooled centrifugal	R134a	No significant change. COP (Kw/RT) drops quickly and significantly over time. Higher GWP of R134a. Better design will only result in temporary improvement in chiller plant efficiency. Cheapest upfront CAPEX.
Air-cooled screw /centrifugal type	R134a	Water-cooled screw /centrifugal	R134a	Slight improvement but COP still drops over time and GWP of R134a is higher. Design of the new plant in terms of layout must be optimal
Air cooled Screw / centrifugal type	R134a	Water-cooled Centrifugal	R123	Most significant change. Highest ROI and COP provided design is optimal. Improves significantly and can be maintained over time provided chiller plant design is optimal. Lowest noise, lowest vibrations and lowest emissions. Higher upfront CAPEX.

The figure below is from the National Environment agency (NEA) that depicts the average EEC of commercial and industrial buildings to be 1.36KW/TR. Most building owners and their facilities managers do not utilize the same calibration, measurement and monitoring guidelines.



1.36 KW/TR is the average value obtained using various chiller efficiency values publicly available in Singapore through NEA, which are shown in the scattered graph. The data for this graph are from audits performed on various buildings by Accredited ESCOs for clients who were recipients of NEA's EASe grant scheme. The measurements were taken during audits conducted in 2008.

The 2008 data along with data from further audits completed in the first quarter of 2009 were presented at an APEC workshop on Sustainable Development in a Built Environment in April 2009 by the NEA, and can be accessed at:

http://www.egeec.apec.org/www/UploadFile/2.iii_EE_%20improvement_asstnce_scheme_EASe_Singapore.pdf.

The Table below is reproduced in verbatim from the NEA website : http://www.e2singapore.gov.sg/ease-success-stories.html .

"The following are some of the "success stories" of companies funded by the Energy Efficiency Improvement Assistance Scheme (EASe). Through the implementation of the energy conservation and efficiency measures identified by the ESCO, companies have reaped significant energy and cost savings.

NEA's EASe scheme to promote energy efficiency in chiller plants

Sector	Company	Annual Savings achieved	Implementation Costs	Payback Period	Measures implemented
Industry	Systems on Silicon Manufacturing Co. Pte Ltd (SSMC)	S$319,000 2456MWh	S$74,000	0.23 year	Optimisation of chillers: The optimal level of refrigerant charging was determined for best chiller efficiency and controller was implemented to maintain optimal performance under all operating/loading conditions.
	Singapore Oxygen Air Liquide Pte Ltd (SOXAL)	S$324,000 2,160MWh	S$266,000	0.82 year	Shutting down of chiller plant at night: Before the implementation of this measure, the chiller plant was operated 24 hours daily although the facility only operates from 8am to 7pm on a 5.5-day week. The main reason for this was to prevent condensation from taking place. The shutdown sequence was modified such that the AHUs are switched off only after a period of time where the supply, exhaust and scrubber fans have stopped operation. This minimised condensation problems. Retrofit of chiller plant: The existing chillers and associated pumps were replaced with more efficient ones. System efficiency improved by 38%. Optimisation of chilled water pumpsVariable speed drives were installed on the new chilled water pumps, allowing them to run relative to the cooling load demand. Optimisation of chilled water primary pumps. The pumps were optimised by converting direct-on-line to variable speed drive that supplies power to the pumps at reduced speed depending on pressure.

Building	Singapore Post Center	S$1.2 million	S$2.0 million	1.7 year	The chiller plant system efficiency is improved from 1.1 kW/RT to 0.6kW/RT via the following measures Chiller replacement: Three (3) numbers of the existing chillers were replaced with more efficient ones. Optimisation of pumps and cooling towers. Variable speed drives were installed to the pumps and cooling towers.
	Singapore Airline House	S$212,000 1,196,000 kWh	S$200,000	0.9 year	Optimization of pumps and cooling towers: A 20% improvement in chiller plant system efficiency was achieved by installing new condenser pumps and installing variable speed drives to chilled water pumps and cooling towers.

From the above there have been 4 buildings listed as "success stories" under the NEA's EASe incentive program that essentially provides grants for buildings that only reduce their energy bill. That however does not mean that these projects are achieving 0.65KW/RT or better measured and monitored at 1-minute intervals because there is no specific requirement for this and this is also not stated categorically in the table above.

Singapore acceded to the Kyoto Protocol on July 12, 2006. The projects listed above have been implemented prior to 2006. On top of that only one of them (Singapore Post) specifically states that it achieves a chiller plant efficiency of 0.60 KW/TR and is known to have its performance measured and monitored at one-minute intervals. However this project was conceived before Singapore acceded to the Kyoto Protocol.

The other 3 projects also utilize methods that are disallowed under the rules of the CARE PoA as those projects have instances where only they only optimize the equipment in the chiller plants and do not retrofit the chiller plant which means that it would also not be possible to accurately monitor and measure the efficiency of the system at the point of implementation and post-implementation.

Another point is that one of the projects above claim a better efficiency due to shutting down the chiller plant which is also not allowed under this PoA as the baseline cooling load would vary significantly from the cooling load during the operation in the considered project activity.

One project that achieves a system efficiency of better than even 0.6KW/RT is the Galen located at Singapore Science Park II and was the prime motivation of this CARE PoA. The project considered CDM in 2009 and was fully implemented by the end of 2009 but is currently unable to join the CARE PoA as the start date of the project is prior to the start date of this PoA.

Therefore it can be determined that Capricorn is really the first building in Singapore to meet the requirements of this CARE PoA.

Further analysizng this train o thought A newer incentive provided as a grant by the NEA which is called "GREET": http://www.e2singapore.gov.sg/greet.html and aims to assist in the funding of CAPEX for chiller plant replacement does not categorically state that a chiller plant efficiency of 0.65KW/RT or better measured and monitored at 1minute intervals much be achieved. The main requirements for GREET are reproduced in verbatim as follows:

- The project must involve installation and use of energy efficient equipment or technologies with a proven track record of energy savings in an industrial facility.
- The project must result in measurable and verifiable energy savings.

- The project must not have been contracted at the time of application.
- The project should be completed within 18 months from the approval of grant.

The “success stories” of GREET still do no meet the requirements of the CARE PoA.

Factors that lead to non-prevailing practice and hence dealt with due to the implementation of the Program of Activities

Design & Know-How

Most ESCOs at the moment are unable to design or implement chiller plant systems that accurately perform at an EEC of 0.65KW/TR or better - although chiller plant technology itself allows them to do so – provided the design is optimal. On top of that, the EMS systems deployed are unable to compute data measurements at such a high resolution that leads to an ability of both the ESCO and building owner to accurately measure and verify energy savings.

The implementation of the POA will lead to capacity enhancement on the subject and encourages building owners to discuss with their respective ESCOs how they can achieve such an EEC. The CPAs under the POA will allow a greater dissemination of such knowledge leading to internal building management staff to be educated and also leads to the possibility of the building owner hiring additional staff to learn and operate this process – hence leading to new (Green Collar job) workers at a skilled level.

Improving the Grants & Schemes Policy

The Singapore government through its various energy efficiency motivation incentives is trying to promote energy efficiency through its agencies – the National Environment Agency (NEA) and the Building Construction Authority (BCA).

The NEA offers incentives of providing CAPEX for up to 50% of the total retrofit cost, but not exceeding S$4m (grants) to potential chiller plant system projects as well as offering to subsidized payments for energy audits.

The BCA offers rating systems under their GreenMark scheme (www.bca.gov.sg) to allow building owners to receive a high rating for overall sustainability (which includes chiller plant system efficiency) that then promotes the building owners to potential buyers or lessees as a sustainable building.

Both agencies should be commended for promoting energy efficiency and overall sustainability within resource and energy-constrained Singapore.

However, in specific reference to chiller plant systems, these incentives, grants and rewards still do not ensure that the EEC of 0.65KW/TR or better is achieved with an accurate long-term and measurable monitoring system as described in this SSC-PoA-DD and so it is still non-common practice to achieve the desired results under this PoA.

The POA offers the opportunity for these incentive or reward schemes to be modified to suit the eligibility criteria of the PoA to ensure that the correct sustainability objectives of Singapore are achieved.

ESCO Competitiveness

According to the National Environment Agency (NEA) there are several Energy Service Companies (ESCOs) that approves its accreditation that are listed under its register that can be located that are able to provide both the technology and service aspects of conducting baseline energy audits and implementing chiller plant replacements.

However, as described earlier, not all of them are to able to achieve the required EEC with the respective monitoring and verification procedures prescribed in this POA. This thus presents an issue to both short and long-term sustainability from the environmental, economic and social standpoint.

The PoA encourages, supports and provides these ESCOs a vehicle to improve their knowledge and technical capacities to a point where they are able to improve their products and services to a level where they remain relevant and competitive within their market space. This also promotes Singapore as a hub where energy efficiency calibration, measurement and monitoring competencies can be sought by other developed and developing countries.

The Republic of Singapore's government and administrative agencies are both keen and open to ensure that ESCOs are capable of designing and installing the highest quality operational systems that improve efficiency at the best available standards while reducing emissions.

Moreover, the letter from NEA indicates that 0.65 KW/TR is not a prevailing practice in Singapore and this conclusion / opinion is provided by NEA is based on the database they have and is utilized for demonstrating the baseline scenario, on the average in Singapore. The Graphical representation of the Chiller plant output in Singapore for the period 2008 – 2010 indicates that the average chiller plant system efficiency is about 1.36KW/TR, on average.

Following on:

(i) The proposed POA is a voluntary coordinated action;

- Singapore has no mandatory requirements to replace old chillers/ chiller plants in buildings with more efficient ones. Although there are various schemes and incentives provided for by the NEA and BCA for building owners - it is not mandatory and has hence not caused widespread change in chiller plant operated nationwide.

(ii) If the POA is implementing a voluntary coordinated action, it would not be implemented in the absence of the POA;

- Since the average energy efficiency coefficients (EEC) of chiller plants in buildings in Singapore is 1.36kW/TR the PoA can provide added incentive for this conversion to jointly reduce electrical energy consumption and to reduce emissions from unsuitable refrigerant consumption. However, at an individual CPA (Building Level) the

transaction cost of CDM is prohibitive and hence there is a reluctance to proceed. The POA allows them the opportunity to participate in an island-wide Program and avail CDM benefits with reduced transaction costs. This would not have occurred in the absence of the POA, as it is not a prevalent practice.

- This Program has the aim of allowing only CPAs that commit to achieve a minimum 0.65kW/TR on its chiller plant efficiency. Also, this POA focuses on retrofitting the entire chiller plant as ancillary power consumption (other than the chiller) –e.g. pumps, cooling towers, valves, etc contributes to as high as 40-50% of the entire power consumption of the plant. Pure optimization projects are not allowed in this PoA.

- One of the key advantages of this PoA is that through its calibration techniques and measurement requirements – it ensures the level of accuracy for measurement, monitoring and verification of each specific parameter that leads to the computation of electrical energy savings. The objective of the monitoring plan is to conduct accurate, long-term and measurable checks on the chiller plant system in order to achieve factory-calibrated standards and to further calculate the heat balance of the system to ensure consistency in data measurement and computation.

- All this is done to ensure that equipment utilized in the chiller plant room conforms to manufacturing (factory) standards and tested to even greater loading stresses in many more thousands of hours than that of the manufacturing (factory) standards to achieve extremely high accuracy standards.

- This is unlike contemporary / common practices where mostly only a chiller or other components are replaced and a loose monitoring system employed. This raises the bar for participation within the POA and thus the CPAs would need to access considerably advanced technology, train manpower in new operations, and install new monitoring software. This acts as a credible barrier towards implementation as it is not a prevailing practice.

- This PoA only allows CPAs that utilize refrigerants that are CFC-Free (No refrigerants that are disallowed under the Montreal Protocol)

(ii) If the POA is implementing a mandatory policy/regulation, this would/is not enforced;

- Not applicable.

(iii) If mandatory a policy/regulation is enforced, the POA will lead to a greater level of enforcement of the existing mandatory policy/regulation.

- Not applicable

A.4.4. Operational, management and monitoring plan for the programme of activities (POA):

A.4.4.1. Operational and management plan:

(i) A record keeping system for each CPA under the POA,

Data Field	Record Details	Record Owner/ Maintenance
Building Owner ID	Name, Unique Identification Number (UIN)	CRX
CPA ID	Name, Geographical Location of Building, UIN of CPA	CRX
Scrapping Monitoring ID	Name, Geographical Location of Building, UIN of CPA, UIN of scrapping party, 3rd party verifier ID	CRX, CPA, Scrapping Party, 3rd party verifier ID
Baseline Monitoring	Electricity consumption in baseline scenario/ Plant efficiency	CPA
Emission Reduction Monitoring	Electricity consumption in project scenario/ Plant efficiency	CPA
Aggregate Monitoring Data	Monitoring Data that is compiled by the EMS and converted to tCO_2 of each CPA over its crediting period	CRX

(ii) CRX will ensure before inclusion whether there is any other similar CPA covering the region where the CPA exists or whether there is an existing CDM project which has the CPA as a component. This check will be undertaken across the CDM Pipeline analyzing projects/ POAs across various stages of the CDM Cycle (Registered/ Requesting Registration/ Validation/ Review)

(iii) The SSC-CPA included in the POA is not a de-bundled component of another CDM programme activity (CPA) or CDM project activity:

The CME will ensure that any CPA that is signed on for the POA is not a de-bundled component of a large-scale activity. The process for the same is described in the figure below below:

The CME will assign a code for each of the building owners and link them to another code that governs the respective CPA. This shall be described in the monitoring plan to prevent double-counting and erroneous inclusions of CPAs within / to be included in POAs.

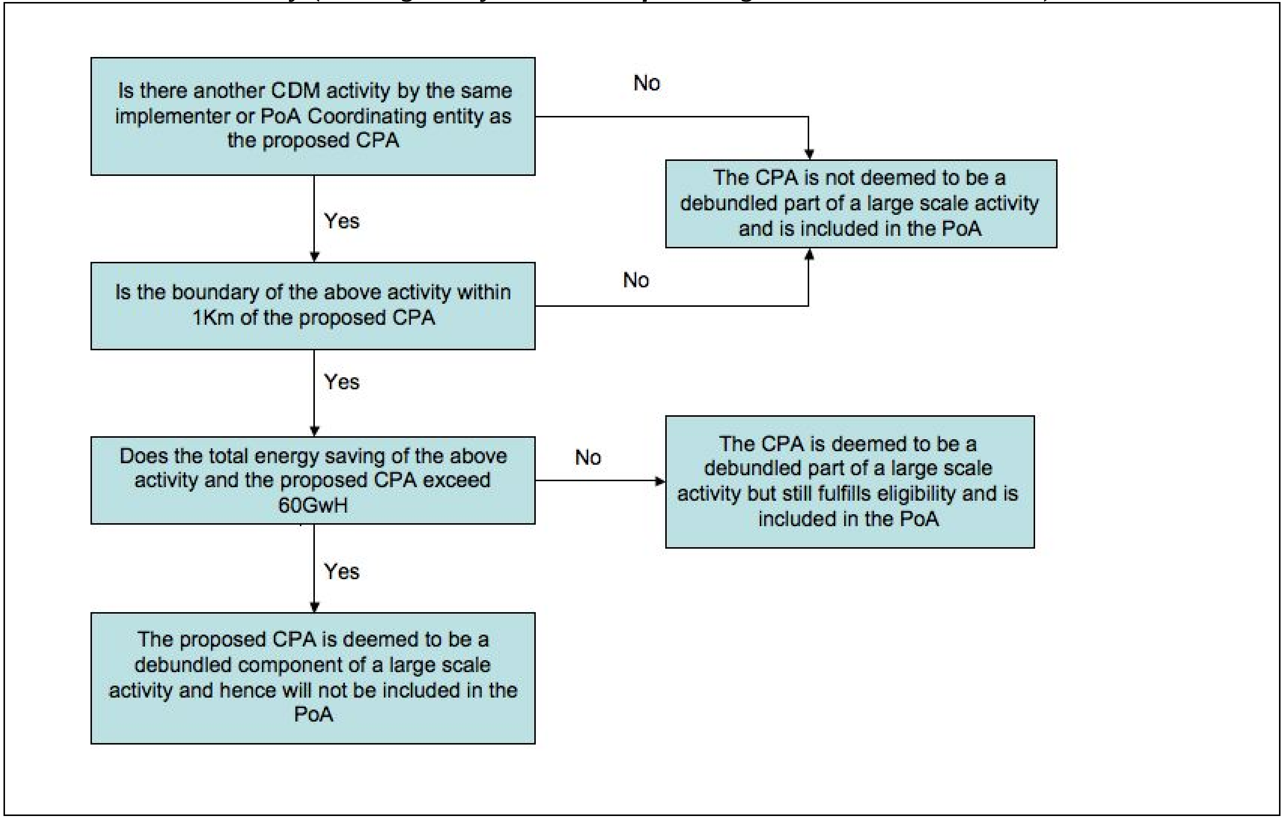
In addition, the CME is also not acting as the co-ordinating entity of a large scale POA in the same sectoral scope within the boundary of this program.

The CME will also require the project implementers to declare that they do not have another CPA under a registered or work-in-progress POA implemented or being implemented by

another CME within the same sectoral scope. This declaration will be submitted to the DOE as evidence, prior to inclusion of the said CPA into this POA.

As a further requirement for inclusion into the POA, the precise geographical data of each building (in measurements of longitude and latitude) shall be stated. Also the system will allow for the DOE to check using a match of Google Earth Technology and the software that will generate a unique code for verification.

Figure: Tool to determine that each CPA is not part of De-Bundled project under a large-scale activity (as designed by the CME – following the International Rules)



(iv) The provisions to ensure that those operating the CPA are aware of and have agreed that their activity is being subscribed to the POA;

The coordinating entity is responsible for sourcing buildings, informing them about the POA, the provisions therein and also the liable benefits to them. Thereafter, the building owners will sign relevant legal agreements with the coordinating entity consenting to their buildings being included in the POA. It is assumed that since building owners will sign the consent agreements voluntarily, they will be well aware of their inclusion.

A.4.4.2. Monitoring plan:

(i) Description of the proposed statistically sound sampling method/procedure to be used by DOEs for verification of the amount of reductions of anthropogenic emissions by sources or removals by sinks of greenhouse gases achieved by CPAs under the POA.

For the CPAs under this POA, the DOE shall employ data gathered as follows:

(1) Difference in the GWP of refrigerant used in the baseline as compared to the GWP of the refrigerant used in the CPA.
(2) Temperature for chilled water supply and return
(3) Rate of Flow of chilled water
(4) Electrical Energy Demand for each and every component within the chiller plant

The measurement of data shall be at 1-minute intervals.

After the data is gathered using a suitable Energy Management Software (EMS), this data is computed to account for (1) chiller plant loading (in TR – tons of refrigeration) over a time series to obtain: TR-H and (2) Electrical Energy Consumption in KW – Kilowatts) over a time series to derive: KW-H

These two values (TR-H and KW-H) are computed independently using the integration of area under curve (trapezoidal rule). Later, these computed values are used to determine the energy efficiency coefficient in kW/TR.

The difference in electrical energy consumption between the baseline scenario and the project activity for the same loading (in TR) shall be computed. This kWh savings is then multiplied by the grid emission factor, as expressed in kg $CO2$ /kWh to determine the number of Certified Emission Reductions (CERs) that the CPA is eligible to receive for the period. This added to the total emissions from refrigerants used in the baseline as compared to the emissions from refrigerants used in the CPA as per values prescribed by the IPCC shall give the final CER volume eligible to be received during the crediting period.

The DOE may further verify this data by comparing the energy bills of each CPA in the baseline scenario to the project activity scenario in the same period for the same cooling load.

(ii) In case the coordinating/managing entity opts for a verification method that does not use sampling but verifies each CPA (whether in groups or not, with different or identical verification periods) a transparent system is to be defined and described that ensures that no double accounting occurs and that the status of verification can be determined anytime for each CPA;

Each and every CPA that is included in the POA will use a verification process that is precise and as outlined by the CME in the monitoring plan. There shall be NO sampling method used.

In addition, the Operational and Management Plan as described above would take care of non-erroneous inclusions and double counting issues.

A.4.5. Public funding of the programme of activities (POA):

No public funding will be used for this program

SECTION B. Duration of the programme of activities (POA)

B.1. Starting date of the programme of activities (POA):

06/04/2010 – 6th of April 2010 (date of first Global Stakeholder Consultation as uploaded by DOE)

B.2. Length of the programme of activities (POA):

28 years from 06/04/2010 (6th of April 2010)

SECTION C. Environmental Analysis

C.1. Please indicate the level at which environmental analysis as per requirements of the CDM modalities and procedures is undertaken. Justify the choice of level at which the environmental analysis is undertaken:

1. Environmental Analysis is done at SSC-POA level ☐
2. Environmental Analysis is done at SSC-CPA level ☐

According to the rules defined in the CDM Modalities & Procedures Annex - Section G Paragraph 37(c): "Project participants have submitted to the designated operational entity documentation on the analysis of the environmental impacts of the project activity, including trans-boundary impacts and, if those impacts are considered significant by the project participants or the host Party, have undertaken an environmental impact assessment in accordance with procedures as required by the host Party".

The following is an assessment of the above requirement:

The CME will demonstrate that:

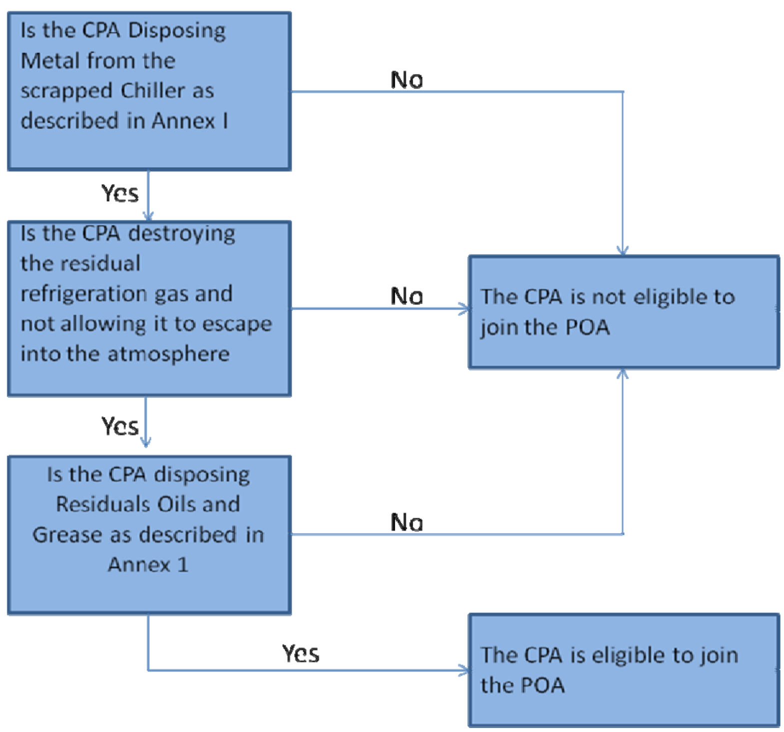
(a) Environmental Analysis across the duration of the CARE will be carried out at the CPA Level. The CME have setup the following criterion which assures that the scrapping of old chillers replaced as a result of the POA implementation has no significant impact to the Environment – provided that they conform to the code of practice on the disposal and recycling of equipment as

prescribed and administered by the National Environment Agency (NEA). These code of practices can be found at www.nea.gov.sg

(b) Only those CPAs that can demonstrate that they adhere to these procedures and furthermore to the criteria below will be included under the POA.

Criteria	Description
Scrapping of Metal Parts	Should be disposed off by a licensed general industrial waste contractor
Safe disposal of Refrigeration Gas	Should not be allowed to openly vent in the atmosphere. Can be recycled or resold for re-use. R11 and R12 refrigerants cannot be re-used again under the Montreal Protocol
Oils and Greases	Should be disposed off by a licensed toxic industrial waste contractor

Tool to demonstrate EIA eligibility of CPA to join POA:



The justification to choose the SSC-CPA level for the environmental impact is done so as to establish the standard or level of compliance at which each SSC-CPA (must be demonstrated with evidence) joining the POA must comply with and is thus set out as an eligibility criterion for inclusion into the SSC-POA.

C.2. Documentation on the analysis of the environmental impacts, including transboundary impacts:

Under the POA requirements for EIA: The following are the documents required to be submitted by the CPA to the CME for consideration of inclusion into the POA

1. The old chillers have been scrapped and a letter from an approved (licensed) agent – general waste contractor: stating that non-toxic general waste such as all metal parts has been scrapped.

2. The refrigerant has been resold for use (or recycled) by the licensed agent – general waste contractor for chillers that use the same. This does not apply to R11 and R12 refrigerants that cannot be re-used again.

3. Residuals Oils and Greases from the chillers are disposed off by a licensed industrial toxic waste contractor and not allowed to run off in common water drainage system and can be recycled where appropriate by the licensed agent.

Further – there are no significant trans-boundary environmental impacts of the POA since the CPA must adhere to the prescriptions listed above and also adheres to the Codes Of Practice provided for by the NEA (Host Party). This will be especially made so by the condition that no chillers or other equipment from the old chiller plants are re-sold or re-directed to other nations for re-use.

Accordingly – these shall be proven by the records as required for inclusion of any given CPA into the PoA.

C.3. Please state whether in accordance with the host Party laws/regulations, an environmental impact assessment is required for a typical CPA, included in the programme of activities (POA),:

A full Environmental Impact Assessment (EIA) is not required for any energy efficiency projects in replacing chiller plants specifically. However – as described above – each CPA must conform to the requirements stated in this POA and also to follow the requirement spelt out under the Codes of Practice stipulated by the NEA (Host Party).

In any case, the prescriptions in this POA must be followed in accordance with its conditions and eligibility criteria before the inclusion of any CPA is considered.

SECTION D. Stakeholders' comments

D.1. Please indicate the level at which local stakeholder comments are invited. Justify the choice:

1. Local stakeholder consultation is done at POA level ☐
2. Local stakeholder consultation is done at SSC-CPA level ☐

Note: If local stakeholder comments are invited at the POA level, include information on how comments by local stakeholders were invited, a summary of the comments received and how due account was taken of any comments received, as applicable.

The justification to choose the SSC-POA level for the stakeholder consultation is done so as to educate the stakeholders on various aspects of the POA itself with respect to the importance of calibration,

measurement and verification and how potential SSC-CPAs should be developed so as to achieve long-term real and measurable reductions in emissions. This level of stakeholder consultation also allows potential CPA developers to be educated on a mass scale and hence encourage them to join the POA with a view to doing their part in implementing sustainable operations within their buildings.

D.2. Brief description how comments by local stakeholders have been invited and compiled:

The CME, CRX together with CER buyer, Standard Bank agreed to engage a leading international media organization, Thomson Reuters Communities, to open a platform to discuss the CARE POA, to attract as many stakeholders as possible for the meeting. The appointed DOE for the POA, Bureau Veritas SAS was also invited and turned up to witness the meeting.

The DNA of Singapore – The National Environment Agency was also specifically invited by CRX as well as the first CPA owner under the POA – Ascendas / Singapore Science Park Ltd. Both parties turned up. Various other governmental agencies, NGOs, private sector participants and academics were also invited through Thomson Reuters Communities networks. The meeting was held on Feb 3, 2010 at the premises of Thomson Reuters Communities located at 1 Raffles Quay, #28-01 North Tower Singapore 048583. Both CRX and Standard bank gave presentations on the POA and this was followed by an interactive Q&A session with the stakeholders present.

CRX prepared a Stakeholders Questionnaire for participants to answer and the summary of comments is described in D3

D.3. Summary of the comments received:

The comments received are based on the questionnaire designed and distributed by CRX. A Copy of the questionnaire is attached for reference.

Summary of the Comments were received as follows:

1. Majority agreed that this POA will lead to a net reduction of CO2 emissions in the foreseeable future.

2. Most agreed that the POA would lead to an increase in employment opportunities in Singapore due to the skilled worked required in monitoring and verification.

3.Most agreed that the POA would lead to improvement of skill sets for the general workforce of Singapore

4. Most agreed that the POA would lead to an adoption of improved design skills and technology in Singapore for energy efficient methods and technologies.

5.Most agreed that the POA (and energy efficiency) is a nationally appropriate GHG mitigation activity.

6. Most agreed that the POA Stakeholders meeting had exposed new concepts and ideas by the POA presentation, which they feel, contributes to their field of work.

7.Most agreed that the POA would assist in Singapore's objective to reduce CO2 emissions by 2020.

D.4. Report on how due account was taken of any comments received:

1. Comments were received by way of forms created by CRX and distributed to the stakeholders at the start of the meeting. All forms were signed off and dated by the participant at point of collection after the meeting. All forms received are being held as hard copy with CRX.

2. The entire event was caught on video camera and minutes were hence captured during the question and answer session.

Since the POA was very well received, the CME will continue with the plan to continue with the submission of its methods and application as under the CDM and aims for registration for the POA as soon as possible.

SECTION E. Application of a baseline and monitoring methodology

This section shall demonstrate the application of the baseline and monitoring methodology to a typical SSC-CPA. The information defines the POA specific elements that shall be included in preparing the POA specific form used to define and include an SSC-CPA in this POA (POA specific CDM-SSC-CPA-DD).

E.1. Title and reference of the approved SSC baseline and monitoring methodology applied to an SSC-CPA included in the POA:

AMSIIC Version 13 – **Demand-side energy efficiency activities for specific technologies**

E.2. Justification of the choice of the methodology and why it is applicable to a SSC-CPA:

NOTE: In the case of CPAs which individually do not exceed the SSC threshold, SSC methodologies may be used once they have first been reviewed and, as needed, revised to account for leakage in the context of a SSC-CPA.

Following are the three-applicability criterion of the methodology:

1. This methodology comprises activities that encourage the adoption of energy-efficient equipment/appliance (e.g., lamps, ballasts, refrigerators, motors, fans, air conditioners, pumping systems) at many sites. These technologies may replace existing equipment or be installed at new sites. In the case of new facilities, the determination of baseline scenario shall be as per the procedures described in the general guidance to SSC methodologies under the section 'Type II and III Greenfield projects (new

facilities)'. The aggregate energy savings by a single project may not exceed the equivalent of 60 GWh per year for electrical end use energy efficiency technologies. For fossil fuel end use energy efficient technologies, the limit is 180 GWh thermal per year in fuel input.

- Each CPA activity in this POA will comprise retrofit/ installation of an energy efficiency chiller plant with a SEC of 0.65kW/TR or better in a building/ group of similar buildings. Also each CPA will not exceed energy savings of 60GWh per annum. This is also included in the eligibility criteria for enrolment of CPAs.

2. For each replaced appliance/equipment/system the rated capacity or output or level of service (e.g., light output, water output, room temperature and comfort, the rated output capacity of air-conditioners etc.) is not significantly smaller (maximum - 10%) than the baseline or significantly larger (maximum + 50%)[4] than the baseline.

- There are metering solutions (as provided for in the monitoring and plan below), which make it both possible and necessary to easily monitor the specific energy consumption of each component of the chiller plant. Projects where loaded capacity significantly deviates: either - smaller (maximum - 10%) than the baseline or significantly larger (maximum + 50%) than the baseline shall be excluded from the PoA. This is further placed as one of the eligibility criterion for the PoA.

3. If the energy efficient equipment contains refrigerants, then the refrigerant used in the project case shall be CFC free. Project emissions from the baseline refrigerant and/or project refrigerants shall be considered in accordance with the guidance of the Board (EB 34, paragraph 17). This methodology credits emission reductions only due to the reduction in electricity consumption from use of more efficient equipment/appliances.

- In accordance with EB34 paragraph 17(b) this project shall not utilize energy efficient technology from other project activities so as avoid leakage emissions.
- As the PoA is focused on technology that utilizes refrigerants, each CPA will consider emissions from refrigerants used in the baseline as compared to the CPA and the net emissions shall be included in the resultant CER volume eligible to be received.

E.3. Description of the sources and gases included in the SSC-CPA boundary

The major gas considered in this PoA is CO2eq which is derived from 2 sources:

(a) Electrical Energy consumption from the National Grid.

[4] Project activities involving increase in output level compared to the baseline scenario are only eligible if they comply with the related and relevant guidance in the General Guidance for SSC methodologies which require a demonstration that the baseline scenario for the increased amount of output is the same as the baseline scenario defined by this methodology. Otherwise, in the event project output in year y is greater than the average historical output (average of three most recent years +/-10%) before the implementation of the project activity, the value of the output in year y is capped at the value of the historical average output level.

(b) Refrigerant gases calculated in CO2eq in accordance with their respective GWP potential in both the baseline and project activity scenario.

No other gases as defined under the Kyoto Protocol have been included.

E.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

Objective

The baseline scenario that was decided upon was using the trapezoidal integration of area under curve with respect to energy consumption (KWH) and building loading (TRH) and under a time series. It has been established that any other methods such as averaging data sums would lead to highly inaccurate readings and thus – an unreal perspective of the baseline scenario. As such, the project activity scenario also uses the same method to ensure consistency and accuracy.

Quantification of the Baseline

Energy savings is expressed as a function of Energy Efficiency. Efficiency is determined by highly accurate monitoring equipment measuring cooling load and system power consumption. Total cooling load and total energy consumed, is affected by building occupancy, weather conditions, the number of weekends in the month, etc., and therefore is not a controllable quantity. However efficiency is an intrinsic quality of the system and which is a quantity that can be measured accurately.

Based on this principle, it was determined that a baseline can be reasonably and conservatively demonstrated from that of which is prescribed in ASHRAE Guideline 14 section 5.2.2 wherein it states:

"5.2.2 Selecting the Baseline Period. Generally the period immediately before retrofit is preferred as the baseline period since its operations are most likely representative of the post-retrofit period. Also, since the operating conditions of the most recent period are most easily remembered by operating staff, the most recent period is least likely to introduce bias or error from unaccounted for factors"

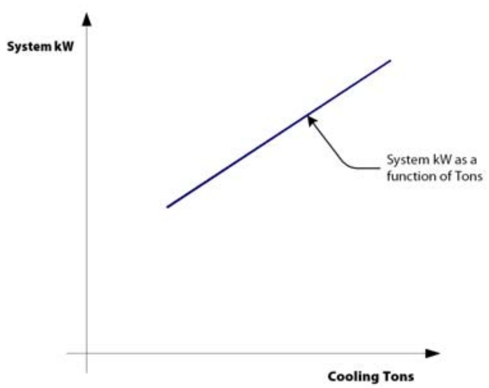
The guideline goes on further to state that in case the weather changes tremendously (such as in winter vs. summer), then an entire annual (12 month) baseline should be used "to reduce uncertainty in computed savings". In the context of Singapore, this is not the case and thus it can be reasonably and conservatively assumed that the average annual ambient temperature varies between 24 and 33 degrees Celsius (range between night and day). Therefore, it can be said that the baseline accurately measured and computed (as per systems used in the post-retrofit period over a 1 month period is conservative and representative of the average scenario, beyond a reasonable doubt.

To further corroborate this assumption, it was proven with data that building occupancy did not drop during the period in which the baseline was measured and computed, thus demonstrating that a second key factor (building occupancy) accurately demonstrates that of the scenario in the post-retrofit period.

The following describes the system parameters measured in the baseline scenario:

The system parameters that are measured are:

- Air conditioning kW and kWh, using a kW transducer at the main switchboard, including chillers, pumps, cooling towers; and
- Air-conditioning load, using high accuracy flow-meters (in litres/ second) and high accuracy thermistors on chilled water header supply and return (the delta between the supply and return in degrees Celsius).



Baseline System KW against Cooling Tons (TR) (Efficiency)

<u>Baseline and Savings</u>

After implementation of works, savings is determined by the difference between the actual kW consumption and baseline kW consumption, which will be calculated.

Saving through system efficiency improvement

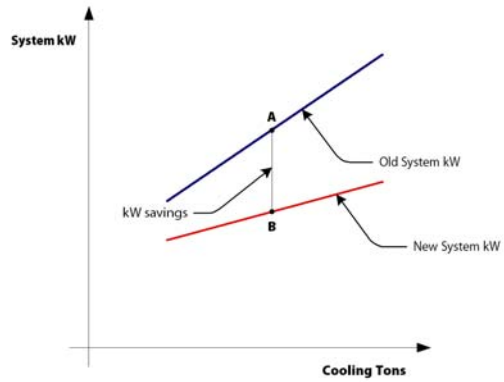
$kW_{saved} = (kW_A - kW_B)$ (which is being trended under 1 minute interval continuously)

Where

kW_A = Ton x Base line efficiency

kW_B = Ton x New system average efficiency

Ton = new system average tonnage, which is calculated from measured parameter



Baseline and Post-Implementation Efficiency

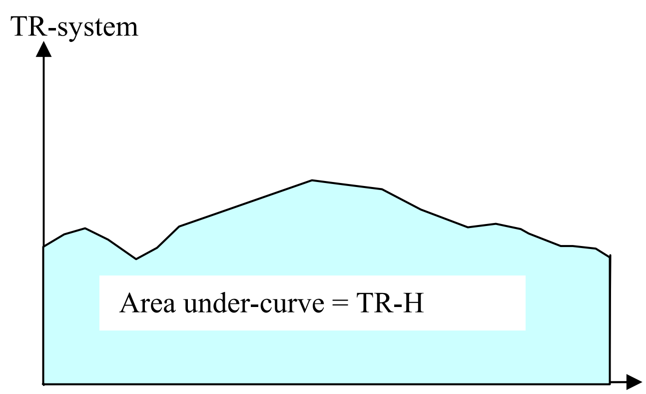
The energy savings formula used is:

Power (kW) saved per minute = $(TR)_{baseline} \times [(KW/TR)_{baseline} - (KW/TR)_{post\text{-}retrofit}]$

The following chiller plant performance metrics shall be measured and verified during the baseline period and post-retrofit period.

Cooling load demand
Cooling load demand (TR) = 1.19 x CHW flow rate (L/S) x CHW Delta T (C)

Cooling load consumption
Cooling load consumption (TR-H) = Trapezoidal integration of area under the cooling demand curve for the designated period.



Electrical consumption
Electrical consumption (KWH) = Trapezoidal integration of area under the electrical demand curve for the designated period.

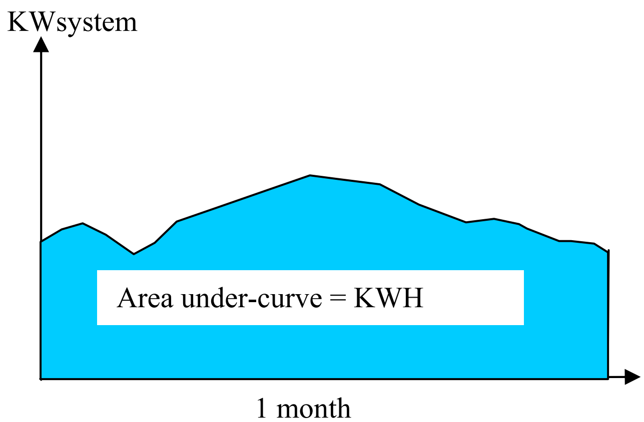
Chiller plant efficiency

$$\text{Chiller plant efficiency (KW/TR)} = \frac{\text{Electrical consumption (KWH)}}{\text{Cooling load consumption (TR-H)}}$$

The energy savings formula used is:

Energy saved per month =

$(TR\text{-}H)_{baseline\ (per\ month)} \times [(KW/TR)_{baseline(1\text{-}month)} - (KW/TR)_{post\text{-}retrofit(per\ month)}$



Important notes

a. The chiller plant efficiency shall be the continuous average efficiency over the entire year. No instantaneous or partial window period efficiency metric shall be allowed.

b. The average supply chilled water temperature for the baseline and post-retrofit period shall be consistent with an allowable tolerance of +/- 0.03C.

E.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the SSC-CPA being included as registered POA (assessment and demonstration of additionality of SSC-CPA): >>

E.5.1. Assessment and demonstration of additionality for a typical SSC-CPA:

As per the description for the assessment of additionality demonstrated in section A.4.3 of the PoA-DD a typical SSC shall be assessed to be additional if it meets the following criteria:

- The baseline efficiency of the chiller plant system was higher than 0.65kW/TR and/or an accurate monitoring system taking readings at 1-minute intervals was not in place. A baseline energy audit was conducted by an accredited ESCO.
- The new Chiller Plant System Efficiency must achieve 0.65kW/TR
- The typical CPA-DD must meet all the eligibility criteria set out in section A.4.2.2 of the Registered PoA-DD
- All data measured and monitored at 1-minute intervals.
- Design-approach must be consistent with ASHRAE Guidelines 14
- Calibration & Measurement Accuracy must be consistent with AHRI 550 Guidelines
- Cooling load capacity in the CPA must not deviate by less than 10% or more than 50% from the baseline cooling load and in accordance with methodology AMSIIC Version 13

E.5.2. Key criteria and data for assessing additionality of a SSC-CPA:

As per the guidelines set out in EB65 Meeting Report Annex 3 on Assessment of Additionality for small scale CDM Project activities - The CME has chosen to demonstrate additionality at the PoA level.

Hence please refer to Section E.5.1 above.

In addition, please refer to part (f) of the eligibility criteria stated in section A.4.2.2 of this PoA-DD.

E.6. Estimation of Emission reductions of a CPA:

E.6.1. Explanation of methodological choices, provided in the approved baseline and monitoring methodology applied, selected for a typical SSC-CPA:

S/No	Applicability conditions under the methodology	Justification for the PoA / CPAs
1	This methodology comprises activities that encourage the adoption of energy-efficient equipment/appliance (e.g., lamps, ballasts, refrigerators, motors, fans, air conditioners, pumping systems) at many sites. These technologies may replace existing equipment or be installed at new sites. In the case of new facilities, the determination of baseline scenario shall be as per the procedures described in the general guidance to SSC methodologies under the section 'Type II and III Greenfield projects (new facilities)'. The aggregate energy savings by a single project may not exceed the equivalent of 60 GWh per year for electrical end use energy efficiency technologies. For fossil fuel end use energy efficient technologies, the limit is 180 GWh thermal per year in fuel input.	The project implements a 'Integrated System Design Approach' which covers modification/replacement of one or more components in the existing cooling system with more efficient components and changes in the existing design of the cooling system to improve the overall energy efficiency of the cooling system. The electricity savings from each CPA will not exceed 60 GWh capacity limit prescribed by the Approved methodology.
2	For each replaced appliance/equipment/system the rated capacity or output or level of service (e.g., light output, water output, room temperature and comfort, the rated output capacity of air-conditioners etc.) is not significantly smaller (maximum - 10%) than the baseline or significantly larger (maximum + 50%)[5] than the baseline.	While CPA inclusion Chiller Plant System Capacities / Cooling Loads in baseline and in Project Scenario shall be verified to check the increase or decrease is well within the prescribed limit.
3	If the energy efficient equipment contains refrigerants, then the refrigerant used in the project case shall be CFC free. Project emissions from the baseline refrigerant and/or project refrigerants shall be considered in accordance with the guidance	The refrigerant used in the project is CFC free. As per the guidance under para 17 of EB 34, project emissions account for all greenhouse gas (GHG) emissions, as

[5] Project activities involving increase in output level compared to the baseline scenario are only eligible if they comply with the related and relevant guidance in the General Guidance for SSC methodologies which require a demonstration that the baseline scenario for the increased amount of output is the same as the baseline scenario defined by this methodology. Otherwise, in the event project output in year y is greater than the average historical output (average of three most recent years +/-10%) before the implementation of the project activity, the value of the output in year y is capped at the value of the historical average output level.

S/No	Applicability conditions under the methodology	Justification for the PoA / CPAs
	of the Board (EB 34, paragraph 17). This methodology credits emission reductions only due to the reduction in electricity consumption from use of more efficient equipment/appliances.	defined in paragraph 1 of the convention but not included in Annex A of the Kyoto Protocol. The global warming potential (GWP) used to calculate the carbon dioxide equivalent of GHGs not listed in Annex-A are those accepted by IPCC in its fourth assessment report (2007).

E.6.2. Equations, including fixed parametric values, to be used for calculation of emission reductions of a SSC-CPA:

ALGORITHM FOR ENERGY SAVINGS & CALCULATION OF CO2 EMISSION REDUCTIONS:

Baseline Emissions

$BE_y = E_{BL,y} * EF_{CO2,ELEC,y} + [Q_{ref, BL} \text{ X } GWP_{ref,BL}]$ (1)

$E_{BL,y} = \sum_i (n_i * \rho_i * o_i)/(1-l_y)$ (2)

Project Activity Emissions:

$PE_y = EP_{PJ,y} * EF_{CO2,y} + [PE_{ref,y} = Q_{ref,PJ,y} * GWP_{ref,PJ}]$

Emission Reductions = BE_y - PE_y

Further - Savings in KWH x Grid Emission Factor = tons of emission reductions in tCO2. This explanation is given as follows:

Under the EB50 Report – Annex 14: "Methodological Tool to calculate the emission factor for an electricity system" it states that:

"If the DNA of the host country has published a delineation of the project electricity system that is connected electricity systems, these delineations should be used."

The Singapore DNA, which is the National Environment Agency (NEA), has published these numbers on February 25 2011 (latest publication) which applies to CDM projects or programs in Singapore.

The Singapore DNA has also chosen to use the Step 3(a) as prescribed under EB50 Annex 14 which is to calculate the Simple Operating Margin (OM) of the grid. In the case of Singapore, data has been provided over a 3 year chosen period as per the document provided for by the DNA that has been gathered over the years, 2007, 2008 and 2009. The document itself is dated February 25, 2011 and is publicly available at www.nea.gov.sg

The CME (CRX) has decided to use the *Ex ante* option which complies with the EB50 Annex 14 rule,

where-in it states that:

"If the *Ex ante* option is chosen, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. For grid power plants, use a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation."

This too applies for The Build Margin as well which has also been derived from data from the Singapore DNA. Under Step 5, Option 1 of EB50 Annex 14 this is defined as:

"For the first crediting period, calculate the build margin emission factor *ex ante* based on the most recent information available on units already built for sample group *m* at the time of CDM-PDD submission to the DOE for validation."

A 3-year generation weighted average has been derived for the years, 2007,2008 and 2009.

For both sets of (OM and BM) data these have presented as follows by the Singapore DNA:

2009	a. Simple Operating Margin (OM)	0.4761 kg CO_2/kWh
	b. Build Margin (BM)	0.3988 kg CO_2/kWh
2008	a. Simple Operating Margin (OM)	0.5016 kg CO_2/kWh
	b. Build Margin (BM)	0.4111 kg CO_2/kWh
2007	a. Simple Operating Margin (OM)	0.5233 kg CO_2/kWh
	b. Build Margin (BM)	0.3990 kg CO_2/kWh

Therefore the average the Simple OM for the Singapore Grid is:

$(\sum 0.4761, 0.5016, 0.5233)/3 = 0.5000$ kg CO_2/kWh

and it follows that the average BM is:

$(\sum 0.3988, 0.4111, 0.3990)/3 = 0.4023$ kg CO_2/kWh

In order to calculate the overall grid emission factor: the build and operating margins of the grid are considered as a product of the weighted average for each margin and summed to give the final value of the emission factor ($EF_{grid,CM,y}$) and expressed in kilograms $C0_2$ per KWH as follows:

Hence:

$EF_{grid,CM,y} = EF_{grid,OM,y} \text{ x } W_{OM} + EF_{grid,BM,y}, \text{ x } W_{BM}$

Where,

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year y (kg CO_2/KWH)
$EF_{grid,OM,y}$ = Operating margin CO_2 emission factor in year y (kg CO_2/KWH)
W_{OM} = Weighting of operating margin emission factor (%)
W_{BM} = Weighting of build margin emission factor (%)

Therefore in accordance with the values provided by the DNA, the Grid Emission Factor for Singapore is calculated as:

Where default values of 50% have been used for the W_{OM} & W_{BM} as prescribed by the tool for projects not concerned with wind and solar power in the first crediting period.

$EF_{grid,CM,y}$ = (0.5000 x 50%) + (0.4023 x 50%) = 0.25 + 0.2012 = **0.4512kg CO_2 / KWH**

Measurement of chiller plant performance

The following chiller plant performance metrics shall be measured and verified during the baseline period and post-retrofit period.

Cooling load demand
Cooling load demand (TR) = 1.19 (conversion factor) x CHW flow rate (L/S) x CHW Delta T (C)
Delta T is the difference of temperature between the chilled water supply and return, which is usually in the area of 6 degrees Celsius.

Cooling load consumption
Cooling load consumption (TR-H) = Integration of area under the cooling demand curve for the designated period. This value is calculated by taking readings of the cooling load demand using the equation above at 1 min intervals and using the trapezoidal rule of integration of area under curve.

Electrical consumption
Electrical consumption (KWH) = Integration of area under the electrical demand curve for the designated period. This data is obtained from the power meters reading at source. The reading should be sampled at 5minute intervals although more frequent readings will result in higher accuracy. The average of the readings in and hour provide the KWH reading.
Chiller plant efficiency

$$\text{Chiller plant efficiency (KW/TR)} = \frac{\text{Electrical consumption (KWH)}}{\text{Cooling load consumption (TR-H)}}$$

E.6.3. Data and parameters that are to be reported in CDM-SSC-CPA-DD form:

(Copy this table for each data and parameter)

Parameter 1:	**Electrical Power Demand – Baseline (*P_i*)**
Data unit:	kW
Description:	Power of the devices of the group of "*i*" baseline devices (e.g., 40W incandescent bulb, 5hp motor). In the case of a retrofit activity, "power" is the weighted average of the devices replaced. In the case of new installations, "power" is the weighted average of devices in the chiller plant.
Source of data used:	Power transducer
Value applied:	Range of data measured at 1-minute intervals to compute KWH.
Justification of the choice of data or description of measurement methods	As measured and computed using integrated area under curve by data logger in acquisition system.

and procedures actually applied :	
Any comment:	Baseline measurement taken at 1minute intervals from [start date of energy audit] – [end date of energy audit]

Parameter 2:	**Average annual operating hours in the baseline (O_i)**
Data unit:	Hours
Description:	Average annual operating hours of the devices of the group of "*i*" baseline devices in the chiller plant
Source of data used:	Extracted from data-logger or automation system used in 1-minute intervals.
Value applied:	
Justification of the choice of data or description of measurement methods and procedures actually applied :	This data is essential to capture the operating hours of the devices in the baseline in order to determine the electrical energy consumption in KwH by multiplying Parameter 1 (Kw)
Any comment:	The time data obtained here can be averaged and multiplied by 8760hrs to obtain estimated annual consumption.

Parameter 3:	**Chilled Water Flow Demand in Baseline**
Data unit:	Litres/sec
Description:	Total chilled water flow produced by the chiller plant
Source of data used:	Magnetic or ultrasonic flow meter
Value applied:	Range of data measured at 1-minute intervals to compute cooling load (TR)
Justification of the choice of data or description of measurement methods and procedures actually applied :	As described in monitoring plan
Any comment:	

Parameter 4:	**Chilled Water Supply Temperature in Baseline**
Data unit:	Degrees C
Description:	Chilled water flow temperature supplied from the chiller plant
Source of data used:	Thermistor probe
Value applied:	Range of data measured at 1-minute intervals to compute cooling load (TR)
Justification of the choice of data or description of measurement methods and procedures actually applied :	As described in monitoring plan
Any comment:	

Parameter 5:	**Chilled Water Return Temperature in Baseline**
Data unit:	Degrees C
Description:	Chilled water flow temperature return to the chiller plant
Source of data used:	Thermistor probe
Value applied:	Range of data measured at 1-minute intervals to compute cooling load (TR)
Justification of the choice of data or description of measurement methods and procedures actually applied :	As described in monitoring plan
Any comment:	

Parameter 6:	**Chilled Water Cooling Load in Baseline**
Data unit:	TR (refrigerant tonnes)
Description:	Chilled Water Heat load
Source of data used:	Calculated TR=1.19 x CHW flow rate (L/S) x CHW Delta T (C)
Value applied:	Range of data computed at 1-minute intervals
Justification of the choice of data or description of measurement methods and procedures actually applied :	As described in monitoring plan
Any comment:	

Parameter 7:	**Chilled Water Cooling Load Energy in Baseline**
Data unit:	TR-H (refrigerant tonnes-Hour)
Description:	Chilled Water Cooling Load Energy
Source of data used:	Integrated area under-curve of cooling load (TR) usage over time series
Value applied:	
Justification of the choice of data or description of measurement methods and procedures actually applied :	The integrated area under-curve measurement (trapezoidal rule) is more accurate than using the other method of averaging the data measured for TR and KW over a time series.
Any comment:	

Parameter 8:	**Energy consumption in project activity in year *y*. ($E_{PJ,y}$)**
Data unit:	kW
Description:	Total power demand of all chiller plant equipment used in the project activity
Source of data to be used:	Power Transducer (multiple)
Value applied:	Range of data measured ex-post at 1-minute intervals
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class. **<u>Electrical Demand Measurement</u>** Electrical input to the system consists of the power usage for the CH, CHWP, CWP and CT. Electrical Power can be measured quite accurately by using a ±1% digital power meter. Since, the data are converted and transmitted digitally using Modbus protocol, the error of A/D conversion is eliminated.
QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	

Parameter 9:	**Average annual operating hours in the project activity (O_i)**
Data unit:	Hours
Description:	Integrated power usage over time or hours used to measure power consumption during the audit of the project activity
Source of data to be used:	Extracted from data-logger or automation system used in 1-minute intervals.
Value applied:	8760 hrs
Description of measurement methods and procedures to be applied:	This data is essential to capture the operating hours of the devices in the project activity in order to determine the electrical energy consumption in KwH by multiplying value applied in Parameter 8 (Kw)
QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	The time data obtained here can be averaged over the time taken to conduct the project activity audit and multiplied by 8760 hrs to obtain estimated annual consumption.

Parameter 10:	**Chilled Water Flow Demand in Project Activity**
Data unit:	Litres / Second
Description:	Total chilled water flow produced by the chiller plant
Source of data to be used:	Magnetic or Ultrasonic Flow Meter

Value applied:	Range of data measured at 1-minute intervals
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class. **Water Flow Rate Measurement** Flow can be measured accurately by installing a magnetic flow meter or ultrasonic flow meter at the correct location and correct straight pipe length as suggested by the manufacturer. The accuracy of the flow measurement can be good to 0.5% of the rate for magnetic flow meter and 1.0% for ultrasonic flow meter. However, site conditions sometimes do not permit the correct straight pipe length upstream and downstream of the flow meter. Therefore an error allowance of +/- 2% is allocated for site flow rate measurement.
QA/QC procedures to be applied:	
Any comment:	

Parameter 11:	**Chilled Water Supply Temperature during Project Activity**
Data unit:	Degrees Celsius
Description:	Chilled water flow temperature supplied from the chiller plant
Source of data to be used:	Thermistor Probe
Value applied:	Range of data measured at 1-minute intervals
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class. **Water Temperature Measurement** To measure temperature of water accurately, only laboratory-graded sensors will be used. Chilled water temperature difference is defined as the difference in chilled water temperature return with respect to chilled water supply temperature. A ±0.5°C error in temperature sensor will cause an error of 17.86% in TR measurement (see table below).

Temperature Sensor Error	±0.0°C	±0.5°C	±0.03°C
usgpm (no error)	2,400	2,400	2,400
CHWS °C	6.700	6.200	6.670
CHWR °C	12.300	12.800	12.330
DT °C	5.600	6.600	5.660
Computed Tons	1,008	1,188	1,019
Errror %		17.86%	1.07%

	A temperature sensor that has an uncertainty of ±0.03°C error at site will cause an error of 1.07% in Ton measurement. Therefore, temperature sensor in the laboratory must have an uncertainty of ±0.01°C or better.
QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	

Parameter 12:	**Chilled Water Return Temperature in Project Activity**
Data unit:	Degrees Celsius
Description:	Chilled water flow temperature return to the chiller plant
Source of data to be used:	Thermistor Probe
Value applied:	Range of data measured at 1-minute intervals
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class. **Water Temperature Measurement** To measure temperature of water accurately, only laboratory-graded sensors will be used. Chilled water temperature difference is defined as the difference in chilled water temperature return with respect to chilled water supply temperature. A ±0.5°C error in temperature sensor will cause an error of 17.86% in TR measurement (see table below). (table below) A temperature sensor that has an uncertainty of ±0.03°C error at site will cause an error of 1.07% in Ton measurement. Therefore, temperature sensor in the laboratory must have an uncertainty of ±0.01°C or better.
QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	

Temperature Sensor Error	±0.0°C	±0.5°C	±0.03°C
usgpm (no error)	2,400	2,400	2,400
CHWS °C	6.700	6.200	6.670
CHWR °C	12.300	12.800	12.330
DT °C	5.600	6.600	5.660
Computed Tons	1,008	1,188	1,019
Errror %		**17.86%**	**1.07%**

Parameter 13:	**Chilled Water Cooling Load in Project Activity**

Data unit:	Metric Tonnes of Refrigeration (TR)
Description:	Chilled Water Heat Load
Source of data to be used:	Calculated TR=1.19 x CHW flow rate (L/S) x CHW Delta T (C)
Value applied:	Range of data computed at 1-minute intervals
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class. As prescribed for water temperature measurement and water flow that is measured and subsequently used in this calculation.
QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	

Parameter 14:	**Chilled Water Cooling Load Energy in Project Activity**
Data unit:	Metric Tonnes of Refrigeration per Hour (TR-H)
Description:	Integrated area under-curve of cooling load (TR) usage over time series
Source of data to be used:	
Value applied:	Value applied will be calculated as follows: Obtain TRH data measured from 1-minute intervals of TR (cooling load) reading over a 1-year period using trapezoidal rule (integration of area under curve) during the project activity. **This value is: ___________TR-H**
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class As prescribed for water temperature measurement and water flow that is measured and subsequently used in this calculation with time-series factor.
QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	

Parameter 15:	**Annual Chiller Plant System Cooling Efficiency in Project Activity**
Data unit:	Kilowatt Hours (KW-H) divided by Tonnes of Refrigeration per Hour (TR-H) known as: KWH/TRH
Description:	Calculating Energy Efficiency of Chiller Plant System in Project Activity
Source of data to be used:	(Parameter 8*9) divided by Parameter 14
Value applied:	

	__________ KWH / _________ TRH = ________ KWH/TR-H
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class. As prescribed for water temperature measurement and water flow that is measured and subsequently used in this calculation with time-series factor.
QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	

Parameter 16:	**Calculated annual electrical energy savings of project activity**
Data unit:	Kilowatt Hours (KW-H) per year : KWH/year
Description:	The numerical difference between the product of (Parameter 1 * Parameter 2) and (Parameter 8 * Parameter 9)
Source of data to be used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	**________KWH – _______KWH = _______KWH**
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class. As prescribed for water temperature measurement and water flow that is measured and subsequently used in this calculation with time-series factor.
QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	

Parameter 17:	Calculated Grid Emission Factor (Combined Margin).
Data unit:	$kgCO_2/KwH$
Description:	The calculated Grid Emission Factor of the Singapore Grid based on information provided for by the DNA
Source of data to be used:	The Simple Operating Margin (OM) and Build Margin (BM) data provided over a 3 year period and averaged for the 3 year period (at each margin) and multiplied by the weighted factor of 0.5 for each margin. Utility or government records or official publications.
Value applied:	$EF_{grid,CM,y}$ = (0.5000 x 50%) + (0.4023 x 50%) = 0.25 + 0.2012 = **0.4512 kg CO_2 / KWH**
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	

Parameter 18:	Average annual technical grid losses (L_y)
Data unit:	Percentage
Description:	Transmission & Distribution Losses of the National Power Grid
Source of data to be used:	Utility or government records or official publications. In this case: The National Climate Change Secretariat and the National Research Foundation of Singapore
Value applied:	3%
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	This value need not be monitored and is fixed across the lifetime of the PoA.

Parameter 19:	**$Q_{ref,BL}$**
Data unit:	Tons/year
Description:	Average annual quantity of refrigerant used in the baseline.
Source of data to be used:	Each chiller manufacturer or ESCO should supply the actual figure (in kg) for the initial refrigerant charge in the baseline. In the event this data is not available this quantity may be qualified and calculated by utilizing the data in Table 9 (Page 62) and based on each refrigerant charge in kg/kW of a specific refrigerant gas - of the "Energy and Global Warming Impacts of HFC Refrigerants published by the US EPA and DOE together with the Alternative Fluorocarbons Environmental Acceptability Study (AFEAS).
Value applied:	To be applied with respect to each CPA
Justification of the choice of data or description of measurement methods and procedures actually applied:	As per guidance from Chapter 7: Emissions of fluorinated substitutes for Ozone depleting substances, Volume 3, Industrial Processes and Product Use, 2006 IPCC Guidelines for National Greenhouse Gas Inventories. As per table 7.9 this refrigerant charge range may be from between 10kg to 2,000kg per chiller and a maximum leakage of 15% per annum is determined for developing countries. Further - The refrigerant charge used for these calculations is a composite kg/kW value for screw and centrifugal compressors integrated over the size range of interest. Individual sources for these values were 1) those published in the original TEWI report, 2) those estimated by an Ad-Hoc subcommittee formed by ARI member companies, and 3) those published in the 1995 UNEP Report (Fischer 1991, Hourahan 1996a, UNEP 1995).
Any comment:	This data parameter will remain constant for the entire crediting period of the CPA.

Parameter 20:	**$GWP_{ref,BL}$**
Data unit:	Tons CO_{2eq}/ton refrigerant
Description:	Global warming potential of the baseline refrigerant
Source of data to be used:	IPCC values
Value applied:	To be applied with respect to each CPA
Justification of the choice of data or description of measurement methods and procedures actually applied:	This is in line with the requirement of the baseline and monitoring methodology.
Any comment:	This data parameter will remain constant for the entire crediting period of the CPA.

Parameter 21:	$Q_{ref,Y}$
Data unit:	tons/year
Description:	Average annual quantity of refrigerant used in year *y* in the project activity to replace refrigerant that has leaked in year *y*
Source of data to be used:	Each chiller manufacturer or ESCO needs to supply the actual figure (in kg) for the initial refrigerant charge in each new CPA
Value applied:	To be applied with respect to each CPA
Justification of the choice of data or description of measurement methods and procedures actually applied:	As per guidance from Chapter 7: Emissions of fluorinated substitutes for Ozone depleting substances, Volume 3, Industrial Processes and Product Use, 2006 IPCC Guidelines for National Greenhouse Gas Inventories. As per table 7.9 – This refrigerant charge range may be from 10kg to 2,000kg per chiller and a maximum leakage of 15% per annum is determined for developing countries.
Any comment:	This data parameter will remain constant for the entire crediting period of the CPA.

Parameter 22:	$GWP_{ref,PJ}$
Data unit:	Tons CO_{2eq}/t refrigerant
Description:	Global warming potential of the refrigerant that is used in the project equipment.
Source of data to be used:	IPCC Values
Value applied:	To be applied with respect to each CPA
Justification of the choice of data or description of measurement methods and procedures actually applied:	This is in line with the requirement of the baseline and monitoring methodology.
Any comment:	This data parameter will remain constant for the entire crediting period of the CPA.

E.7. Application of the monitoring methodology and description of the monitoring plan:

E.7.1. Data and parameters to be monitored by each SSC-CPA:

Parameter 1:	**Electrical Power Demand – Baseline (P_i)**
Data unit:	kW
Description:	Power of the devices of the group of "*i*" baseline devices (e.g., 40W incandescent bulb, 5hp motor). In the case of a retrofit activity, "power" is the weighted average of the devices replaced. In the case of new installations, "power" is the weighted average of devices in the chiller plant.
Source of data used:	Power transducer
Value applied:	Range of data measured at 1-minute intervals to compute KWH.
Justification of the choice of data or description of measurement methods and procedures actually applied :	As described in monitoring plan
Any comment:	

Parameter 2:	**Average annual operating hours in the baseline (O_i)**
Data unit:	Hours
Description:	Average annual operating hours of the devices of the group of "*i*" baseline devices in the chiller plant
Source of data used:	Extracted from data-logger or automation system used in 1-minute intervals.
Value applied:	**8760hrs**
Justification of the choice of data or description of measurement methods and procedures actually applied :	This data is essential to capture the operating hours of the devices in the baseline in order to determine the electrical energy consumption in KwH by multiplying Parameter 1(Kw)
Any comment:	The time data obtained here can be averaged over the time taken to conduct the baseline audit and multiplied by 8760 hrs to obtain estimated annual consumption.

Parameter 3:	**Chilled Water Flow Demand in Baseline**
Data unit:	Litres/sec
Description:	Total chilled water flow produced by the chiller plant
Source of data used:	Magnetic or ultrasonic flow meter
Value applied:	Range of data measured at 1-minute intervals to compute cooling load (TR)
Justification of the choice of data or description of measurement methods and procedures actually applied :	As described in monitoring plan
Any comment:	

Parameter 4:	**Chilled Water Supply Temperature in Baseline**
Data unit:	Degrees C
Description:	Chilled water flow temperature supplied from the chiller plant
Source of data used:	Thermistor probe
Value applied:	Range of data measured at 1-minute intervals to compute cooling load (TR)
Justification of the choice of data or description of measurement methods and procedures actually applied :	As described in monitoring plan
Any comment:	

Parameter 5:	**Chilled Water Return Temperature in Baseline**
Data unit:	Degrees C
Description:	Chilled water flow temperature return to the chiller plant
Source of data used:	Thermistor probe
Value applied:	Range of data measured at 1-minute intervals to compute cooling load (TR)
Justification of the choice of data or description of measurement methods and procedures actually applied :	As described in monitoring plan
Any comment:	

Parameter 6:	**Chilled Water Cooling Load in Baseline**
Data unit:	TR (refrigerant tonnes)
Description:	Chilled Water Heat load
Source of data used:	Calculated TR=1.19 x CHW flow rate (L/S) x CHW Delta T (C)
Value applied:	Range of data computed at 1-minute intervals
Justification of the choice of data or description of measurement methods and procedures actually applied :	As described in monitoring plan
Any comment:	

Parameter 7:	**Chilled Water Cooling Load Energy in Baseline**
Data unit:	TR-H (refrigerant tonnes-Hour)
Description:	Chilled Water Cooling Load Energy
Source of data used:	Integrated area under-curve of cooling load (TR) usage over time series
Value applied:	
Justification of the choice of data or description of measurement methods and procedures actually applied :	The integrated area under-curve measurement (trapezoidal rule) is more accurate than using the other method of averaging the data measured for TR and KW over a time series.
Any comment:	

Parameter 8:	Energy consumption in project activity in year *y*. ($E_{PJ,y}$)
Data unit:	kW
Description:	Total power demand of all chiller plant equipment used in the project activity and measured *ex-post.*
Source of data to be used:	Power Transducer (multiple)
Value applied:	Range of data measured at 1-minute intervals
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class. **Electrical Demand Measurement** Electrical input to the system consists of the power usage for the CH, CHWP, CWP and CT. Electrical Power can be measured quite accurately by using a ±1% digital power meter. Since, the data are converted and transmitted digitally using Modbus protocol, the error of A/D conversion is eliminated.
QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	

Parameter 9:	**Average annual operating hours in the project activity (O_i)**
Data unit:	Hours
Description:	Integrated power usage over time or hours used to measure power consumption during the audit of the project activity
Source of data to be used:	Extracted from data-logger or automation system used in 1-minute intervals.
Value applied:	8760 hrs
Description of measurement methods and procedures to be applied:	This data is essential to capture the operating hours of the devices in the baseline in order to determine the electrical energy consumption in KwH by multiplying Parameter 8 (Kw)
QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	The time data obtained here can be averaged over the time taken to conduct the project activity audit and multiplied by 8760 hrs to obtain estimated annual consumption.

Parameter 10:	**Chilled Water Flow Demand in Project Activity**
Data unit:	Litres / Second
Description:	Total chilled water flow produced by the chiller plant
Source of data to be used:	Magnetic or Ultrasonic Flow Meter

Value applied:	Range of data measured at 1-minute intervals
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class. **Water Flow Rate Measurement** Flow can be measured accurately by installing a magnetic flow meter or ultrasonic flow meter at the correct location and correct straight pipe length as suggested by the manufacturer. The accuracy of the flow measurement can be good to 0.5% of the rate for magnetic flow meter and 1.0% for ultrasonic flow meter. However, site conditions sometimes do not permit the correct straight pipe length upstream and downstream of the flow meter. Therefore an error allowance of +/- 2% is allocated for site flow rate measurement.
QA/QC procedures to be applied:	
Any comment:	

Parameter 11:	**Chilled Water Supply Temperature during Project Activity**
Data unit:	Degrees Celsius
Description:	Chilled water flow temperature supplied from the chiller plant
Source of data to be used:	Thermistor Probe
Value applied:	Range of data measured at 1-minute intervals
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class. **Water Temperature Measurement** To measure temperature of water accurately, only laboratory-graded sensors will be used. Chilled water temperature difference is defined as the difference in chilled water temperature return with respect to chilled water supply temperature. A ±0.5°C error in temperature sensor will cause an error of 17.86% in TR measurement (see table below).

	<table><tr><td>Temperature Sensor Error</td><td>±0.0°C</td><td>±0.5°C</td><td>±0.03°C</td></tr><tr><td>usgpm (no error)</td><td>2,400</td><td>2,400</td><td>2,400</td></tr><tr><td>CHWS °C</td><td>6.700</td><td>6.200</td><td>6.670</td></tr><tr><td>CHWR °C</td><td>12.300</td><td>12.800</td><td>12.330</td></tr><tr><td>DT °C</td><td>5.600</td><td>6.600</td><td>5.660</td></tr><tr><td>Computed Tons</td><td>1,008</td><td>1,188</td><td>1,019</td></tr><tr><td>Errror %</td><td></td><td>17.86%</td><td>1.07%</td></tr></table> A temperature sensor that has an uncertainty of ±0.03°C error at site will cause an error of 1.07% in Ton measurement. Therefore, temperature sensor in the laboratory must have an uncertainty of ±0.01°C or better.
QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	

Parameter 12:	Chilled Water Return Temperature in Project Activity
Data unit:	Degrees Celsius
Description:	Chilled water flow temperature return to the chiller plant
Source of data to be used:	Thermistor Probe
Value applied:	Range of data measured at 1-minute intervals
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class. **Water Temperature Measurement** To measure temperature of water accurately, only laboratory-graded sensors will be used. Chilled water temperature difference is defined as the difference in chilled water temperature return with respect to chilled water supply temperature. A ±0.5°C error in temperature sensor will cause an error of 17.86% in TR measurement (see table below). <table><tr><td>Temperature Sensor Error</td><td>±0.0°C</td><td>±0.5°C</td><td>±0.03°C</td></tr><tr><td>usgpm (no error)</td><td>2,400</td><td>2,400</td><td>2,400</td></tr><tr><td>CHWS °C</td><td>6.700</td><td>6.200</td><td>6.670</td></tr><tr><td>CHWR °C</td><td>12.300</td><td>12.800</td><td>12.330</td></tr><tr><td>DT °C</td><td>5.600</td><td>6.600</td><td>5.660</td></tr><tr><td>Computed Tons</td><td>1,008</td><td>1,188</td><td>1,019</td></tr><tr><td>Errror %</td><td></td><td>17.86%</td><td>1.07%</td></tr></table>

	A temperature sensor that has an uncertainty of ±0.03°C error at site will cause an error of 1.07% in Ton measurement. Therefore, temperature sensor in the laboratory must have an uncertainty of ±0.01°C or better.
QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	

Parameter 13:	**Chilled Water Cooling Load in Project Activity**
Data unit:	Metric Tonnes of Refrigeration (TR)
Description:	Chilled Water Heat Load
Source of data to be used:	Calculated TR=1.19 x CHW flow rate (L/S) x CHW Delta T (C)
Value applied:	Range of data computed at 1-minute intervals
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class. As prescribed for water temperature measurement and water flow that is measured and subsequently used in this calculation.
QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	

Parameter 14:	**Chilled Water Cooling Load Energy in Project Activity**
Data unit:	Metric Tonnes of Refrigeration per Hour (TR-H)
Description:	Integrated area under-curve of cooling load (TR) usage over time series
Source of data to be used:	
Value applied:	Value applied will be calculated as follows: Obtain TRH data measured from 1-minute intervals of TR (cooling load) reading over a 1-year period using trapezoidal rule (integration of area under curve) during the project activity. **This value is: ___________TR-H**
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class As prescribed for water temperature measurement and water flow that is measured and subsequently used in this calculation with time-series factor.

QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	

Parameter 15:	**Annual Chiller Plant System Cooling Efficiency in Project Activity**
Data unit:	Kilowatt Hours (KW-H) divided by Tonnes of Refrigeration per Hour (TR-H) known as: KWH/TRH
Description:	Calculating Energy Efficiency of Chiller Plant System in Project Activity
Source of data to be used:	(Parameter 8*9) divided by Parameter 14
Value applied:	**__________ KWH / _________ TRH = _______ KWH/TR-H**
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class. As prescribed for water temperature measurement and water flow that is measured and subsequently used in this calculation with time-series factor.
QA/QC procedures to be applied:	Based on maintenance schedule
Any comment:	

Parameter 16:	**Calculated annual electrical energy savings of project activity**
Data unit:	Kilowatt Hours (KW-H) per year: KWH/year
Description:	The numerical difference between the product of (Parameter 1 * Parameter 2) and (Parameter 8 * Parameter 9)
Source of data to be used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	**________KWH – _______KWH = _______KWH**
Description of measurement methods and procedures to be applied:	In this section the project participants shall provide description of equipment used for measurement, if applicable, and its accuracy class. As prescribed for water temperature measurement and water flow that is measured and subsequently used in this calculation with time-series factor.
QA/QC procedures to	Based on maintenance schedule

be applied:	
Any comment:	

Parameter 17:	**$Q_{ref,BL}$**
Data unit:	Tons/year
Description:	Average annual quantity of refrigerant used in the baseline.
Source of data to be used:	Each chiller manufacturer or ESCO should supply the actual figure (in kg) for the initial refrigerant charge in the baseline. In the event this data is not available this quantity may be qualified and calculated by utilizing the data in Table 9 (Page 62) and based on each refrigerant charge in kg/kW of a specific refrigerant gas - of the "Energy and Global Warming Impacts of HFC Refrigerants published by US EPA and DOE together with the Alternative Fluorocarbons Environmental Acceptability Study (AFEAS)
Value applied:	To be applied with respect to each CPA
Justification of the choice of data or description of measurement methods and procedures actually applied:	As per guidance from Chapter 7: Emissions of fluorinated substitutes for Ozone depleting substances, Volume 3, Industrial Processes and Product Use, 2006 IPCC Guidelines for National Greenhouse Gas Inventories. As per table 7.9 this refrigerant charge may range from 10kg to 2,000kg per chiller and a maximum leakage of 15% per annum is determined for developing countries. Further - The refrigerant charge used for these calculations is a composite kg/kW value for screw and centrifugal compressors integrated over the size range of interest. Individual sources for these values were 1) those published in the original TEWI report, 2) those estimated by an Ad-Hoc subcommittee formed by ARI member companies, and 3) those published in the 1995 UNEP Report (Fischer 1991, Hourahan 1996a, UNEP 1995).
Any comment:	This data parameter will remain constant for the entire crediting period of the CPA.

Parameter 18:	**$GWP_{ref,BL}$**
Data unit:	Tons CO_{2eq}/ton refrigerant
Description:	Global warming potential of the baseline refrigerant
Source of data to be used:	IPCC values
Value applied:	To be applied with respect to each CPA
Justification of the choice of data or description of measurement methods and procedures actually applied:	This is in line with the requirement of the baseline and monitoring methodology.
Any comment:	This data parameter will remain constant for the entire crediting period of the CPA.

Parameter 19:	$Q_{ref,Y}$
Data unit:	tons/year
Description:	Average annual quantity of refrigerant used in year *y* in the project activity to replace refrigerant that has leaked in year *y*
Source of data to be used:	Each chiller manufacturer or ESCO needs to supply the actual figure (in kg) for the initial refrigerant charge in the CPA.
Value applied:	To be applied with respect to each CPA
Justification of the choice of data or description of measurement methods and procedures actually applied:	As per guidance from Chapter 7: Emissions of fluorinated substitutes for Ozone depleting substances, Volume 3, Industrial Processes and Product Use, 2006 IPCC Guidelines for National Greenhouse Gas Inventories. This range may be from 10kg to 2,000kg per chiller and a maximum leakage of 15% per annum is determined for developing countries.
Any comment:	This data parameter will remain constant for the entire crediting period of the CPA.

Parameter 20:	$GWP_{ref,PJ}$
Data unit:	Tons CO_{2eq}/t refrigerant
Description:	Global warming potential of the refrigerant that is used in the project equipment.
Source of data to be used:	IPCC Values
Value applied:	To be applied with respect to each CPA
Justification of the choice of data or description of measurement methods and procedures actually applied:	This is in line with the requirement of the baseline and monitoring methodology.
Any comment:	This data parameter will remain constant for the entire crediting period of the CPA.

E.7.2. Description of the monitoring plan for a SSC-CPA:

Objective of the Monitoring Plan for a typical SSC-CPA

The first objective in creating a highly accurate standard in the monitoring plan is to conduct and produce accurate, long-term and measurable data gathering and verification systems, in order to achieve factory-standards where the actual equipment is manufactured. This is in line with AHRI550, which prescribes accuracy tolerance range of ±5% for cooling load demand. In addition, in order to achieve overall consistency in the monitoring plan, the overall heat balance in the chiller plant room shall be computed for counter-checking the accuracy of data and resultant computation.

The second objective is to ensure that old chillers from the baseline scenario is / are effectively scrapped by keeping track by ensuring 3rd parties ensure that equipment is removed and disposed off according to the code of practices recommended by the government. The serial number of the new chillers shall also be compared against replaced chillers and in accordance with manufacturers specifications for newer equipment. These specifications shall be stored in the database managed by the CME and which data shall be easily verifiable and comparable.

Post-Retrofit Monitoring Procedures

Temperature Sensors: The temperature sensors should be 10k Thermistor type. The temperature sensors used should be calibrated at 3 points (Triple Point of Water, Gallium and 15 Deg C Water bath) to ensure good accuracy of ±0.01° C. No resistance to analogue converter is allowed. All temperature computation shall be NTC non linear.

Data Acquisition System: Data acquisition system used should have an A/D bit of 16-20 bit resolution.

Data Logging Software: All data should be trended at 1minute sampling time interval.

Flow meter: The flow meter should be full bore electromagnetic flow meter for chillers (accuracy ±1%) and clamped-on ultrasonic for headers (accuracy of ±2%).

KW power meter: Power meter should be digital and split cored CT. Power Meters used shall have total system accuracy of ±1% and conform to ANSI C12.1 metering standard.

Data Acquisition & Control System to determine Efficiency (kW/TR)

Magnetic Flow meter from Siemens (accuracy ±0.25%)

10K/30K thermistors for temperature measurement. All sensors are manually calibrated in our laboratory to achieve uncertainty of **±0.01°C**. The 3 calibration points are triple point of water (0.01°C), Gallium melting point (29.7646°C) and water bath (15°C).

3-phase network split core power meter from Veris (±1% total system accuracy, 10% to 100% CT rating)

IO card (Agilent 34901A)

Data Acquisition System (Agilent 34970A)

} 6 1/2 Digital multi meter (equivalent to 22 bit A/D)

AT1616L digital IO card (for Status and Start/Stop Control)

Data acquisition and Control server (DAC Server) – Reliable Industrial PC server with redundancy features

Step-by-step description of a typical monitoring plan using the above standards and required accuracies*: (Please note that ALL data is captured at 1-minute intervals to ensure high resolution of data accuracy)*

1. Data is measured for electrical power demand for equipment within the chiller plant using a series of power transducers.

2. Data is measured for chilled water (CHW) flow in litres / second using a magnetic or ultrasonic flow meter.

3. Data is measured for the temperature of chilled water (CHW) supply (CHWS) and chiller water return (CHWR) in degrees Celsius using a thermistor probe. The delta (difference) in the temperature is the data gathered for computation.

4. The chilled water cooling is then computed by the software (Energy Management System) in tonnes of refrigeration (TR) using the equation:

TR=1.19 x CHW flow rate (L/S) x CHW Delta T (C)

5. Electrical Energy Consumption in KWH is then computed using the rule: integration of area under curve (trapezoidal rule) – electrical energy demand over a time series. This computed by the EMS software.

6.Chilled Water-cooling demand in TRH is also computed using the rule: integration of area under curve (trapezoidal rule) – chiller water-cooling demand over a time series. This is computed by the EMS software.

7. The EMS system then divides Point 5 by Point 6 (KWH/TRH) resulting in the energy efficiency coefficient of KW/TR. This system efficiency is captured and stored in the database.

8.The KWH savings – which is the difference between the electrical energy consumption in the baseline scenario (pre-retrofit) and the electrical energy consumption during the operation of the SSC-CPA (post-retrofit) – **for the same cooling load**, is also computed by the EMS and can be shown on a monthly basis.

9. The KWH savings data is then stored by the EMS and kept securely captured by the Coordinating Entity on a monthly basis and computed for 12 month to determine the KWH savings per year.

10. KWH savings per annum is then multiplied by the National Grid Emission Factor, which in the case of Singapore is **0.4512 kg CO_2 / KWH**
Hence the equation: Annual KWH savings x **0.4512 kg CO_2 / KWH**/ 1000 = ton CO2eq per annum.

11. Refrigerant emissions must also be calculated in the both baseline scenario as well as in the CPA. Net emission reductions shall be included in both scenarios to determine the final quantum of the CERs eligible for each CPA.

E.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

Date of completion of the application of the baseline study and monitoring methodology:

March 5, 2010

Name of the responsible person(s) and entity:

Vinod Kesava – Climate Resources Exchange Pte Ltd

Annex 1

CONTACT INFORMATION ON COORDINATING/MANAGING ENTITY and PATRICIPANTS IN THE PROGRAMME OF ACTIVITIES

Organization:	Climate Resources Exchange Pte Ltd
Street/P.O.Box:	3 Raffles Place #07-01
Building:	Bharat Building
City:	Singapore
State/Region:	Singapore
Postfix/ZIP:	048617
Country:	Singapore
Telephone:	(65) 6329 9748
FAX:	(65) 6552 3457
E-Mail:	v.kesava@climate-resources.com
URL:	www.climate-xchange.com
Represented by:	Vinod Kesava
Title:	Managing Director
Salutation:	Mr
Last Name:	Kesava
Middle Name:	N/A
First Name:	Vinod
Department:	Management
Mobile:	(65) 9384 0166
Direct FAX:	As above
Direct tel:	As per mobile
Personal E-Mail:	vkesava@gmail.com

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Standard Bank Plc
Street/P.O.Box:	20 Gresham Street
Building:	
City:	London
State/Region:	
Postfix/ZIP:	EC2V 7JE
Country:	United Kingdom
Telephone:	+44 20 3145 6890
FAX:	+44 20 3189 6930
E-Mail:	co2@standardbank.com
URL:	www.standardbank.com
Represented by:	Geoff Sinclair
Title:	Head of Carbon Sales & Trading
Salutation:	Mr.
Last Name:	Sinclair
Middle Name:	
First Name:	Geoff
Department:	Energy Trading and Marketing
Mobile:	+44 7769 648 695
Direct FAX:	+44 20 3189 6930
Direct tel:	+44 20 3145 6893
Personal E-Mail:	geoff.sinclair@standardbank.com

Annex 2
INFORMATION REGARDING PUBLIC FUNDING
ANNEX 3
BASELINE INFORMATION
Annex 4
MONITORING INFORMATION