CLEAN DEVELOPMENT 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):

>>
Southern Africa Solar Thermal Energy (SASTE) Programme
Version number of the document: 1.3
Date: 11/11/11

Version History:
Version 1.2 – 18/10/11
Version 1.1 – 08/09/11
Version 1.0 – 08/07/11

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

>> The following information shall be included here:

The purpose of this programme is the promotion of small scale solar technologies that reduce the use of fossil fuels and the associated emissions. Solar thermal energy (STE) is a group of technologies which exploits solar energy to provide thermal energy. These technologies are typically arranged in to three categories:

- Low temperature collectors such as are used to heat swimming pools
- Medium temperature collectors usually used to heat water or air for use in domestic or commercial applications
- High temperature collectors which concentrate sunlight and are typically used to generate electricity

1. General operating and implementing framework of PoA

This small scale programme of activities (hereafter referred to as the PoA) is a programme for the installation devices that utilise solar energy for the production of thermal energy. The programme spans 8 Southern African countries including Namibia, Botswana, Zimbabwe, Zambia, Mozambique, Swaziland, Lesotho and South Africa (hereafter referred to as the Countries). The PoA is an initiative undertaken by EcoMetrix Solar Ventures (hereafter referred as EcoMetrix). The PoA will be coordinated and managed by EcoMetrix Solar Ventures acting as the CME.

2. Policy/measure or stated goal of the PoA

The stated objective of this programme is to reduce reliance on fossil fuel based electricity and thus reduce the associated CO_2 emissions in Southern Africa through the use of solar thermal energy (STE) technology in the domestic, commercial and industrial context.

In addition the PoA will contribute to activities aimed at growing and strengthening the solar industry in the Countries. These activities will involve interacting with consumer awareness and education initiatives, advising industry bodies on the role of the carbon markets in a low carbon economy and the marketing of solar technology as an alternative to fossil fuel technologies.

Whilst the Countries involved in this PoA are well known to have little to no oil or natural gas reserves, they do have well developed coal reserves and exceptional solar potential (Figure **1**).

Programmes such as this one are necessary to move away from a dependence on the most prevalent fossil fuel resources and encourage the uptake of the available renewable resources.

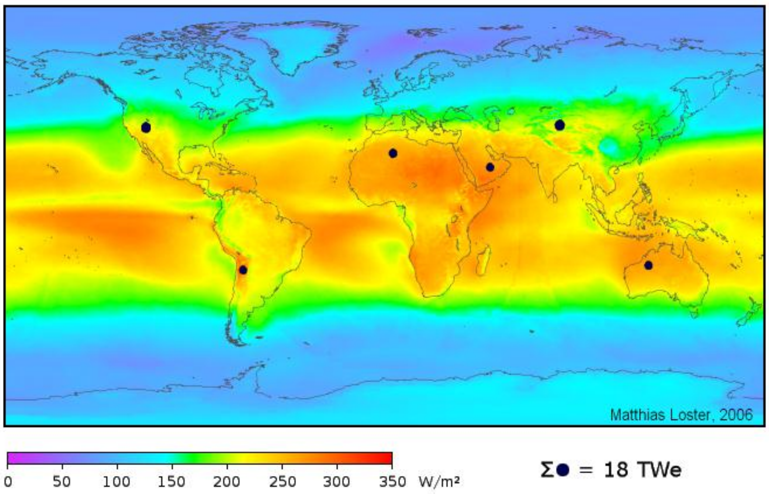

Figure 1:The colours in the map show the local solar irradiance averaged over three years from 1991 to 1993 (24 hours a day) taking into account the cloud coverage available from weather satellites. Black circles indicate the greatest single point insolation.

Chronology of events

The following activities were undertaken in the development of this PoA:

25 November 2010	– Initial CDM meeting
28 January 2011	– Completed CDM Feasibility Study
16 February 2011	– PDD Development begins
11 July 2011	– DOE Contracted
03 August 2011	– Validation Start (GSC)
16 September 2011	– First Store (Strubensvallei Builders Warehouse)

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

The PoA is a voluntary action, not required by law, undertaken by EcoMetrix Solar Ventures (EcoMetrix) who is the coordinating/managing entity for the PoA.

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

>> The following information shall be included here:

Entity	**Coordinating or managing entity of the PoA as the entity which communicates with the Board**	**Project participants being registered in relation to the PoA. Project participants may or may not be involved in one of the CPAs related to the PoA**

EcoMetrix Solar Ventures	Yes	Yes
Ellies Holdings	No	No

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

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The PoA is a programme for the installation of devices or products that utilise solar technology to produce thermal energy for the consumer. It is envisioned that such products will include but are not limited to:

- **Solar water heaters** – These units use solar radiation to heat water which is stored in a tank and used for sanitary needs such as bathing, cleaning, showering etc.
- **Air-source heat pumps** – These units use the heat in the air, from solar radiation, to heat water either for direct sanitary use such as in a water heating vessel or for space heating in a radiator system. Using the same system as a domestic fridge (vapour compression refrigeration) heat is absorbed from outside, transferred to the internal circuit and released into a water heater. These units typically consume 1 unit of electricity for every 3 units of heating produced, thereby replacing grid electricity with 67% solar energy.
- **Concentrated solar plants** – these plants focus energy from the sun onto a very small area wherein a transfer fluid is heated. This heated fluid may be used to generate electricity in a turbine or provide process heat.

A.4.1. Location of the programme of activities:

>>
The PoA is located on the southern tip of Africa and comprises 8 African nations, of which 3 are considered by the UN to be least developed countries[1]. The Host Countries are all members of the Southern African Power Pool which shares a reliance on fossil fuel for the generation of electricity.

A.4.1.1. Host Party(ies):

>>
Republic of South Africa
Namibia
Botswana
Zimbabwe
Zambia*
Mozambique*
Lesotho*
Swaziland

*Denotes Least Developed Country

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

[1] As described in the list published by UN-OHRLLS (http://www.un.org/esa/policy/devplan/profile/ldc_list.pdf)

applicable national and/or sectoral policies and regulations of each host country within that chosen boundary;

The boundary of the PoA is defined as the geographical area within which all the implemented small-scale CDM programme activities (SSC-CPAs) included in the PoA will occur. All installations of these technologies which are enrolled into the CPAs under this PoA will be within the borders of the Host Parties listed in A.4.1.1 (listed above).

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

>>
A typical CPA will consist of an organisation, e.g. retailer or housing developer, who elects to market a solar thermal device which is installed at many locations, to provide heat for domestic or light industrial use, within the borders of the Countries. Only those products which have been shown to adhere to the appropriate local, or regional, standards and were installed by contractors who have met the participation criteria of the programme will be enrolled and thus be eligible to claim emission reductions.

Project developers, such as office parks, mines or shopping malls, who construct a single STE plant for the captive generation of heat or power are also eligible for inclusion as a CPA.

Typical examples of such CPAs include, but are not limited to, the following:

- Housing developers who offer home owners the option of installing a heat pump equipped geyser instead of an electric geyser in newly constructed homes;
- Retailers who offer solar water heaters and other such technologies at reduced rates to incentivise the purchase and installation of these products;
- Industrial operations replacing fossil fuel based heating equipment with solar based heating equipment;
- Commercial operations replacing grid electricity with on-site generation from concentrated solar power plants;

A SSC-CPA may consist of:

1. Installations replacing existing heating technologies with solar based heating technologies ; or
2. New installations at newly built facilities (i.e. no existing heating technology is currently in place);or
3. New installations at facilities that previously obtained their electricity from the grid

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

>>
A CPA consists of quality tested solar thermal technology, which converts solar radiation into thermal energy (heat) which is used at the site of generation. Such technologies may include, but are not limited to, solar water heaters, concentrated solar thermal plants and air-source heat pumps.

Such units will be installed by companies with the necessary qualifications, experience and training for the installation. Installers should also be registered with the appropriate regulatory body, where such a body exists and is recognised as such.

The units to be installed must be compliant with the relevant local requirements for such technologies e.g. performance and quality standards[2] and should be installed as required by such norms and standards.

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

>> Here only a description of criteria for enrolling the CPA shall be described, the criteria for demonstrating additionality of CPA shall be described in section E.5

[2] In South Africa such standards include the SANS 6211-1 Domestic solar water heaters Part 1: Thermal performance using an outdoor test method (Ed. 2, dated 31.05.2011) as well as the relevant building, electrical and plumbing codes. Where a local standard is not available the appropriate SABS or EN/ISO standard will be accepted

The eligibility criteria for the inclusion of a SSC-CPA in a PoA are as follows:

1. All the units under the SSC-CPA are
    a. Approved by the respective standards generating body as required by local regulations;
    b. Installed by installers who are members of a relevant regulatory body; and
    c. Installed in the Countries.
2. In the case of solar water heaters:
    a. All the SWHs installed under the SSC-CPA are
        i. Installations replacing existing water heating technologies with solar based water heating technologies; and/or
        ii. New installations at newly built facilities (i.e. no existing heating technology is currently in place).
    b. All the SWH models installed under the SSC-CPA have been subject to the SANS6211 tests and a third party report specifying the results thereof is available;
    c. The baseline technology for SWHs installed under the SSC-CPA is an electric water heater;
    d. The total installed aperture area is less than or equal to 64,000m^2
3. In the case of air-source heat pumps
    a. All the heat pumps installed under the SSC-CPA are
        i. Installations replacing existing heating technologies with solar based heating technologies. ; and/or
        ii. New installations at newly built facilities (i.e. no existing heating technology is currently in place).
    b. The baseline technology for heat pumps installed under the SSC-CPA is an electric water heater;
    c. The total installed capacity is less than or equal to 45MWth (15MWelectrical)
4. In the case of concentrated solar thermal plants
    a. All the concentrated solar plants installed under the SSC-CPA are
        i. Installations replacing existing heating technologies with solar based heating technologies. ; and/or
        ii. New installations at newly built facilities (i.e. no existing heating technology is currently in place).
        iii. New installations at facilities that previously obtained their electricity from the grid
    b. The baseline technology for concentrated solar plants installed under SSC-CPA may be one of the following:
        i. Electricity from the national grid; or
        ii. Liquid fossil fuel fired boilers/generators; or
        iii. Solid fossil fuel fired boilers/generators
    c. The total installed capacity is less than or equal to 45MWth (15MWelectrical)

5. Each CPA must implement the baseline and monitoring methodology AMS I.C. 'Thermal energy production with or without electricity" version 18 or later;
6. The coordinating entity will ensure that all CPAs under its PoA are neither registered as an individual CDM project activity nor included in another registered PoA, and that the CPA is subscribed to the PoA;
7. Each CPA shall be uniquely identified and defined by way of a set of unique identifying numbers attached to each installation;
8. Each CPA will identify alternatives to the project activity and demonstrate that the project activity is additional by means of a levelised cost analysis or other appropriate benchmark analysis;

9. Each SSC-CPA must be approved by the coordinating entity and DOE prior to its incorporation into the PoA;

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):

>> The following shall be demonstrated here:

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

The PoA is a voluntary action, coordinated and implemented by the coordinating entity in order to support the objective of developing the use of renewable energies in the country, including solar energy for the generation of heat.

There is no mandatory requirement for the installation of such technologies. The solar heating systems implemented in a typical CPA under the PoA are installed by consumers of hot water, heat or electricity who apply voluntarily to be included in the PoA.

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

The PoA is a voluntary action, coordinated and implemented by the coordinating entity in order to support the objective of developing the use of renewable energies in the Countries, specifically solar energy for the generation of thermal energy.

There is no mandatory requirement for the installation of such technologies. The solar heating systems implemented in a typical CPA under the PoA are installed by consumers of hot water and heat who apply voluntarily to be included in the PoA.

The broad availability of cheap coal-fired electricity in the region has resulted in the common practice of utilising electric resistive-heating elements to heat water. Due to the high upfront costs of other technologies electric water heaters have remained the standard technology employed in new buildings and when replacing water heating equipment.

Micro-Scale solar thermal technology – Levelised Cost Of Energy Analysis

Solar thermal technology is significantly more expensive than resistive electrical heating technology. For this reason carbon revenue is necessary to reduce the cost gap and ensure the technology is attractive to consumers of electrical energy and heat.

As discussed below solar water heaters have been available for several decades and heat pumps for more than a decade. But due to the low cost of electricity and resistive heating equipment these technologies have not been widely installed despite Southern Africa's premium operating conditions for such technologies.

An analysis of micro STE technology available in South Africa (Table 1) reveals that the levelised cost of energy from installing either a SWH or a heat pump is 32% and 22% more expensive, respectively, than installing an electric water heater.

Where an electric geyser has already been installed, retrofitting STE equipment would carry a premium, 102% for solar water heaters and 86% for heat pumps, on an annual basis for the lifetime of the equipment.

For this reason, wide spread uptake of micro scale STE equipment would not take place in the absence of this PoA.

Table 1: Levelised Cost of Energy in the South African market (assumes a new installation)

Parameter		**150 litre Electric Geyser**	**150 litre Solar Water Heater**	**2.4kW Heat Pump (150 litre eq.)**
Initial Investment	ZAR	6,248.00	21,949.00	14,364.00
Annual Fuel Expenditure[3]	ZAR	1,564.00	0.00	531.76
Annual Energy Generation	MWh	3.30	3.02	2.75
Discount Rate	%	17	17	17
Assumed Lifetime	Yrs	10	10	10
Levelised Cost of Energy	ZAR/MWh	972.00	1,284.39	1,183.13

Micro-scale solar thermal technology - Barriers due to prevailing practice

In accordance with Attachment A of Appendix B of the simplified modalities and procedures for small scale CDM project activities[4], additionality is demonstrated by showing that the PoA would not have occurred anyway due to the existence of certain barriers. This analysis will identify the barriers that are in place and how they would prevent the implementation of the proposed project activity if the project activity was not registered as a CDM activity.

The prevailing practice in southern Africa is the use of electric geysers due to:

- The lower capital costs of installing an electric geyser;
- Low running costs due to subsidised electricity pricing;
- No maintenance costs due to electric geysers being replaced by homeowners insurance.

Further reasons for the low penetration levels of solar thermal technology include:

- The lack of consumer awareness and education regarding the performance of a such products;
- Lack of product availability in ‘brick & mortar’ establishments;

[3] Based on the 2011/2012 Eskom Megaflex rate, ZAR0.46/kWh, during high demand season, in low demand season this rate drops to R0.32/kWh

[4] Document can be viewed at http://cdm.unfccc.int/methodologies/SSCmethodologies/AppB_SSC_AttachmentA.pdf

- Marginal incentives for major retailers to market these products due to the pervasive high risk-low return paradigm;
- Lack of climate change knowledge, awareness and education and how the installation of a SWH can positively contribute to the reduction in GHG emissions;

In essence the main barrier to the adoption of solar thermal technology is the large cost barrier as demonstrated in the previous sub-section. This is substantiated further by a study carried out in 2008 by the International Energy Agency, and updated in 2010, indicated that the total installed capacity of SWHs in Africa was 410MW_{th}. A comparison with other regions around the world supports the view that penetration of solar thermal technology in Africa is abnormally low given the solar resources available.

Comparison of solar technology penetration by regions[5]

Region	**Installed Capacity MW_{th}**	**kW per 1000 Inhabitants**	**Horizontal Irradiation (kWh/m^2*a)**
China	87,500	66.4	1,281
Europe[6]	26,182	44.8	1,240
Japan	4,112	32.3	1,175
Asia[7]	4,012	3.1	1,565
Middle East[8]	3,266	246.6	2,172
Central + South America[9]	2,893	8.9	1,760
USA + Canada	1,975	5.9	1,548
Australia + New Zealand	1,488	59.1	1,538
Africa[10]	**410**	**5.6**	**2,066**

The previous table clearly demonstrates that the available amount of solar radiation is not a driver of solar thermal technology use. Considering that Africa has both the highest radiation levels and the lowest uptake whilst China has one of the lowest radiation levels and the highest uptake one must conclude that the global market has failed to deliver this technology to Africa.

[5] Solar Heat Worldwide – Markets and Contribution to the Energy Supply 2008, 2010 Edition, Prepared on behalf of the International Energy Agency (Installed Capacity – Fig.8 pg 13; kW per 1000 – Fig.9 pg 13; Horizontal Irradiation Table 12, Pg 43)

[6] Horizontal irradiation obtained from the average of EU27,Albania, Macedonia, Norway, Switzerland & Turkey pg 43, Table 12, Ref. 5 (Above)

[7] Horizontal irradiation obtained from the average of India, South Korea, Taiwan, Thailand, pg 43, Table 12, Ref. 5 (Above)

[8] Horizontal irradiation obtained from the average of Israel & Jordan, pg 43, Table 12, Ref. 5 (Above)

[9] Horizontal irradiation obtained from the average of Barbados, Brazil, Chile, Mexico, Uruguay, pg 43, Table 12, Ref. 5 (Above)

[10] Horizontal irradiation obtained from the average of Namibia, South Africa, Tunisia and Zimbabwe pg 43, Table 12, Ref. 5 (Above)

A 2010 study estimates that there are less than 70,000[5] installed SWH's out of a total of close to 9 million households in South Africa. Of the 9 million households about 4.5million (mainly in the middle to upper income target market) use electric geysers as their primary source of water heating.

The lack of penetration in the domestic water heating market is evidenced by the low levels of penetration of SWH's in SA with less than 280,000m^2 of domestic SWH collectors being installed in 2010.

The uptake of heat pumps and other such technologies has been significantly lower than that of solar water heaters. Indeed the domestic air source heat pump market globally is in its infancy and carbon revenues are required to overcome the same barriers currently preventing uptake of these technologies.

The registration of the PoA will overcome these barriers in the following ways:

1. *Decreasing the financial barriers*
By reducing the initial cost of the products, through carbon revenues, the barrier to investment is lessened for the consumer. Furthermore, we anticipate that participating in this programme will result in the consumer becoming more aware of the issues around emissions and climate change.

2. *Improving the marketing mechanism*
As described above, there are very few opportunities for consumers to buy solar energy based products 'off the shelf' and thus evaluate the product before the purchase, this breeds distrust and negatively effects the market penetration of these products. This programme will address this issue by encouraging retailers to keep stock of such products and allow retailers to mitigate their marketing risks by participating in the carbon markets and resultant revenues.

3. *Improving consumer awareness & capacity building*
In order to successfully sell these products retailers and suppliers will need to employ and train sales assistants who will be able to educate the consumer on various topics relating to these products including climate change, performance, product choice and financial incentives. The cost of training and employing such people will be reduced by the carbon revenue realised from the installation of such units.

Industrial and commercial solar thermal technology – levelised cost of energy analysis

The cost of solar thermal energy is known to be significantly more expensive than energy derived from fossil fuel fired processes. In Australia the levelised cost of coal fired energy ranges between 28-38AUD/MWh whilst solar thermal energy is approximately 85AUD/MWh, similarly in the United States future conventional coal plants entering service in 2016 will produce energy at approximately 94.8USD/MWh whilst solar thermal energy is expected to cost 311.8USD/MWh. Across the globe solar thermal technology is significantly more expensive than coal based energy.

In March 2011 the National Energy Regulator of South Africa indicated in a report on renewable energy technology[11] in South Africa that the levelised cost of concentrated solar energy is ZAR1.94/kWh whereas grid electricity is available at R0.49/kWh[12]. Entities wishing to construct their own onsite solar plants will be required to pay a 45% premium on energy over the lifetime of the plant.

Therefore in order to incentivise the adoption and distribution of this technology, which would not have happened in the absence of this PoA, it is necessary to register such projects under the CDM in order to recoup costs against carbon revenues.

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

There is no mandatory requirement for the installation of solar thermal technology.

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

There is no mandatory requirement for the installation of solar thermal technology.

The information presented here shall constitute the demonstration of additionality of the PoA as a whole.

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

A.4.4.1. Operational and management plan:

>> Description of the operational and management arrangements established by the coordinating/managing entity for the implementation of the PoA, including:

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

The CME will establish and maintain an extensive database of all enrolled installations wherein the following data will be recorded:

- Date of installation
- Unique Identifier
- Product/installation type
- Manufacturer
- Model
- Serial number
- Installation address

[11] NERSA Consultation Paper, March 2011 (http://www.nersa.org.za/Admin/Document/Editor/file/Electricity/Consultation/Documents/Review%20of%20Renewable%20Energy%20Feed-In%20Tariffs%20Consultation%20Paper.pdf)

[12] Based on the 2011/2012 Eskom Megaflex rate during high demand season, in low demand season this rate drops to R0.32/kWh

- Owners details
- Installed capacity

The coordinating entity will be responsible for the management of records and data associated with each CPA and all records will be stored for a period of two years after the end of the crediting period. Relevant data capture, verification and storage procedures will be followed in maintaining the data to ensure its accuracy, validity and completeness.

(ii) A system/procedure to avoid double accounting e.g. to avoid the case of including a new CPA that has been already registered either as a CDM project activity or as a CPA of another PoA,

Each installation included in a CPA will be uniquely identified. The set of unique identifiers for the installed units in the CPA will allow for the unique identification of each CPA.

As the geographical boundary for the PoA and each of the CPA's is limited by the borders of the Countries and may overlap each other, it is impractical to distinguish each of the CPA's by way of geographical region. Each individual installation will however still be distinguishable based on the information contained within database to be maintained by the coordinating entity. The database will contain the physical address of each installation or geographic coordinates where appropriate. The location of each potential inclusion in a SSC-CPA will be tested against the locations of all the installations already included in the PoA database.

Prior to registering a new CPA within the proposed PoA, the coordinating entity will check the CDM project database to establish whether a CDM project activity or CPA of another PoA for the installation of SWH has already been registered within the borders of the Countries. This search will cover registered project activities, project activities requesting registration, project activities under review and project activities for which either a review or corrections have been requested.

In an instance where a CPA of another PoA or CDM project activity is already registered in a Country for the installation of these products, the coordinating entity will ensure through cross-checking the database of the other SSC-CPA or CDM project that there is no double counting of the individual unit included in the SSC-CPAs for this PoA.

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

In the case of an STE product with a rated capacity of no greater than $0.45MW_{th}$ ($0.15MW_{e}$) and in accordance with Annex 32 "Guidelines on assessment of de-bundling for SSC project activities" paragraph 10[13]:

- If each of the independent subsystems/measures (e.g. biogas digester, solar home system) included in the CPA of a PoA is no greater than 1% of the small scale

[13] http://cdm.unfccc.int/Reference/Guidclarif/ssc/methSSC_guid17.pdf

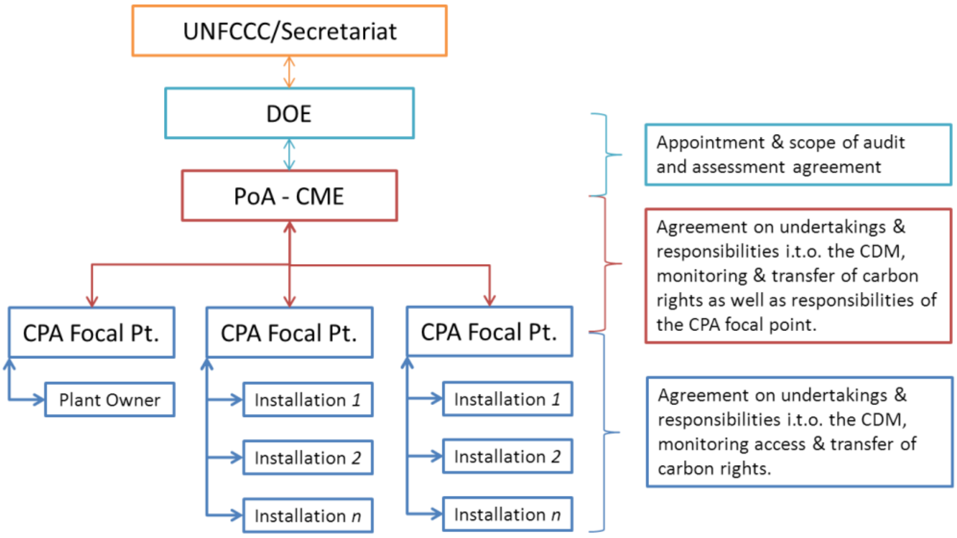
thresholds defined by the methodology applied[14], then that CPA of the PoA is exempted from performing a de-bundling check.

However in the case of an installation larger than 0.45MW_{th}, a de-bundling check will be conducted according to Annex 32 “Guidelines on assessment of de-bundling for SSC project activities”.

(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;

Contractual relations will be established throughout the supply chain to ensure that all parties are aware of the Programme and how they are affected by its CDM registration. The agreements are grouped into 2 types:

- CPA CDM Undertaking Agreement: CPA participants agree to adhere to the requirements of the Programme including monitoring requirements;
- Project Developer CDM Undertaking Agreement: The project developer or focal point e.g. SWH retailer, will sign a contract of undertaking wherein the role and responsibility of the project developer in the PoA/CPA is prescribed especially in respect to additionality criteria and monitoring requirements.



A.4.4.2. Monitoring plan:

>> The following information shall be provided here:

(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.

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[14] i.e. 45MW_{th} installed capacity

(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;

The CME will implement a monitoring protocol that allows the DoE to verify all CPAs. As described previously a database will be established that contains all the CPA specific data required to identify and locate the units enrolled in the CPA. This data is also used to obtain the data required to calculate and verify the emission reductions achieved by the CPA.

A monitoring report will be provided by the coordinating entity to allow the DOE to verify the emission reductions for each monitoring period of each individual CPA. The use of unique identifiers and QA/QC procedures will ensure that double counting is not possible.

The start and end dates of each monitoring period for each individual CPA, together with the emission reductions attributable to that monitoring period will be recorded in the database. Record keeping procedures undertaken by the coordinating entity will ensure that the data attributed to a monitoring period can be clearly attributed to an individual CPA and will furthermore prevent double counting of emission reduction data.

The DOE will be able to audit the data in the database to determine the current status of an individual CPA, the duration of applicable monitoring periods, the location of installations included in the determination of emission reductions and the data recorded therefrom.

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

>>

The proposed PoA will not receive any public funds resulting from official development assistance from Parties included in Annex I to the Convention.

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

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

>>
03 August 2011, the start of global stakeholder consultation and validation.

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

>>
28 years.

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 PoA level ☐
2. Environmental Analysis is done at SSC-CPA level X

Due to the different technologies used under this programme it would not be appropriate to apply a global analysis of environmental benefits and impacts. For this reason the environmental analysis should be applied at the CPA level in a manner appropriate to the technology to be utilised.

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

>>

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),:

>>

This will be determined at the CPA level on the basis of the specific technology to be installed and the size of the installation.

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 X

Due to the different technologies used under this programme it would not be appropriate to apply a generic local stakeholder consultation approach. For this reason stakeholder comments should be applied at the CPA level in a manner appropriate to the technology to be utilised and the location it is deployed in.

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

>>

D.3. Summary of the comments received:

>>

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

>>

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 a 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 a SSC-CPA included in the PoA:

>>
The approved SSC baseline and monitoring methodology is AMS-1.C. version 18 Thermal Energy Production with or without electricity is applied to each SSC-CPA included in the PoA.

NOTE: The approved SSC baseline and monitoring methodology should be approved for use in a PoA by the Board.

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

>>
The CPAs included in this PoA comprise renewable energy technologies that supply users with solar thermal energy that displaces the use of fossil fuels. AMS.I.C provides a baseline and monitoring methodology for projects that provide thermal energy that displaces fossil fuel. Since the size of most STE installations, such as heat pumps and solar water heaters, are expected to be significantly smaller than 45MWth a small scale methodology is appropriate.

The methodology AMS-I.C. under the section with specific considerations for PoAs indicates that there are specific clauses (a) to (c) which might apply to a PoA utilising this methodology.. The CPAs included in this PoA do not apply the PoA specific clauses (a) and (b) in methodology AMS-I.C. because the CPAs are not biomass project activities. The CPAs included in this PoA do apply clause (c) because the CPAs do involve the replacement of equipment, "that are in a working condition". For this reason, leakage must be considered and dealt with in an appropriate manner.

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

>>
As provided for in the methodology the project boundary includes the physical site of the SWH and includes the facilities to which it provides heat.

The GHG reduced through the CPAs under this PoA is CO_2. The reduction takes place through the avoidance of fossil fuels used to produce heat, in the absence of the CPAs.

	Source	Gas	Included	Justification / Explanation
Baseline	Grid Electricity supply	CO_2	Yes	According to AMS-1.C. which refers to AMS-1.D. and therein the "Tool to calculate the emission factor for an electricity system", only CO^2 emissions from electricity generation should be accounted for.
		CH_4	No	There is no emission
		N_20	No	There is no emission
	Solid fossil fuel supply	CO_2	Yes	Only CO^2 emissions from fossil fuel use shall be accounted for as per paragraph 18 of methodology AMS-1.C v18.
		CH_4	No	There is no emission
		N_20	No	There is no emission
	Liquid fossil fuel	CO_2	Yes	Only CO^2 emissions from fossil fuel use shall be

	supply			accounted for as per paragraph 18 of methodology AMS-1.C v18.
		CH_4	No	There is no emission
		N_20	No	There is no emission
SSC-CPA Activity	Solar Thermal Energy supply	CO_2	Yes	Where the installed solar thermal energy has an electrical component, such as a compressor in an air-source heat pump, there will be emissions through the use of electricity from the national grid. According to AMS-1.C. which refers to AMS-1.D. and therein the "Tool to calculate the emission factor for an electricity system", only CO_2 emissions from electricity and/or fossil fuel consumption should be accounted for.
		CH_4	No	There is no emission
		N_20	No	There is no emission

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

>>

The prevailing practice for generating heat in Southern Africa is through the use of electricity and resistive heating elements and this practice would continue in the absence of the individual SSC-CPAs and the PoA as a whole.

Because the energy displaced is electricity, the baseline emissions are calculated as the product of the amount of electricity that would be required to deliver the heat using the baseline technology, and the emission factor for electricity.

Thus the baseline emissions for a single installation are determined to be the rated energy production of the solar thermal unit[15] , adjusted by the efficiency of the equipment used in the baseline and multiplied by the emission factor for the respective grid supplied electricity.

In the case of on-site, captive, electricity generation the baseline emissions are calculated as:

$$BE_{captelec,y} = \frac{EG_{captelec,PJ,y}}{\eta_{BL,captive\ plant}} * EF_{BL,FF,CO2}$$

Where:

$BE_{captelec,y}$ = The baseline emissions from electricity displaced by the project activity during the year y (tCO2)

$EG_{captelec,\ PJ,\ y}$ = The amount of electricity produced by the project activity during the year y (MWH)

$\eta_{BL,\ captive\ plant}$ = The efficiency of the plant using fossil fuel that would have been used in the absence of the project

[15] Determined according to an applicable local or international standard. For more information please refer to the end of this section.

$EF_{BL,FF,CO2}$ = The Co2 emission factor of the fossil fuel that would have been used in the baseline plant obtained from reliable local or national data if available otherwise IPCC default emission factors are used (tCO2/MWH)

In the case of on-site heat production from fossil fuels the baseline emissions are calculated as:

$$BE_{thermal,CO2,y} = \frac{EG_{thermal,y}}{\eta_{BL,thermal}} * EF_{FF,CO2}$$

Where:

$BE_{thermal,y}$ = The baseline emissions from heat/steam displaced by the project activity during the year *y* (tCO2)

$EG_{thermal,\,y}$ = The net quantity of heat/steam supplied by the project activity during the year *y* (TJ)

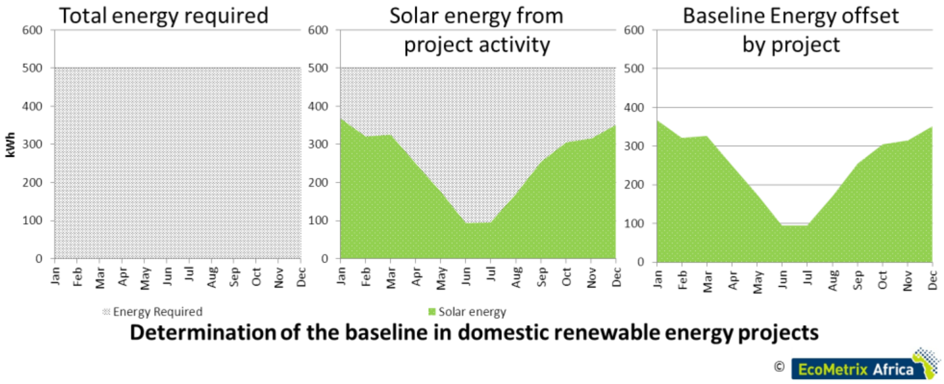
$\eta_{BL,thermal}$ = The efficiency of the plant using fossil fuel that would have been used in the absence of the project

$EF_{FF,CO2}$ = The Co2 emission factor of the fossil fuel that would have been used in the baseline plant obtained from reliable local or national data if available otherwise IPCC default emission factors are used (tCO2/TJ)

Special considerations for solar water heaters

In the case of hot water geysers the baseline technology is a resistive heating element that is placed inside a vessel and used to heat water.

Since a solar water heater is incapable of providing all the energy required to heat the body of water, a backup element is usually included in the SWH system. This backup element will use electricity to supplement the energy from the solar collectors as necessary to maintain the water at a setpoint temperature (indicated below in the middle graph by the residual gray area[16]).



Determination of the baseline in domestic renewable energy projects

In accordance with the methodology and the General Guidelines on SSC CDM methodologies (paragraph 12, v15-Annex23 EB58) the baseline to the project activity is determined to be the rated performance of the project equipment (here measured in kWh and indicated in the graph above by the green areas) multiplied by an appropriate emission factor.

[16] The data in this graph are obtained from the measured performance of a SWH in Johannesburg, South Africa

Thus the baseline emissions for a single installation are determined to be the rated energy saving of the solar thermal unit[17]**[Q_{SWH}]** multiplied by the emission factor for the respective grid supplied electricity [**EF**].

The rating for a solar water heater is determined according to a national standard,SANS6211-1: Thermal performance using an outdoor test method, which determines the amount of energy contributed by the SWH model under given environmental conditions. Due to the sensitivity of SWH performance to changing environmental conditions (specifically solar radiation, ambient temperature and inlet temperature) these conditions are monitored ex-post and the baseline energy displaced is determined on a daily basis. This approach is explained further in later sections.

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:

>> Here the PPs shall demonstrate, using the procedure provided in the baseline and monitoring methodology applied, additionality of a typical CPA.

The Standard for demonstration of additionality of GHG emission reductions achieved by a programme of activities (EB63-Annex2) is utilised as required by the CDM Executive Board as of EB63. In the Standard the use of the Simplified modalities and procedures for small scale CDM Projects is prescribed since this PoA utilises a small scale methodology.

Where a CPA is limited to an installed capacity of 5MWe or less (i.e. 21,333m^2 in the SWH case) the Guidelines for demonstrating additionality of Microscale Project Activities v.3 (EB63, Annex 23) shall be applied by the CPA.

Where a CPA has an installed capacity of greater than 5MWe but less than 15MWe the **Standard for demonstration of additionality of GHG emission reductions achieved by a programme of activities** (EB63-Annex2) is utilised as required by the CDM Executive Board as of EB63. In the Standard the use of the Simplified modalities and procedures for small scale CDM Projects is prescribed since this PoA utilises a small scale methodology.

It shall be demonstrated that barriers exist to the uptake of the specific Solar Thermal Technology advocated by the CPA as per Attachment A of appendix B (v.8, EB63 – Annex 24) and that as a result emissions would have been higher in the absence of the project activity.

As specified in Attachment A of appendix B (v.8, EB63 – Annex 24) of the Simplified modalities and procedures for small scale CDM Projects project participants shall provide an explanation to show that the project activity would not have occurred anyway due to at least one of the following barriers:

- **Investment Barrier** – a financially more viable alternative to the project would have led to higher emissions;
- **Technological barrier** – a less technologically advanced alternative to the project activity involves lower risks and so would have led to higher emissions;

[17]Determined according to an applicable local or international standard. For more information see section E.4.

- **Barrier due to prevailing practice** – prevailing practice would have led to implementation of a technology with higher emissions;
- **Other barriers** – without the project activity, for a specific reason identified by the project participant emissions would have been higher.

Investment Barrier
As a minimum the CPA shall identify a more financially viable alternative to the project and demonstrate that a barrier exists preventing the adoption of the advocated solar thermal technology. This should be done using the latest market information available and the following formula for Levelised Cost of Energy Analysis[18]:

$$LCoE = \frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

Where:

$LCoE$	= Levelised Cost of Energy (aka Levelised Energy Cost)
I_t	= Investment expenditures in year *t*
M_t	= Ops and maintenance expenditures in year *t*
F_t	= Fuel expenditures in year *t*
E_t	= Energy generation in year *t*
r	= Discount rate
t	= year
n	= Life of system

In order to demonstrate additionality of the CPA it shall be shown that an investment barrier[19] exists by substantiating:

$$LCoE_{baseline} \leq LCoE_{project}$$

If this cannot be demonstrated, the existence of at least one other barrier, e.g. technology risk, prevailing practice or access to finance, must be substantiated.

Where a CPA has an installed capacity of greater than 15MW, this activity is not eligible under this PoA.

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

>> Here the PPs shall provide the key criteria for assessing additionality of a CPA when proposed to be included in the registered PoA. The criteria shall be based on additionality assessment undertaken in E.5.1 above. The project participants shall justify the choice of criteria based on analysis in above section.
It shall be demonstrated how these criteria would be applied to assess the additionality of a typical CPA at the time of inclusion.

[18] http://en.wikipedia.org/w/index.php?title=Levelised_energy_cost&direction=next&oldid=365220846

[19] An investment barrier is defined as “a financially more viable alternative to the project activity would have led to higher emissions” EB35, Annex 34.

NOTE: Information provided here shall be incorporated into the PoA specific CDM-SSC-CPA-DD that shall be included in documentation submitted by project participants at registration of PoA.

The CPAs will demonstrate additionality based on the barriers identified in E.5.1 above as follows:

Where a CPA is limited to an installed capacity of 5MWe or less (i.e. 21,333m^2 of aperture area in the SWH case) the Guidelines for demonstrating additionality of Microscale Project Activities v.3 (EB63, Annex 23) shall be applied by the CPA whereby a project activity is additional if any of the following apply:

a) The geographic location of the project is in one of the Least Developed Countries or Small Island States or in a special underdeveloped zone of host country identified by the Government before 28 May 2010;
b) The project is an off grid activity supplying energy to households/communities;
c) The project is designed for distributed energy generation (not connected to a national or regional grid) with both of the following conditions satisfied:
    a. Each of the independent subsystems in the project activity is smaller than or equal to 1500kW electrical installed capacity;
    b. End users of the sub systems or measures are households/communities/SMEs.
d) The project activity employs specific renewable energy technologies/measures recommended by the host country DNA and approved by the Board to be additional in the host country.

Where a CPA has an installed capacity of greater than 5MWe but less than 15MWe (between 21,333m^2 and 64,000 m^2 of aperture area in the SWH case) an analysis of solar thermal technology in the respective country will be performed using the latest publicly available information on the industry in to demonstrate that the cost of energy delivered by solar thermal technology presents a significant investment barrier to uptake of this technology in comparison to continued use of electricity. It shall be demonstrated that:

$$LCoE_{baseline} \leq LCoE_{project}$$

In order to conduct such an analysis the following data shall be available for both the baseline technology and the project technology:

Investment expenditures	I_t
Ops and maintenance expenditures	M_t
Fuel expenditures	F_t
Energy generation	E_t
Discount rate	r
Life of system	n

If the required data is not available, or if for some other reason this cannot be demonstrated, the existence of at least one other barrier (e.g. technology risk, prevailing practice or access to finance) must be substantiated.

Where a CPA has an installed capacity of greater than 15MW (64,000 m^2 of aperture area in the SWH case), this activity is not eligible under this PoA.

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:

>>

Methodology AMS-1.C (Version 18), **Thermal energy production with or without electricity**, was chosen as the most appropriate methodology for the programme as the object of encouraging the uptake of Solar Thermal Energy technology. The primary product of STE technology is heat which may be used directly or used in the production of electricity. Therefore AMS-1.C was chosen as it is applicable to "…technologies such as solar thermal water heaters and dryers, solar cookers, energy derived from renewable biomass and other technologies that provide thermal energy that displaces fossil fuel".

A typical CPA is eligible as a small scale project according to AMS-I.C. (Version 18) if the total installed capacity of all equipment within a CPA is limited to $45MW_{th}$ according to the rated thermal energy output as stipulated by the manufacturer.

Where electricity is consumed or generated AMS-I.C. (Version 18) refers to AMS-1.D which further refers to the "Tool to calculate the emission factor for an electricity system". This tool will be applied to a typical CPA. The equations used to determine the emission reduction are discussed in E.6.2.

The *"Tool to calculate the emission factor for an electricity system (version 2.2.1)"* is applicable to a grid-connected project activity where the CM emission factor of the baseline grid electricity system is calculated for grid power plants only, or, an option, it can include off-grid power plants. The relevant electricity systems to the CPAs are not located partially or totally in an Annex I country and therefore the *"Tool to calculate the emission factor for an electricity system (version 2.2.1)"* is applicable.

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

>>

1. Determining Electricity Emissions Displaced

<u>Determining Electricity Emissions Displaced</u>

The Grid Emission Factor will be calculated as per the "*Tool to calculate the Emission Factor for an electricity system*." The combined margin (CM) is calculated to determine the CO2 emission factor for the displacement of electricity generated by power plants in an electricity system. The CM is the result of a weighted average of two emission factors pertaining to the electricity system: the "operating margin" (OM) and the "build margin" (BM). The OM is the emission factor that refers to the group of existing power plants whose current electricity generation would be affected by the proposed CDM project activity. The BM is the emission factor that refers to the group of prospective power plants whose construction and future operation would be affected by the proposed CDM project activity.

The tool prescribes a step-based approach to calculate the CM:

Step 1: Identify the relevant electricity systems

A project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity i.e. the photovoltaic system installations and that can be dispatched without significant transmission constraints.

None of the project electricity systems for any of the Host Countries are located in an Annex-I country. The geographical extent of the project electricity system will be documented transparently and all grid power plants/units connected to the system will be identified.

Electricity transfers from connected electricity systems to the project electricity system are defined as electricity imports and electricity transfers to connected electricity systems are defined as electricity exports. Where electricity imports and/or exports exist, these will be identified and electricity exports will not be subtracted from electricity generation data used for calculating and monitoring the electricity emission factors.

Step 2: Choose whether to include off-grid power plants in the project electricity system (optional)
This programme selects option I to calculate the operating margin and build margin emission factor whereby only grid power plants are included in the calculation. This is because the applicable methodology AMS-I.F provides for specific emission factor calculations where the installation is off-grid (or connected to a mini-grid) and therefore off-grid electrical generation is dealt with separately.

Step 3: Select a method to determine the operating margin (OM)
The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

(a) Simple OM; or
(b) Simple adjusted OM; or
(c) Dispatch data analysis OM; or
(d) Average OM.

The below criteria will be considered by each CPA in determining the selection of the method to calculate OM. Each CPA will outline their choice and justification for the method employed in line with the below restrictions.

The simple OM method (Option a) can only be used if low-cost/must-run resources constitute less than 50% of total grid generation in:
1) average of the five most recent years, or
2) based on long-term averages for hydroelectricity production.

The dispatch data analysis (Option c) cannot be used if off-grid power plants are included in the project electricity system as per Step 2 above; however, this will not be a constraint as off-grid power generation is specifically excluded from the grid-connected baseline scenario according to AMS-I.F. Dispatch data analysis will therefore not be used as the method to calculate OM by a CPA.

The simple adjusted OM method (Option b) could be used, but detailed data is needed for this method and is not available for all of the Host Countries. Therefore this method is excluded and will not be selected by a CPA.

The average OM (Option d) method should only be used if the data for simple OM is not available. This method should therefore be used in the case where the Host country does not have the data available to use the simple OM method.

For the simple OM, the simple adjusted OM and the average OM, the emissions factor can be calculated using either *ex ante* or *ex post* data vintages. An ex-ante approach will be adopted for all CPAs included in the PoA. The emission factor is determined once at the validation stage and thus no monitoring and recalculation of the emissions factor during the crediting period will be required.
For grid power plants a 3-year generation-weighted average, based on the most recent data available at the time of inclusion of the CPA will be used.

Step 4: Calculate the operating margin emission factor according to the selected method
Only the simple OM or average OM method may be used by a CPA. The two methods are outlined below:

(a) Simple OM

The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units. The simple OM may be calculated:

Option A: Based on the net electricity generation and a CO_2 emission factor of each power unit[20] or
Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

Option B can only be used if:
a) The necessary data for Option A is not available; and
b) Only nuclear and renewable power generation are considered as low-cost/must-run power sources and the quantity of electricity supplied to the grid by these sources is known; and
(c) Off-grid power plants are not included in the calculation

Option A - Calculation based on average efficiency and electricity generation of each plant

Under this option, the simple OM emission factor is calculated based on the net electricity generation of each power unit and an emission factor for each power unit, as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_{m} EG_{m,y} \cdot EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

Where:
$EF_{grid,OMsimple,y}$ = Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$ = CO_2 emission factor of power unit m in year y (tCO_2/MWh)
m = All power units serving the grid in year y except low-cost / must-run power units
y = The relevant year as per the data vintage chosen in Step 3

[20] Power units should be considered if some of the power units at the site of the power plant are low-cost/must-run units and some are not. Power plants can be considered if all power units at the site of the power plant belong to the group of low-cost/must-run units or if all power units at the site of the power plant do not belong to the group of low-cost/must-run units.

Determination of $\mathbf{EF_{EL,m,y}}$

The emission factor of each power unit m should be determined as follows:

• Option A1. If for a power unit m data on fuel consumption and electricity generation is available, the emission factor ($EF_{EL,m,y}$) should be determined as follows:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{EG_{m,y}}$$

Where:

$EF_{EL,m,y}$ = CO_2 emission factor of power unit m in year y (tCO_2/MWh)
$FC_{i,m,y}$ = Amount of fossil fuel type *i* consumed by power unit m in year *y* (Mass or volume unit)
$NCV_{i,y}$ = Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$ = CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
m = All power units serving the grid in year *y* except low-cost/must-run power units
i = All fossil fuel types combusted in power unit m in year *y*
y = The relevant year as per the data vintage chosen in Step 3

• Option A2. If for a power unit m only data on electricity generation and the fuel types used is available, the emission factor should be determined based on the CO2 emission factor of the fuel type used and the efficiency of the power unit, as follows:

Where:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \cdot 3.6}{\eta_{m,y}}$$

$EF_{EL,m,y}$ = CO2 emission factor of power unit m in year y (tCO2/MWh)
$EF_{CO2,m,i,y}$ = Average CO2 emission factor of fuel type i used in power unit m in year y (tCO_2/GJ)
$\eta_{m,y}$ = Average net energy conversion efficiency of power unit m in year y (ratio)
m = All power units serving the grid in year y except low-cost/must-run power units
y = The relevant year as per the data vintage chosen in Step 3

Where several fuel types are used in the power unit, use the fuel type with the lowest CO_2 emission factor for $EF_{CO2,m,i,y}$.

• Option A3. If for a power unit *m* only data on electricity generation is available, an emission factor of 0 tCO_2/MWh can be assumed as a simple and conservative approach.

Determination of $\mathbf{EG_{m,y}}$

For grid power plants, $EG_{m,y}$ should be determined as per the provisions in the monitoring tables.

Option B - Calculation based on total fuel consumption and electricity generation of the system.

Under this option, the simple OM emission factor is calculated based on the net electricity supplied to the grid by all power plants serving the system, not including low-cost/must-run power plants/units, and based on the fuel type(s) and total fuel consumption of the project electricity system, as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_i \left(FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y}\right)}{EG_y}$$

Where:

$EF_{grid,OMsimple,y}$ = Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$F_{Ci,y}$ = Amount of fossil fuel type i consumed in the project electricity system in year y (mass or volume unit)
$NCV_{i,y}$ = Net calorific value (energy content) of fossil fuel type i in year y (GJ/mass or volume unit)
$EF_{CO2,i,y}$ = CO2 emission factor of fossil fuel type i in year y (tCO2/GJ)
EG_y = Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units, in year y (MWh)
i = All fossil fuel types combusted in power sources in the project electricity system in year y
y = The relevant year as per the data vintage chosen in Step 3

For this approach (simple OM) to calculate the operating margin, the subscript m refers to the power plants/units delivering electricity to the grid, not including low-cost/must-run power plants/units, and including electricity imports to the grid. Electricity imports should be treated as one power plant m.

(d) Average OM

The average OM emission factor ($EF_{grid,OM-ave,y}$) is calculated as the average emission rate of all power plants serving the grid, using the methodological guidance as described under (a) above for the simple OM, but including in all equations also low-cost/must-run power plants.

Option B should only be used if the necessary data for Option A is not available.

Step 5: Calculate the build margin emission factor

The vintage of data used by the CPAs will be that as classified under **Option 1** where:

- For the first crediting period, the build margin emission factor is calculated *ex ante* based on the most recent information available on units already built for sample group *m*. Most recent refers to the time at which the CPA is submitted for inclusion under the PoA. For the second crediting period, the build margin emission factor will be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

The sample group of power units *m* used to calculate the build margin should be determined as below::

Identify the set of five power units that have started to supply electricity to the grid most recently ($SET_{5-units}$), excluding power units registered as CDM project activities. Determine their annual electricity generation ($AEG_{SET-5-units}$ in MWh); ;

b) Determine the annual electricity generation of the CPA electricity system (excluding power units registered as CDM project activities). Identify the set of power units that stared to supply electricity to the grid most recently and that comprise 20% of the AEG_{total} (excluding power units registered as CDM project activities) Determine their annual electricity generation ($AEG_{SET\geq20\%}$ in MWh).

c) From the $SET_{5-units}$ and $SET_{\geq20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample})

CPAs should then identify the date when the power units in the SET_{sample} started to supply electricity to the grid. If none of the power units in SETsample started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the BM.

Otherwise:

d) Exclude from the SET_{sample} the power units which started to supply electricity to the grid more than 10 years ago. Include that set the power units registered as CDM project activity (if any) starting with power units that started to supply electricity to the grid most recently, until the electricity generation set comprises 20% of the annual electricity generation of the project electricity system. Determine for the resulting set ($SET_{sample-CDM}$) the annual electricity generation ($AEG_{SET-sample-CDM}$ in MWh).

If the annual electricity generation of that set comprises at least 20% of the annual electricity generation of the project electricity system i.e. $AEG_{SET-sample-CDM} \geq 0.2 \times AEG_{total}$, then the CPA should use the sample group $SET_{sample-CDM}$ to calculate the BM;

Otherwise:

e) Include in the sample group $SET_{sample-CDM}$ the power units that started to supply electricity to the grid more than 10 years ago until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit should be funny included in the calculation).

f) The sample group of power units *m* used to calculate the BM is the resulting set. ($SET_{sample-CDM>10yrs}$)

Capacity additions from retrofits of power plants should not be included in the calculation of the build margin emission factor.

The build margin emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year *y* for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year y (tCO_2/MWh)

$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)

$EF_{EL,m,y}$ = CO_2 emission factor of power unit m in year y (tCO_2/MWh)

m = Power units included in the build margin

y = Most recent historical year for which power generation data is available

The CO_2 emission factor of each power unit *m* ($EF_{EL,m,y}$) should be determined as per the guidance in Step 4 (a) for the simple OM, using options A1, A2 or A3, using for *y* the most recent historical year for which power generation data is available, and using for *m* the power units included in the build margin.

Step 6: Calculate the combined margin (CM) emissions factor
The combined margin (CM) emission factor is calculated based on one of the following methods:
Option A - Weighted Average CM
Option B - Simplified CM

Option A should be used as the preferred option.
Except where the CPA:
a) Is located in a Least Developed Country (LDC) i.e. Lesotho, Mozambique or Zambia, or;
b) In a country with less than 10 registered CDM projects at the date that the CPA is submitted for inclusion in the PoA or;
c) Where the CPA cannot meet the data requirements of *Step 5* above.

Option A – The weighted average CM
The combined margin emission factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

Where:
$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,OM,y}$ = Operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
w_{OM} = Weighting of operating margin emissions factor (%)
w_{BM} = Weighting of build margin emissions factor (%)

The following default values should be used for w_{OM} and w_{BM}:
• Wind and solar power generation project activities: w_{OM} = 0.75 and w_{BM} = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods;

Option B – The simplified CM
The combined margine emission factor is calculated as follows:

Using the equation as specified under Option A
Where:
w_{OM} = 0
w_{BM} = 1

If the simplified CM is used, the OM emission factor $EF_{grid,OM,y}$ must be calculated using the average OM (option (d) in step 3)

2. Baseline Emissions

As per AMS-I.C (v.18) the baseline is determined to be fuel consumption of the technologies used in the absence of the project activity multiplied by an emission factor for the fuel displaced.

Thus the baseline emissions for a single installation are determined to be the rated energy production of the solar thermal unit , adjusted by the efficiency of the equipment used in the baseline and multiplied by the emission factor for the respective fuel used in the baseline.

In the case of on-site, captive, electricity generation the baseline emissions are calculated as:

$$BE_{captelec,y} = \frac{EG_{captelec,PJ,y}}{\eta_{BL,captive\ plant}} * EF_{BL,FF,CO2}$$

Where:

$BE_{captelec,y}$ = The baseline emissions from electricity displaced by the project activity during the year y (tCO2)

$EG_{captelec,\ PJ,\ y}$ = The amount of electricity produced by the project activity during the year y (MWH)

$\eta_{BL,\ captive\ plant}$ = The efficiency of the plant using fossil fuel that would have been used in the absence of the project

$EF_{BL,FF,CO2}$ = The Co2 emission factor of the fossil fuel that would have been used in the baseline plant obtained from reliable local or national data if available otherwise IPCC default emission factors are used (tCO2/MWH)

In the case of on-site heat production from fossil fuels the baseline emissions are calculated as:

$$BE_{thermal,CO2,y} = \frac{EG_{thermal,y}}{\eta_{BL,thermal}} * EF_{FF,CO2}$$

Where:

$BE_{thermal,y}$ = The baseline emissions from heat/steam displaced by the project activity during the year y (tCO2)

$EG_{thermal,\ y}$ = The net quantity of heat/steam supplied by the project activity during the year y (TJ)

$\eta_{BL,thermal}$ = The efficiency of the plant using fossil fuel that would have been used in the absence of the project

$EF_{FF,CO2}$ = The Co2 emission factor of the fossil fuel that would have been used in the baseline plant obtained from reliable local or national data if available otherwise IPCC default emission factors are used (tCO2/TJ)

<u>Solar Water Heaters</u>

In this Programme, the use of an electrical heating system may be displaced by the use of solar energy, in order to provide heat. The unit which captures the solar energy and heats the water is given a rating, defined by national standards, to indicate how much energy is displaced by the use of that unit. The use of this approach to establish equipment performance is stipulated in the General Guidelines to SSC CDM Methodologies (EB58, v15, para.9b).

In the case of Solar Water Heaters this rating is termed a Q-factor and is specified in MJ/day. This rating is determined according to the SANS6211 standard which uses an outdoor test method specifically adjusted for southern African conditions. The Q-factor is equivalent to the amount of electricity that has been displaced and is determined as:

$$Q_{SWH} = \alpha_1 H + \alpha_2 (T_a - T_C) + \alpha_3$$

Where:
Q – heat output (MJ)
α_1 – coefficient (m^2)
H – radiation received by a surface over a specific time interval (MJ/m^2)
α_2 – coefficient (MJ/K)
T_a – average ambient temperature
T_C – incoming water temperature
α_3 – coefficient (MJ)

Every solar water heating model has to undergo testing according to the SANS6211 standard and the alpha coefficients are established in an official report. These coefficients are used on an installation specific basis to determine the energy that was provided by the SWH unit and thus the grid electricity that was subsequently displaced.

The baseline emissions are then determined by summing the Q-factor, which is calculated on a daily basis for the site specific ambient temperature, inlet temperature and solar radiation, across all installations over the monitoring period and multiplying the total energy displaced by the an appropriate grid factor as follows:

$$EG_{thermal,y} = \sum_{i=1}^{N} \sum_{d=1}^{D} \alpha_1 H_d + \alpha_2 \left(T_{ambient_d} - T_{inlet_d}\right) + \alpha_3$$

Where:

d	-	day *d* of the year
i	-	installation *i*
H	-	solar irradiation (MJ/m2)
$T_{ambient}$	-	ambient temperature
T_{inlet}	-	temperature of inlet water
N	-	total units enrolled in CPA
D	-	total days of operation for unit *i* in the monitoring period

Calculation of Enthalpy

The quantity of heat provided by a system shall be determined as:

$$\Delta H = C_p * M * \Delta T$$

Where:
ΔH = heat provided by the system (J) to transfer fluid
C_p = specific heat capacity ($H_2O = 4.2Jg^{-1}K^{-1}$, $EtOH = 2.4Jg^{-1}K^{-1}$) of transfer fluid *p*
M = mass (g) of transfer fluid
ΔT = change in temperature (K) of transfer fluid

3. Project Leakage

Solar units are not transferred from another activity and where existing equipment is replaced either:

- The electric heating capability in the replaced heating equipment will be disabled; or
- A scrapping certificate is obtained form an independent third party salvage company as proof that the replaced equipment has been scrapped; or
- Where the baseline equipment has been replaced with STE equipment under an insurance claim it is assumed that the baseline equipment is unserviceable.

Leakage is thus not considered and the CPA shall identify the most appropriate action to be undertaken in the context of the specific CPA.

4. Project Emissions

Project emissions may occur from the use of electricity to operate project equipment such as compressors and pumps.

Electricity from the operation of back up electrical elements is not considered here since emission reductions are calculated on the actual energy delivered by the solar system and back up elements are only used when the solar system is not in operation. Thus emissions resulting from the backup element are considered to be related to baseline activities.

In the case of a circulating pump, or similar device, connected to a solar water heater, the project emissions are determined by multiplying the total energy consumption of the device, as determined by the manufacturer, by an appropriate emission factor determined above.

In the case of a compressor connected to an air-source heat pump, the project emissions are determined by multiplying the total energy consumption of the device, as determined by the manufacturer, by an appropriate emission factor determined above.

In any case, the Tool to calculate baseline, project and/or leakage emissions from electricity consumption (v1, EB39) is applied as follows:

Project emissions are determined as:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y})$$

Where:

$PE_{EC,y}$ = Project emissions from electricity consumption in year y (tCO_2/yr)

$EC_{PJ,j,y}$ = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)

$TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to source j in year y

j = Sources of electricity consumption in the project

Under Scenario A, electricity consumption from the grid, option A1 is chosen and the grid emission factor is determined as:

$$EF_{EL,j,y} = EF_{grid,CM,y}$$

5. Emission Reductions

$$ER_{EC,y} = BE_{EC,y} - PE_{EC,y}$$

Where:

$ER_{EC,y}$ = Emission reductions from avoided electricity consumption in year *y* (tCO_2/y)

$BE_{EC,y}$ = Baseline emissions from electricity consumption in year *y* (tCO_2/y)

$PE_{EC,y}$ = Project emissions from electricity consumption in year *y* (tCO_2/y)

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)

Data / Parameter:	EFCO2
Data unit:	tCO2e/kWh
Description:	Grid emission factor as determined according to AMS-I.D
Source of data used:	South African grid emission factor
Value applied:	n/a
Justification of the choice of data or description of measurement methods and procedures actually applied :	The grid emission factor will be determined by each CPA according to AMS-I.D using the most appropriate local data sources.
Any comment:	

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

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

Data / Parameter:	**N**
Data unit:	Units
Description:	Number of Operational installations enrolled in the CPA
Source of data to be used:	Coordinating entity database
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	The owner of each unit installed will be required to complete a form which enrols the unit into this program. That form will be captured electronically and stored. The coordinating entity will keep records of each consumer participating in the SSC-CPA.
QA/QC procedures to be applied:	The value of N will be determined by the installations recorded in the database maintained by the coordinating entity and updated at the time of a new installation. The procedures used to update and maintain the database will ensure that the information in the database is accurate, valid and complete and that these assertions can be fully audited.
Any comment:	

Data / Parameter:	$\mathbf{d_i}$
Data unit:	Days
Description:	Number of days that the equipment *i* is operated

Source of data to be used:	• If the emissions reduction per system is less than five tonnes of CO_2e a year; or • In the case of household or commercial applications/systems, whose maximum output capacity is less than 45 kW thermal and where it can be demonstrated that the metering of thermal energy output is not plausible: (i) Recording annually the number of systems operating (evidence of continuing operation, such as on-going rental/lease payments could be a substitute), if necessary using survey methods; (ii) Estimating the annual hours of operation of an average system, if necessary using survey methods. Annual hours of operation can be estimated from total output (e.g. tonnes of grain dried) and output per hour if an accurate value of output per hour is available. Where necessary refer to the General guidelines for sampling and surveys for SSC project activities.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	In the case of a sampling approach, the number of days of operation should be determined as described above. In the case of a single installation, operating days should be determined from the heat supplied per day, or per hour aggregated daily.
QA/QC procedures to be applied:	In the case of a single installation, a plant logbook should be kept and the days of operation recorded. This will be used to cross check this value.
Any comment:	n/a

Data / Parameter:	$EG_{capelec,PJ,y}$
Data unit:	(MWh/yr)
Description:	Quantity of electricity generated or supplied by the project in year *y*
Source of data to be used:	The CPA should measure the quantity of electricity generated using an electricity meter calibrated according to manufacturer's recommendations and the relevant paragraphs of General guidelines to SSC CDM methodologies.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	The measurement of electricity generated should be continuously monitored, integrated hourly and recorded, at least, monthly.
QA/QC procedures to be applied:	In the case of a single site weekly meter readings should be recorded in a plant logbook. These values will be cross checked against the monitored value.

	The calibration cycle stipulated by the manufacturer of the equipment shall be observed.
Any comment:	In case the project activity is exporting electricity to other facilities, the metering shall be carried out at the recipient's end and measurement results shall be cross checked with records for sold/purchased electricity (e.g. invoices/receipts). Metering the energy produced by a sample of the systems is acceptable where the simplified baseline is based on the energy produced multiplied by an emission coefficient.

Data / Parameter:	$Q_{air,y}$
Data unit:	Nm^3/hr
Description:	Quantity of hot air
Source of data to be used:	The CPA should measure the quantity of hot air supplied using a meter calibrated according to manufacturer's recommendations and the relevant paragraphs of General guidelines to SSC CDM methodologies.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	The measurement of hot air supplied should be continuously monitored, integrated hourly and recorded, at least, monthly. Where it is not feasible (e.g. because of too high temperature), spot measurements can be used through sampling with a 90% confidence level and a 10% precision.
QA/QC procedures to be applied:	In the case of a single site weekly meter readings should be recorded in a plant logbook. These values will be cross checked against the monitored value. The calibration cycle stipulated by the manufacturer of the equipment shall be observed.
Any comment:	In case the project activity is exporting hot air to other facilities, the metering shall be carried out at the recipient's end and measurement results shall be cross checked with records for sold/purchased heat (e.g. invoices/receipts). Metering the energy produced by a sample of the systems is acceptable where the simplified baseline is based on the energy produced multiplied by an emission coefficient.

Data / Parameter:	$Q_{steam,y}$
Data unit:	Nm^3/hr
Description:	Quantity of steam
Source of data to be used:	The CPA should measure the quantity of steam supplied using a meter calibrated according to manufacturer's recommendations and the relevant paragraphs of General guidelines to SSC CDM methodologies.

Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	The measurement of steam supplied should be continuously monitored, integrated hourly and recorded, at least, monthly. Where it is not feasible (e.g. because of too high temperature), spot measurements can be used through sampling with a 90% confidence level and a 10% precision.
QA/QC procedures to be applied:	In the case of a single site weekly meter readings should be recorded in a plant logbook. These values will be cross checked against the monitored value. The calibration cycle stipulated by the manufacturer of the equipment shall be observed.
Any comment:	In case the project activity is exporting heat to other facilities, the metering shall be carried out at the recipient's end and measurement results shall be cross checked with records for sold/purchased heat (e.g. invoices/receipts). Metering the energy produced by a sample of the systems is acceptable where the simplified baseline is based on the energy produced multiplied by an emission coefficient.

Data / Parameter:	$EG_{thermal,y}$
Data unit:	TJ
Description:	Net quantity of thermal energy supplied by the project activity during year *y*
Source of data to be used:	The CPA should monitor the quantity of energy supplied continuously and aggregate annually.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	Heat generation is determined as the difference of the enthalpy of the steam or hot fluid and/or gases generated by the heat generation equipment and the sum of the enthalpies of the feed-fluid and/or gases blow-down and any condensate returns. The respective enthalpies should be determined based on the mass (or volume) flows, the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure. In case of equipment that produces hot water/oil this is expressed as difference in the enthalpy between the hot water/oil supplied to and returned by the plant. In case of equipment that produces hot gases or combustion gases, this is expressed as difference in the enthalpy between the hot gas produced and all streams supplied to the plant. The enthalpy of all relevant streams shall be

	determined based on the monitored mass flow, temperature, pressure, density and specific heat of the gas.
QA/QC procedures to be applied:	In the case of a single site this parameter should be recorded weekly in a plant logbook. These values will be cross checked against the monitored value. In the case of multiple sites the monitored values should be crosschecked against the stipulated equipment performance on an annual basis. The calibration cycle stipulated by the manufacturer of the equipment shall be observed.
Any comment:	In case the project activity is exporting electricity to other facilities, the metering shall be carried out at the recipient's end and measurement results shall be cross checked with records for sold/purchased electricity (e.g. invoices/receipts). Metering the energy produced by a sample of the systems is acceptable where the simplified baseline is based on the energy produced multiplied by an emission coefficient.

Data / Parameter:	T
Data unit:	°C
Description:	Temperature
Source of data to be used:	The CPA should measure the temperature using a meter calibrated according to manufacturer's recommendations and the relevant paragraphs of General guidelines to SSC CDM methodologies.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	The measurement of temperature should be sampled hourly and recorded, at least, monthly.
QA/QC procedures to be applied:	In the case of a single site weekly meter readings should be recorded in a plant logbook. These values will be cross checked against the monitored value. The calibration cycle stipulated by the manufacturer of the equipment shall be observed.
Any comment:	Metering the temperature by a sample of the systems is acceptable where the simplified baseline is based on the energy produced multiplied by an emission coefficient.

Data / Parameter:	P
Data unit:	Kg/cm^2
Description:	Pressure

Source of data to be used:	The CPA should measure the pressure using a meter calibrated according to manufacturer's recommendations and the relevant paragraphs of General guidelines to SSC CDM methodologies.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	The measurement of temperature should be sampled hourly and recorded, at least, monthly.
QA/QC procedures to be applied:	In the case of a single site weekly meter readings should be recorded in a plant logbook. These values will be cross checked against the monitored value. The calibration cycle stipulated by the manufacturer of the equipment shall be observed.
Any comment:	Metering the pressure by a sample of the systems is acceptable where the simplified baseline is based on the energy produced multiplied by an emission coefficient.

Data / Parameter:	$EC_{pj,j,y}$
Data unit:	(MWh/yr)
Description:	Quantity of electricity consumed by the project electricity consumption source j in year y
Source of data to be used:	The coordinating entity will perform monitoring procedures as per the monitoring plan to determine the electricity consumed by the project equipment
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	The use of electricity will be determined by a third party test, on a model basis, according to appropriate national standards or measured directly using an appropriately calibrated meter.
QA/QC procedures to be applied:	In the case of a sample-based survey will be conducted on an annual basis to verify the quantity of electricity consumed in the monitoring period. Appropriately calibrated instruments will be used for monitoring. Monitored values to be cross checked with manufacturers specifications. The calibration cycle stipulated by the manufacturer of the equipment shall be observed.
Any comment:	

Data / Parameter:	C_p
Data unit:	$(J.g^{-}1.K^{-1})$
Description:	Specific heat capacity of transfer fluid *p*
Source of data to be used:	Suppliers material datasheet
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	Determined by 3rd party tests
QA/QC procedures to be applied:	n/a
Any comment:	

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

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Monitoring Approach

The monitoring approach is adapted to suit the particular technology that is used in the CPA. Three specific technologies are discussed below as the CME believes these technologies will make up the bulk of the CPAs under the PoA:

- Solar water heaters;
- Heat pumps;
- Concentrated solar plants.

In the case of a specific Solar Thermal Technology, or an installation of such a technology, that cannot be adequately monitored as described below, the CPA will implement a monitoring systems that adheres to the requirements of the CDM. The basic monitoring premise that must be adhered to by all CPA regardless of technology, is that energy generated by the project is calculated as the change in enthalpy between the substance/material when it enters the system and when it leaves the system.

At a minimum the following parameters will be monitored directly or on a sampling basis:

- Net thermal energy supplied to the user;
- Internal electricity consumption in the production of thermal energy;
- Project emissions as a result of the production of energy by a solar thermal plant/device;
- Leakage emissions as a result of the production of energy by a solar thermal plant/device;
- Net emission reductions achieved.

<u>Solar water heaters</u>

A CPA of solar water heaters may be installed at multiple locations such a home or at a single location such as a shopping mall. Figure 2 illustrates how the appropriate monitoring approach is chosen for a particular CPA. In the case of multiple installations a remote sensing monitoring approach is used whereby daily field data is used to model performance of the equipment. Where a CPA comprises a single installation direct monitoring of the equipment performance is required.

Multiple Sites: This PoA has adopted a monitoring approach that utilises the rated equipment performance to determine the emission reductions achieved by the installation of the solar thermal devices where these devices have been installed at multiple, dispersed, locations. As the Methodology does not stipulate the equipment performance for solar water heaters (SWH) the PoA will utilise the values determined according to the appropriate national standard[21].

This value for energy supplied to the user ($\mathbf{EG_{swh}}$), as determined by a third party according to an appropriate national standard, and is adjusted according to the installation parameters to ensure the relevant circumstances are accounted for, using the coefficients determined during the 3rd party tests. The installation parameters include:

A. Inlet water temperature

B. Ambient temperature

C. Solar radiation

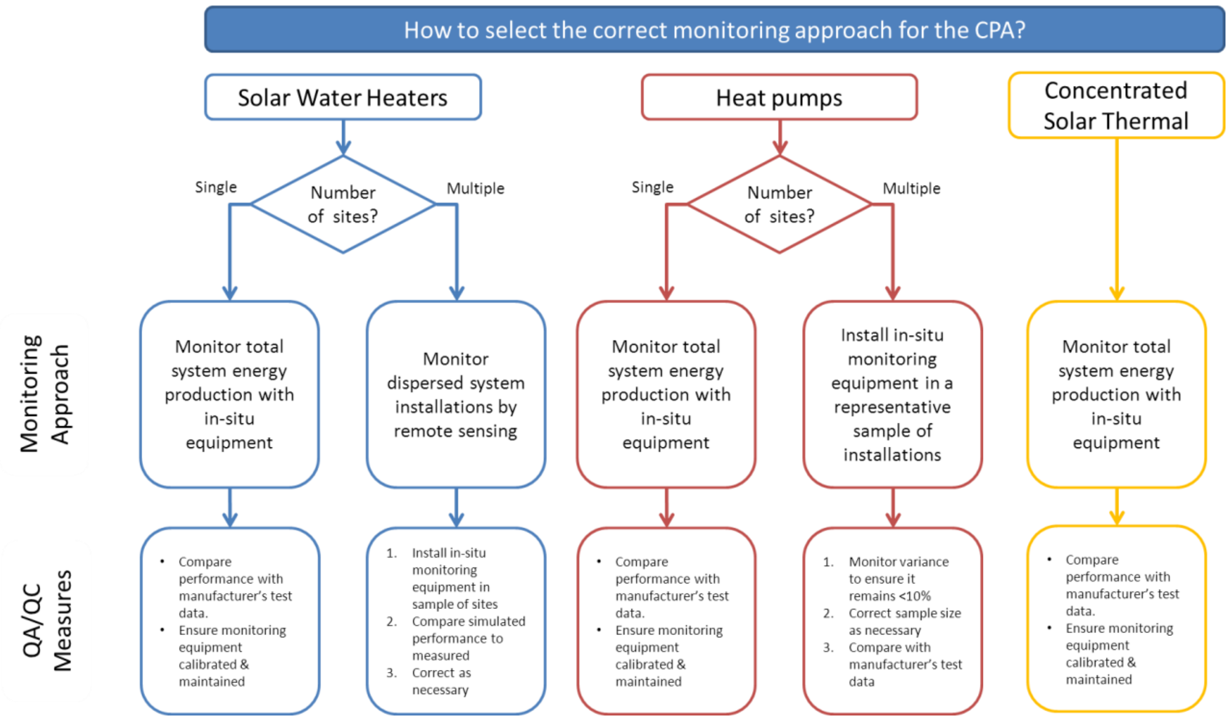

Figure 2: Flowchart used to select the appropriate monitoring approach for a Solar Thermal Energy CPA

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[21] General Guidelines to SSC CDM Methodologies v15, para 9.

The resulting Q-factor is then summed over the number of Operating days in the year and summed across all installations to obtain the total energy obtained from the installed units. From these data the total thermal energy produced can be determined. In this way the emission reductions achieved by the CPA are determined from an empirical model which was determined using an internationally recognised method applied by a third party verification institute.

Since these units typically cannot supply all of the energy required for heating at the installation it is assumed that all of the energy supplied by these units is used. To substantiate this, one can consider these units as low-cost must run 'power' units since the initial investment is only repaid if the unit is used instead of grid electricity, and thus there is a financial imperative to use energy from these units first. Furthermore quality assurance measures are undertaken to monitor this assumption and are discussed below.

Single Site: The energy supplied by the total system is monitored using in-situ monitoring equipment. The following parameters are monitored:

- Inlet water temperature
- Outlet water temperature
- Volume of hot water consumed

Heat Pump

Heat pumps utilise a modified Rankine cycle to extract energy from air or water and transfer it to another substance. The mechanism is very similar to that used in refrigerators and air conditioners. Because the Rankine cycle uses the compression and expansion of gases to store & release energy an electric compressor is needed and therefore some electricity is used.

Whilst the energy provided by the heat pump is usually about 3 times the energy consumed, the emission from electricity consumed should be offset against the emission reductions from electricity saved. It is therefore necessary to monitor the energy consumed and supplied by the system.

Multiple Sites: A monitoring sample is selected as described below. In those installations admitted to the sample group the following parameters are monitored:

- Inlet water temperature
- Outlet water temperature
- Volume of hot water consumed
- Electricity consumed by the heat pump

Single Site: In CPAs consisting of a single installation the following parameters are monitored:

- Inlet water temperature
- Outlet water temperature
- Volume of hot water consumed
- Electricity consumed by the heat pump

Concentrated Solar Energy

Concentrated solar plants utilise a trough or tower design to focus the incoming solar radiation onto a small surface area. This system acts to amplify the energy density and much higher temperatures are available. This energy is typically used to heat a transfer fluid which may be used to create process steam, preheat substances or generate electricity.

Single Site or multiple sites: In CPAs consisting of CSPs the following parameters are monitored:

- Starting/return transfer fluid temperature
- Outlet/heat exchanger transfer fluid temperature
- Hours of operation
- Mass of transfer fluid supplied

Quality Assurance

The quality assurance system is described according to the equipment that is deployed in the CPA and the nature of the CPA i.e. single versus many installations. A quality assurance report shall be compiled at least once during each verification cycle.

Solar water heater

Multiple Sites: In order to ensure the quality of the emission reductions claimed during any monitoring period a sample based survey is conducted to allow the verifier to benchmark the parameters used in the model against empirical data. During the survey monitoring data is gathered and the total energy supplied by a unit is determined using the same approach as the relevant national standard, described previously. This is compared with the value obtained from the model for the same unit. The following table contains all the parameters that are monitored for each installation of a specific technology in the sample group:

Parameter	**Unit**	**Frequency of recording**	**Note**
Unique Identifier	Barcode/Serial Number	Once-off	Initially recorded at installation, verified annually by sample-based survey
Location	DD.dddddd	Annual	Initially recorded at installation, verified annually by sample-based survey
Inlet Water Temperature	Degrees Celcius	Hourly	Monitored annually by sample-based survey (Used only to calculate energy supplied)
Model Installed		Annual	Initially recorded at installation, verified annually by sample-based survey
Rated Q-Factor	MJ/day @ specified standard radiation level	Once-off	Initially determined by 3rd party according to national standard
Volume	Litres	Daily	Monitored annually by sample-based survey (Used only to calculate energy supplied)
Outlet Water Temp	Degrees Celcius	Hourly	Monitored annually by sample-based survey (Used only to

			calculate energy supplied)
Days in Operation		Annual	Verified annually by sample-based survey
Electrical Energy Consumption	MWh	Daily	Monitored annually by sample-based survey (Used only to calculate energy supplied)

Single Site: Performance of the equipment shall be compared to manufacturers test data. Monitoring equipment will be maintained and calibrated according to manufacturer's specifications. An on-site logbook should be kept detailing equipment performance on a regular basis.

<u>Heat Pump</u>

Multiple Sites: Performance of the equipment shall be compared to manufacturers test data and monitoring equipment deployed to the sample group installations will be maintained and calibrated according to manufacturer's specifications. The variance from the sample group should be monitored to ensure it remains within the limits of the sampling plan.

Single Site: Performance of the equipment shall be compared to manufacturers test data. Monitoring equipment will be maintained and calibrated according to manufacturer's specifications. An on-site logbook should be kept detailing equipment performance on a regular basis.

<u>Concentrated Solar Energy</u>

Single Site or Multiple Sites: Performance of the equipment shall be compared to manufacturers test data. Monitoring equipment will be maintained and calibrated according to manufacturer's specifications. An on-site logbook should be kept detailing equipment performance on a regular basis.

Data Management

The coordinating entity will maintain a database containing information that can be attributed to each individual CPA and the PoA as a whole. The information maintained will include:

- A list of entities participating in each CPA including name, address and contact details and unique identifier;
- Name, contact details and registration particulars for each installer responsible for the installation of SWH included in the CPA;
- Records of all visits made to installations in respect to the programme and activities of the CME;
- Proof in the form of the necessary SABS or equivalent certification that equipment enrolled in the programme has been certified by the appropriate body;
- Solar radiation data for all installations
- Ambient temperature data for all installations
- Inlet water temperature data for all installations
- Results of monitoring activities from monitoring sample

The data included in the database will be sourced from documents completed by installers, manufacturers / agents, intermediaries and end-users as well as CME management and monitoring activities. These data will be reviewed to ensure completeness, validity and accuracy. No units will be included in the PoA unless all required documentation has been completed correctly.

For each monitoring period the coordinating entity will produce a monitoring report for the DOE to verify the information related to the emission reductions contained in the CPA. PoA record keeping procedures will prevent double counting across CPAs. These procedures will include cross checking of unique identifiers on enrolled equipment throughout the database to ensure that the equipment has not been included more than once in the database.

The CME will ensure that a manufacturers' stipulated calibration cycle is observed for all monitoring equipment employed in a CPA and the CPA will supply the CME with all relevant certificates and test reports.

Verification of each CPA will occur at the end of each monitoring period. Appropriate record keeping procedures will be implemented to ensure that each monitoring period data set can be transparently attributed to its corresponding CPA, preventing any occurrences of double counting. An audit of the project database, conducted by the DOE, will be able to determine the current status of each CPA – the duration of previous monitoring periods, the households and sample groups delivering monitoring data, and current verification activities.

Monitoring of a Sample

The PoA uses a monitoring approach of stratified random sampling to measure the quantity of fossil-fuel generated electricity that is displaced by the installation of the STE systems. A directly monitored sample of each CPA to verify the emission reductions as a result of the installations will be monitored using correctly calibrated energy meters on a continuous basis with hourly measurement and daily recording.

The target population is all installations enrolled in the CPA and the sample measurements will be the quantity of net energy displaced per annum by the installed STE systems within the CPA.

<u>Sample Frame</u>
The sampling frame will include a complete list of installations in the CPA as well as the information needed to implement the monitoring plan which is listed in section A.4.4.1 as part of the operational and management plan record keeping requirements for a CPA. The necessary information to implement the metering equipment will thus be available from each CPA via this data source as well as from the primary database maintained by the CME.

<u>Sampling Precision</u>
The sample size for each CPA population will be determined so as to achieve a 90% confidence interval with 10 per cent error margin for the collected data, with a minimum sample size of 50 in each climatic zone. The actual size of the sample will be determined for each CPA individually to achieve the above precision target and will be justified accordingly based on the specific characteristics of the particular CPA population. The expected variance of the population will be estimated ex-ante for each CPA (and their associated strata) but is expected to be low. The expected variance of the CPA will be adjusted ex-post the first monitoring and verification cycle, based on the actual variance observed in the sample from the CPA.

Where CPAs overlay each other geographically, the sample data from the first CPA established in the area may be used to verify the emission reductions of any secondary CPAs in addition to further sampling within the overlaying CPA. The size of the sample in this case will be determined according to the variance in the measured energy produced by the installations in the original CPA sample. Therefore, if the original CPA sample represents a statistically acceptable proxy for the energy generated by the STE system within that climatic zone, a smaller sample will be selected for any secondary CPAs within the same climatic zone to verify the emission reductions.

Stratified Random Sampling
Each CPA's sample will be stratified into an appropriate number of strata based on the primary grouping variables which are the model and climatic zone in which it is installed. Each system installed will ONLY be assigned to one strata as classified first by the location of the installation and second by the model. This will be documented by the CME to ensure that each stratum is mutually exclusive from the other strata and that the strata are collectively exhaustive with no CPA population element excluded.

As a further check, the CME will ensure that each systems serial number within a CPA is assigned to a corresponding sample stratum. The sampled installations will be drawn at random from the sample frame which will include a complete list of installations in the target population as well as the information needed to implement the metering.

Sample Method
The quantity of energy displaced will be directly physically measured and monitored by installing an appropriately calibrated energy metering system at the boundary of the sample installations. The nature of equipment used in the CPA will determine the specifics of the metering equipment used but it will be the responsibility of the CME to ensure it is correctly calibrated. The complete list of installations in the sample frame and their geographic locations will be used to implement the meters at randomly selected installations and to allocate installations into their appropriate stratum within a CPA.

The system will measure the energy output of the system and record the total amount of energy used on a daily basis over the monitoring period. This data will then be transmitted to the central database of the CME for calculation of the emission reductions of the CPA. The energy produced from the STE system represents the energy displaced by the installation that would have been generated by a fossil fuel source in the baseline scenario. Therefore the CPA emission reductions can be verified by directly monitoring a sample of the STE installations within the CPA and the energy drawn from them.

Procedures for administering data collection & minimizing non-sampling errors
Installers who are contracted to install the STE systems by a CPA will be trained in collecting all the necessary data parameters required from an installation. In addition, random checks will be carried out to verify that the information collected at installation is accurate. These checks will be detailed by each CPA but may include:

i. contacting the home-owner to check the system is installed at the specified location,
ii. random site visits to the specified location to check the system is installed properly and in operation,
iii. random site visits to verify the size of the installation and the rated capacity of the system
iv. contacting the home-owner or a random site inspection to confirm the baseline electricity supply scenario.

These checks will minimize any non-sampling measurement errors

Monitoring the Operational Usage of installed SWHs

In terms of methodology ***AMS I.C. Thermal energy production with or without electricity (version 18)*** the CME has selected **option C** where a CPA consists of installations that result in less than 5tCO_2e in emission reductions per year each.

Option C prescribes:

If the emissions reduction per system is less than 5 tonnes of CO_2e a year:
(i) Recording annually the number of systems operating (evidence of continuing operation, such as on-going rental/lease payments could be a substitute), if necessary using survey methods;
(ii) Estimating the annual hours of operation of an average system, if necessary using survey methods. Annual hours of operation can be estimated from total output (e.g., tonnes of grain dried) and output per hour if an accurate value of output per hour is available.

As indicated above the coordinating entity will select a representative sample for quality assurance purposes. The transmission of data by the monitoring equipment to the coordinating entity will be sufficient proof that the system is in continued operation. If no monitoring equipment is installed then the coordinating entity will confirm that the unit has been in continued operation either telephonically or by way of physical inspection on a sample basis.

Where a CPA consists a single, or multiple, installation(s) that reduce in excess of 5tCO_2e/a, the days of operation shall be recorded on site.

Monitoring of the Scrapping of Existing Electric Geysers
STE equipment is not transferred from another activity and where existing equipment is replaced either:
- the heating capability in the replaced equipment will be disabled and attested to by the installer; or
- a scrapping certificate is obtained form an independent third party salvage company as proof that the replaced equipment has been scrapped; or
- where the baseline equipment has been replaced with STE equipment under an insurance claim it is assumed that the baseline equipment is unserviceable.

The CPA shall identify the most appropriate method for monitoring the scrapping of existing electric geysers in the context of the specific 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)

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The baseline study and monitoring methodology were completed on 8 July 2011 by

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Annex 1

CONTACT INFORMATION ON COORDINATING/MANAGING ENTITY and PARTICIPANTS IN THE PROGRAMME of ACTIVITIES

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Annex 3

BASELINE INFORMATION

Annex 4

MONITORING INFORMATION

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